FROM STAPLES TRAP TO CARBON TRAP: CANADA'S PECULIAR FORM OF CARBON LOCK-IN

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> A new country, especially Canada...must attack with all the skill and industry she can command the task of working out a theory adapted to the situation in which she is able to defend herself against exploitation, against the drawing off of her large resources and against the violent fluctuations which are characteristic of exploitation without afterthought. Not only will such a policy serve as a protection to Canada, but it will also serve eventually as a protection against over [ ] industrialism in the highly industrialized countries.
>
> Harold Innis[1]

> There is no minister of the environment on Earth who can stop (the oil sands) from going forward, because there is too much money in it.
>
> Former Environment Minister Stéphane Dion[2]

This paper employs staples political economy to understand the extent of Canada's carbon dependence and introduces a framework to explore Canadian transition pathways towards a low carbon economy. With the boom in the oil sands, the staples trap has gained new relevance. Canada's exploitation of a carbon-intensive staple occurs while global actors struggle to shift towards a green energy paradigm that will produce a series of structural changes in technological and socioinstitutional systems to radically reduce greenhouse gas (GHG) emissions. At this historic moment, the emerging staples trap is also a carbon trap that locks Canada into a dominant development trajectory dependent on increasing global demand for unconventional oil—a trap that suppresses efforts to promote sociotechnical changes consistent with a green energy future. Canadian climate strategies

must consider the implications of this pattern of lock-in.

Harold Innis strove to build an economic theory suited to Canadian needs,[3] and this paper adapts Innisian political economy to outline an approach to climate policy that is rooted in Canada's history, ecological context, and economic structure. This paper discusses the historic basis of Canada's climate policy pitfalls and argues that different policy approaches are required to initiate low-carbon energy transitions.

In order to outline a new climate policy approach, the paper commences with a review of the influence of staple resources on Canadian development patterns and theories of political economy. The second section develops an analytical approach to explore low-carbon transitions in the Canadian context. The third section applies this approach by surveying the institutional and technological implications of the exploitation of Canada's bitumen staple against the backdrop of the potential emergence of a green energy paradigm. The fourth section explores implications for Canadian climate and industrial strategies.

Innis, Staples, and Canadian Development Pathways Harold Innis (1894–1952) was a pioneer in the study of Canada and its relationship to the wider world. He was the head of the University of Toronto's Department of Political Economy and Dean of its Graduate School.[4] He was the founder of a political economy tradition that builds its theories of development and policy approaches from the exploration of problems peculiar to Canadian experience. This section reviews the evolution of this tradition over time.

Innis explored the connections between resource staples and Canadian social and technological evolutions. He connected the early cod fisheries, and their transport system and preservation techniques, to decentralized political formations. The fur trade's inland expansion via canoe, York Boat, and steamship facilitated centralized organization and traced Canada's geographic boundaries. The timber staple brought canals, immigration, and political union of the central Canadian colonies. Wheat development was linked to railroads, Confederation, and western settlement. In the twentieth century, the mineral, oil, and hydroelectric staples expanded development towards the Precambrian Shield and the Western Sedimentary Basin—contributing

to a more regionally based political economic configuration.[5] Later, the link between the pulp and paper staple and the media technology of the newspaper guided Innis towards studying the role of communications and cultural bias on the rise and fall of empires, until his untimely death.[6]

The discrepancy between the "centre" and the "margin" is at the core of Innis's descriptions of history. Canada's historic position has been one on the margin of the leading sites of global industrialism and innovation, the "centre" economies of the United Kingdom and the United States. For Innis, the study of Canada demanded consideration of not only the nation's domestic situation, but its relation with the dynamics of the international economy as well. The margin teaches lessons about the centre and vice versa. As Innis stated, "the study of the Canadian economy becomes of crucial significance not only within Canada but without. In a sense the economies of frontier countries are storm centres of the modern international economy."[7]

Innis discussed Canadian staples alongside developments in global technoeconomic systems. He linked cod to the search for precious metals under mercantilism, and fur to the early rise of commercial trade in Britain with an emphasis on luxury and fashion. Innis used Lewis Mumford's typology of technological systems to describe "paleotechnic" industrialism using steam, rail, coal, and iron, and demanding timber and wheat from Canada in the nineteenth century, and "neotechnic" industrialism demanding new minerals, oil, electricity, and pulp and paper from Canada in the early twentieth century.[8]

Innis emphasized not only the match between Canadian staples and global technoeconomic systems, but also the mismatch between the ebb and flow of global economic evolutions and Canadian development. He described the geographic expansion of the price system to the shores and interiors of the margin.[9] The centre's demand for Canada's staples was most significant during global phases of mass expansion and diffusion. When Canada eventually fell under the pull of new economic waves, they triggered a period of rapid staple exploitation and importation of capital and technology, which Innis described as cyclonic in character.[10]

The margin experienced booms, busts, and constant vulnerability.[11]

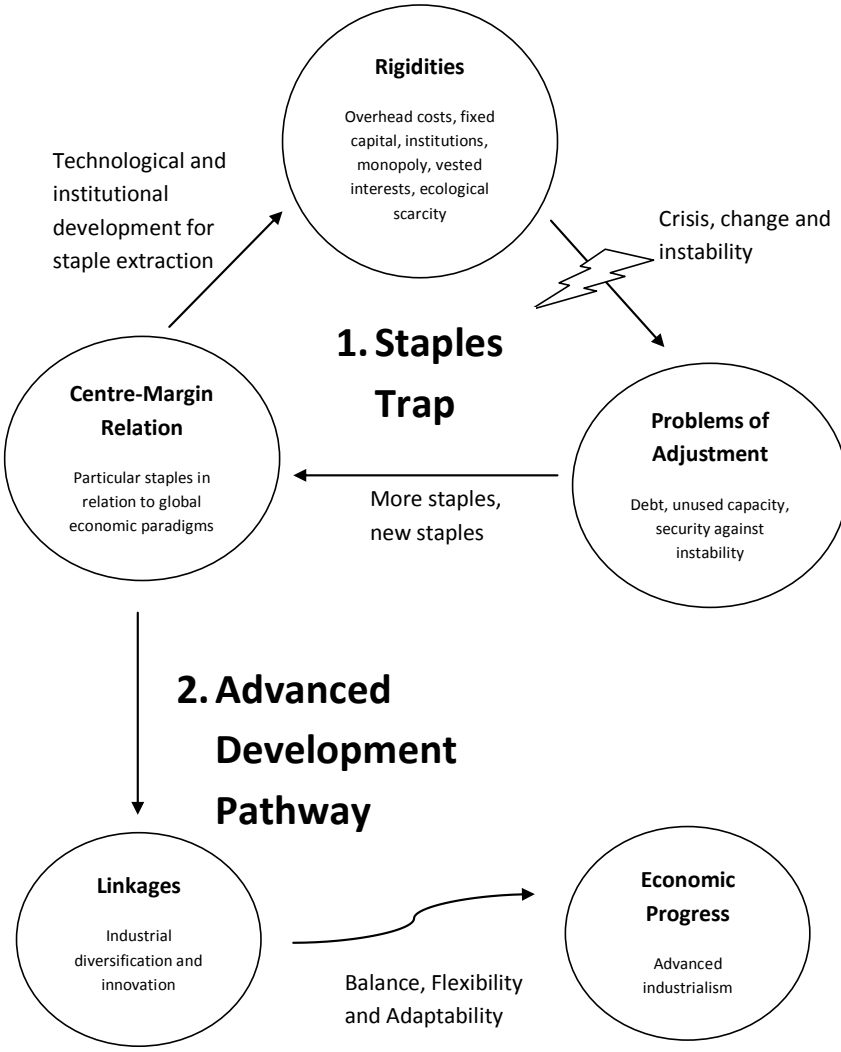
Inelastic global demand produced price instability, and communication lags created supply/demand mismatch. Transformations within the centre disrupted staple trade strategies and threatened to strand the heavy investments made in transportation infrastructure (e.g., canals, railroads).[12] Centralized organizations, monopolies, and government nationalization were the institutional adaptations Canada made to cope.[13]

Innis never articulated a general theory. It was Watkins,[14] Drache,[15] and Neill[16] who undertook to derive an Innisian, or staples-based, theory of Canadian economic development. Figure 1 uses their contributions to provide a new synthesis, by sketching two ideal-type development pathways. Both paths originate from the historic centre-margin relation, where Canada exports staples to a centre defining the pace and characteristics of a phase of global economic development.

In the staples trap, the centre-margin relationship generates a series of self-reinforcing rigidities. They can include the large overhead costs that have resulted throughout Canadian history from the need to install infrastructure with fixed costs. Staples development required the extension of transportation networks over wide areas in short spans of time. Fur traders needed to maintain military protection and alliances with Aboriginal populations. Rigidities can be organizational (centralized organization) and political (vested interests). The concept can also include intellectual rigidities such as ill-suited theory,[17] the "monopolies of knowledge" discussed in Innis's communication studies,[18] and the "inhibiting export mentality" mentioned by Watkins.[19]

Staples theories have seldom highlighted that Innis's conception of rigidities also included nature's incapacity to accommodate human sociotechnical changes. In *The Fur Trade*, Innis said the beaver's "non-migratory tendencies and elaborate housing facilities made destruction certain. In the language of the economists, the heavy fixed capital of the beaver became a serious handicap."[20] Human-ecological mismatches were repeated in subsequent periods with the wastage of timber and soil exhaustion through "wheat mining."[21] The ecological rigidities increased the overhead costs of extraction by driving exploitation farther inland, demonstrating feedback between ecological, technical, and institutional rigidities.

Figure 1. Staple Development Pathways



These rigidities made the margin vulnerable to the recurrent instabilities inherent in staple export markets, and to the deeper and more disruptive impacts of new technological systems emanating from the centre. During these periods, Canada faced adjustment problems. The capacity installed went unused and the overhead costs incurred produced debts. Vested interests sought shelter in government protection and attempted to secure or construct trade preferences and monopolies. They resisted the installation of new technological systems, or attempted to find bridges from old forms of staple growth towards new ones.[22]

When crisis and change disrupt the old centre-margin relationship, the margin most eagerly seeks new connections with a centre to solve its internal problems. It must fill the unused capacity, pay off the debts, and assuage its vested interests. It exploits more staples, often the different types of staples that the centres of the global economy demand, to enable new phases of growth. As noted by Drache, the pattern of development on the margin contrasts with areas that react to crisis by consolidating and renewing their economies.[23] The heavy burden of adjustment causes the margin to rekindle its position within the world economy based on the export of staples and the importation of new technologies from elsewhere.

The staples trap describes the circular pattern behind Canada's historic tendency towards resource lock-in and truncated technological development. The lagged absorption of marginal areas into new technological systems strengthens the rigidities installed and the amplitude of the problems of adjustment in the face of global economic change. An economy caught in the staples trap finds that it lacks the capacities to play the role of advanced innovator in new economic systems. It opts to provide the inputs for those regions that do play this role.

Figure 1 also outlines a second "advanced development pathway" that escapes the staples trap. Watkins outlined how the exploitation of a series of forward, backward, and final demand linkages from the staple base could spin off new industries until "the point where the appellations 'staple economy' will no longer suffice."[24] Industrial diversification gives the economy the "capacity to shift attention to new foreign or domestic markets" during periods of adjustment.[25]

The mid twentieth century brought signs that parts of the Canadian economy were following this more advanced development pathway. Canada built industrial capacity during the world wars and the more flexible and mobile energy resources of the "neotechnic" period introduced industrial opportunities to new areas of the global economy.[26] Canada exploited forward linkages from hydroelectric and forest resources, moving a step up the value chain to produce aluminum and pulp and paper.

However, the twentieth century also introduced new phenomena, new problems, and subsequent theoretical developments concerning the juxtaposition between advanced development and staples trap biases in Canada. The twentieth century increased regionalism. Unlike the fur and wheat staples that tied the economy together through east-west trade, the new form of industrialism and the new staples (i.e., hydro, minerals, oil and gas, pulp and paper) depended upon north-south trade between the United States and Canada's regional economies. Innis described how this put new strains on Canada's political structure.[27] The "Hinterland School" highlighted the discrepancies between the western regions and the industrial heartland in Central Canada and the rise of protest movements,[28] and Pratt and Richards went on to examine the role of western provinces in stimulating staple-linkages.[29]

Drache adds regional segmentation as a factor in the maintenance of the staples trap because of the "inability to develop strong national systems of market institutions."[30] Resource and industrial strategies fail to complement one another. Profits from resource booms are not invested in advanced industries, and the advanced sectors that do exist are not responsive to national development needs and fail to quell the problems of adjustment within resource regions facing crisis.[31]

In the twentieth century, Kari Levitt's *Silent Surrender*,[32] and the Gordon[33] and Watkins[34] reports warned that foreign ownership left Canada vulnerable to US policy decisions and hampered domestic innovation. While Canada joined the league of rich industrialized nations, Levitt suggested that Canada's form of branch-plant industrialism exhibited a recurring pattern of technological dependence and staples bias. She argued that Canada was still stuck in a centre-margin relation where it needed to beg and barter,

this time with the new empire of America, to accept staples exports and to locate manufacturing within its borders.

The problem of truncated industrialization highlighted the need to consider how Canada's staples history shaped its form of entrepreneurship. Easterbrook made this connection. He explained that the development of the Canadian frontier in "one swoop" required large overhead costs and resource-based development that suffered from persistent uncertainties and fluctuations. Canada developed a pattern of entrepreneurship that was defensive, security minded, and reliant on the centralized government bureaucracies for protection and permanence.[35]

Similarly, Naylor's study traced the retardation of an industrial form of entrepreneurship focused on production, innovation, and the rise of a mercantile-financial form focused on earning rents from exchange and distribution in industries such as banking, finance, railways, and utilities. Rather than risking capital in industrial pursuits, Naylor said Canadian capitalists financed the quick extraction of staples and sought rents by taking advantage of tariff policies, transportation rates, and price differentials resulting from scarcities of raw materials and goods. Naylor explains how the dominance of the commercial orientation made Canada's capitalist class subordinate to industrial capital located in the centre of the global economy. When the global economy changed, Canadian capital had to search for "new dependencies" or new centre-margin relations.

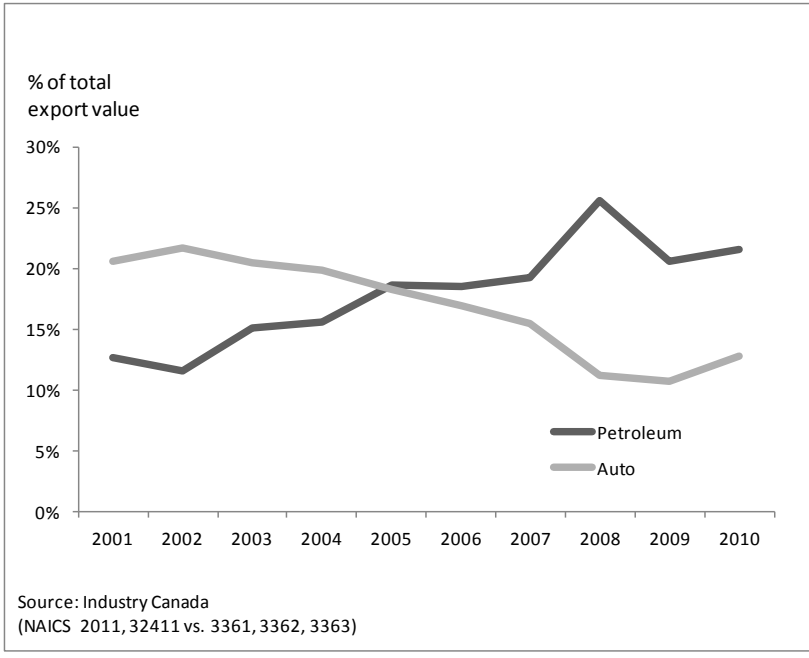
The economic crises of the 1970s triggered new debates.[36] Mahon contributed to staples theory by emphasizing the role of the state in forging compromises between the still dominant "staples fraction" and an emergent nationalist industrial class.[37] The latter group advocated interventionist industrial policies that would restrict foreign ownership and technology imports and increase domestic technological development capacity.[38] Staples interests supported freer trade to secure access to American markets. They argued that market pressure would increase manufacturing efficiencies and economies of scale, a policy that political economists argued would exacerbate Canada's staples bias.[39] In 1985, the Macdonald Commission endorsed free trade, in part due to its finding that Canada's institutions were ill adapted to the implementation of an activist industrial policy. The

challenges of implementing a national industrial policy in a decentralized "weak state" pushed such initiatives onto the provinces.[40]

Jim Stanford suggests that Canada reduced its staples bias significantly in the latter part of the twentieth century. He points to the rising share of manufacturing in Canadian exports and decreases in foreign direct investment as a share of gross domestic product, largely due to the Auto Pact and a low exchange rate.[41] Yet Canada did not fully exhibit the pattern of innovation and dynamic flexibility indicative of an advanced form of development. Industry ran high tech trade deficits and made low investments in research and development, worker training, machinery, and equipment.[42]

In the first decade of the twentieth century, Canada experienced what a Statistics Canada report calls "the longest and strongest cycle for resources in postwar history."[43] A variety of resource sectors boomed, but petroleum gained significant dominance. Petroleum exports climbed to switch places with auto as the leading export industry (Figure 2).

Figure 2. Petroleum vs. Auto Industry Exports



Now, Stanford has revived the notion of the staple trap, this time arguing that it is akin to "Dutch disease" due to an appreciating petro-dollar crowding out the manufacturing sector.[44] Mel Watkins has stated that the boom in the oil sector "may cast Canada as firmly into the staples trap as the fur trade did for New France."[45]

Low-Carbon Transitions and the Staples Approach Today The previous section's historical and theoretical overview demonstrates a pattern of both change and continuity in Canadian development. While Canada has industrialized, the circular pattern of the staples trap has never lost its relevance. The core features of the dynamic have remained, including a truncated capacity for industrial innovation, sharply different regional impacts, and dependence on core countries for capital and markets. Yet the extent, form, and consequences of Canada's staples traps have differed across time and geography, requiring Canadian political economists to revise their theories to accord with the peculiarities and problems confronted at different points in history.

The present historic juncture demands reflection on the staples approach, in light of the need to transition towards a low-carbon economy. Harnessing Canadian political economy to illuminate the nature of carbon dependence in Canada, and to aid in the search for low-carbon development trajectories, requires a re-emphasis and rediscovery of neglected aspects of Innis's thought, and some parting of the ways with the staples-inspired theories and policy agendas constructed in earlier periods.

Canadian political economists employing the staples approach have often combined it with other theories to grapple with new problems.[46] To explore low-carbon transitions, we can fruitfully combine Innisian insights on Canadian context with the growing literature considering energy and environmental issues from systems of innovation perspectives.[47] These perspectives can bring Innis's historic and evolutionary understanding of the economy up to date with the latest conceptions of international development patterns and the latest thinking on processes of structural economic change.[48]

Systems of innovation perspectives emerged from case studies of technological development, which found that firms and individuals do not innovate

in isolation, but in constant interaction with a wider network or system.[49] They emphasize the role of learning in economic development and use interdisciplinary, historical, and evolutionary perspectives. They explain how economic change results from the mutual interaction of a variety of system elements, such as technology and infrastructure, actors, networks, and institutions. In their discussion of sociotechnical systems, system theorists emphasize the role of political and social forces in technological development. When system elements complement one another and form interdependencies, the system as a whole evolves along a particular pathway of change, which gains its own momentum over time.[50] Dosi called these pathways "technological paradigms" and titled incremental developments within a paradigm "technological trajectories." Each paradigm has "powerful exclusion effects" and imposes a particular idea of progress.[51]

The conceptual boundaries of a system will determine whether we can best describe change processes as incremental advance within a given trajectory, or a more radical paradigm shift. A radical change within one system might constitute an incremental change in an alternative conception of a system. An analyst can define the boundaries of an innovation system as national, regional, sectoral, product-based, and technology-specific. At the global level, Freeman, Perez, and Louçã studied the economic history of macroscale "techno-economic paradigms." These paradigms developed due to historically specific interactions across technical, scientific, economic, political, institutional, and cultural subsystems.[52] They identified five different paradigms based upon different core inputs, leading industries and socioinstitutional regimes, with different countries at the core.[53] The first paradigm was the English industrial revolution based on cotton, iron, and waterpower. The second was the age of steam, coal, and railways. The third was the age of steel, heavy engineering, and electrification. The fourth was the age of oil, automobiles, and Fordist mass production/consumption. Today, they describe global economic evolution in the middle stages of the fifth paradigm, based on information and communication technologies (ICT).[54] In his day, Innis relied upon Mumford's typology of technics to describe qualitatively different periods of global economic development. Today we can use the historic study of technoeconomic paradigms to update an Innisian conception of the global economy.

Systems approaches replace the neoclassical concept of optimality with a conception of different paradigms or configurations that work.[55] However, a system's evolution is not necessarily for the better; it could be locked into a socially and/or economically undesirable trajectory. The Innisian staples trap is such an example—a form of resource lock-in, maintained by a series of social, technological, and institutional rigidities.

In the context of climate policy, Unruh outlined how systemic interactions among technologies and institutions produce dependence on fossil fuels and a problem of "carbon lock-in."[56] The notion of carbon lock-in emphasizes that market failure resulting from perverse incentives are not the sole reason for high GHG emissions. Systemic problems produce carbon lock-in. They result from scale, learning and network economies, institutional rigidities, and government and organizational policies that promote existing economic paradigms.

Systems perspectives focus on questions related to why paradigms shift, how systems escape lock-in, and how structural transitions occur. Dosi suggests that paradigm shifts occur when problems with the existing trajectory cause science and technology actors to redirect their searches. These are periods of "extraordinary search" for new technological options.[57] The historic study of technoeconomic paradigms found that paradigms begin to crumble when the core technologies of the existing system demonstrate limits to growth. At this stage, the existing paradigm is ripe to be replaced by a new technological system, one that was able to undergo its initial stages of growth under the old paradigm. The new technologies must present decisive advantages and the capability to produce pervasive economic effects. Social and institutional changes must also occur for these technologies to diffuse widely.[58]

Analysts have used the multilevel perspective to study the historic pattern of sociotechnical transitions at subglobal levels.[59] This perspective separates systems into landscape, regime, and niche levels, and understands systemic change by analyzing the dynamic interactions between them. For instance, regime change occurs through various combinations of external pressure (from the landscape level) and the availability of alternatives that have developed within system "niches."[60] Policy informed by this perspective has

focused on creating protected niche spaces for the development of a variety of new technologies and associated social systems that might eventually gain momentum over time to challenge and replace existing economic systems.[61]

The analysis of historic patterns does not suggest that technological trajectories are inevitable or deterministic, but they can highlight certain times in which systems are more or less open for change. Political and economic actors shape the characteristics of technological paradigms and trajectories by strategically encouraging, stalling, or redirecting the force of momentum behind particular sociotechnical systems. Freeman highlighted the role of agency in changing paradigms, describing them as "self-fulfilling prophecies based on the actors' decisions and expectations of the future…sustained not by 'naturalness' but by the interests that develop in their continuance and the belief that they will continue."[62] Thus, at any point, actors advocate for particular visions of the future, which compete with each other to shape the nature of economic change. Today, a number of actors have outlined the political goal of steering local and global sociotechnical systems towards a sustainable paradigm.

Innisian perspectives can add some new insights to systems-of-innovation approaches. The ecological aspects of Innis's approach emphasize the mutually shaping interactions between ecological and sociotechnical systems.[63] Innis commenced his two staples studies with discussions on the characteristics of cod and beaver and subsequent socioecological interactions.[64] From Innis, we see that the price system introduces radical ecological change by penetrating new geographies, and that the characteristics of resources themselves can play a key role in many sociotechnical evolutions.

Innis's perspective also highlights the role of mismatch between marginal areas and the evolutions of global economic paradigms, and how this mismatch imposes a series of rigidities and instabilities that trigger their own development trajectories. A distinction between laggards and leaders in the transition to new economic paradigms is too simplistic. Marginal areas might never catch up, but instead play a dependent, enabling role during the late stages of global economic transitions.[65]

Redirecting the staples approach to consider the transition to a low-carbon economy will shed new light on previous debates within Canadian

political economy and require some parting of the ways with previous uses and interpretations of staples insights. First, a systemic understanding of the staples approach rejects the labels of resource and technological determinism that others have thrust upon it.[66] We can understand resources and technologies as components that exist in a state of constant interaction with social, political, and institutional system components. Abraham Rotstein's comment on how Innis "seemingly leaps" between geography (and ecology), institutions, and technology speaks to the appropriateness of a systemic interpretation.[67]

The New Canadian Political Economy School developed a nationalist branding of the staples approach by highlighting Canada's dependence upon the "centres" of Britain and the United States.[68] A concern with global transition to a low-carbon economy shifts this attention from dependence upon nations to dependence upon particular economic paradigms. This reconceptualization invites the exploration of crossnational political coalitions to maintain existing paradigms and/or shape the characteristics of new ones.

A renewed focus on economic paradigms highlights the historic specificity of development objectives. This brings to light that the conception of what it means to have an advanced economy changes with each paradigm. This has implications for linkage-building industrial strategies that have traditionally promoted value-added manufacturing. Strong linkages could be an indicator of lock-in within a decaying economic structure, making one paradigm's "linkages" another one's "rigidities."[69] To assess the dynamic flexibility and adaptability of a system's linkage structure, new industrial policy literatures have emphasized the importance of examining knowledge flows, forms of learning, and actor activities.[70] It is important to determine whether the political character of these activities and linkages matches the desired sociotechnical trajectory of the time.

Some have criticized the New Canadian Political Economy's use of staple theory for overemphasizing the weakness of Canada's international position and neglecting its own imperialism.[71] Yet, if we focus on the role of the margin within economic paradigms, there is little to suggest that a country primarily engaged in a marginal relationship with a centre needs to be poor or politically inept. Canada has shown that its resource base and form of

dependent industrialization can produce enormous wealth and an impressive degree of international power. The core concept of the centre-margin dichotomy indicates that a country or region in the confines of a marginal relationship is not a leading site of radical innovation.[72] It has a tendency to support the continuation of existing paradigms due to the problems of adjustment faced when new economic systems emerge that demand new staples and diffuse new technologies. If the Canadian state is able to amass greater international political power, these tendencies become all the more important to understand.

Finally, a dynamic conception of the staples approach does not see staples as a descriptor of one period in Canadian history, as suggested by Hutton's "post-staples" thesis.[73] Rather, it recognizes the flexibility of Innis's approach across time and space because of its recognition of shifts in the global economy and the new staples demanded by these shifts. Baragar outlines a versatile Innisian method, which involves a three-step process: first, situating the subject within the context of the expansionary dynamics of the price system; second, identifying the institutional expressions of the relevant centre-margin relations; and, third, undertaking an exploration of the biases incidental to the institutional arrangement.[74] This method is especially relevant to exploring ecological restructuring across local, national, and global scales when combined with the understanding of the staple trap tendency in Canadian history and the use of resources in economic processes.

At this moment in history, we can use the Innisian approach to consider the political implications of Canada's role within the global economy as a potential site of innovation and as a staple resource supplier. Will Canada's development pattern add momentum to a green paradigm shift or promote persistence in GHG-emitting fossil fuels? The staples trap tendency suggests that dominant Canadian interests will promote existing centre-margin relations, and thus promote persistence in existing economic paradigms, especially during periods of instability and crisis.

Is it possible, instead, that Canada's pathways of development could promote the emergence of green economic paradigms by bringing new ideas about society, technology, and the management of natural resources to the global scene? Neill's study of Innisian thought emphasizes the role of

creativity and values in directing forms of economic development.[75] Watson's interpretation of Innis's communications project proposes that it was pointing to the role of the margin as a niche space, with some autonomy from the monopolies of knowledge that exist in the empires of the global economy.[76] These conceptions are more hopeful and optimistic. They encourage a project that explores the potential for Canada to make unique contributions. To launch such a political project, we must first thoroughly understand the lock-in tendencies that undermine change and the realization of new (ecologically sustainable) social values.

The Bitumen Staple and the Carbon Trap This section discusses how the staples trap pattern is repeating itself in the context of the bitumen staple and the public demand for a transition to a low-carbon economy. It explores the domestic and international implications of the oil sands staple and describes how the latest manifestation of Canada's staples trap also produces a peculiar form of carbon lock-in.

We can begin to explain today's staple trap with a review of the development of Canada's oil industry. Demand for Canadian oil commenced during the Second World War and took off with a series of oil discoveries in the late 1940s, particularly the 1947 discovery of the Leduc oil field.[77] True to the staple development pattern, the western economies facing painful adjustments due to the end of the wheat boom directed themselves towards the oil staple.[78]

The centre-margin relation linking the oil staple to the fossil-based economic paradigm of the twentieth century generated an initial set of rigidities. The early exploitation of oil signalled a move towards regionalism in Canada. Western hinterland provinces with new found political control over resources, coupled with the pull of demand from the United States, contributed to a rush towards this resource. The fight over the National Energy Program exemplified the Canadian federation's inability to use its resource wealth to complement industrial strategies in other areas, or to quell booms and busts.

Stanford highlights that, while Canada reduced its pattern of staples dependency along many dimensions in the latter decades of the twentieth

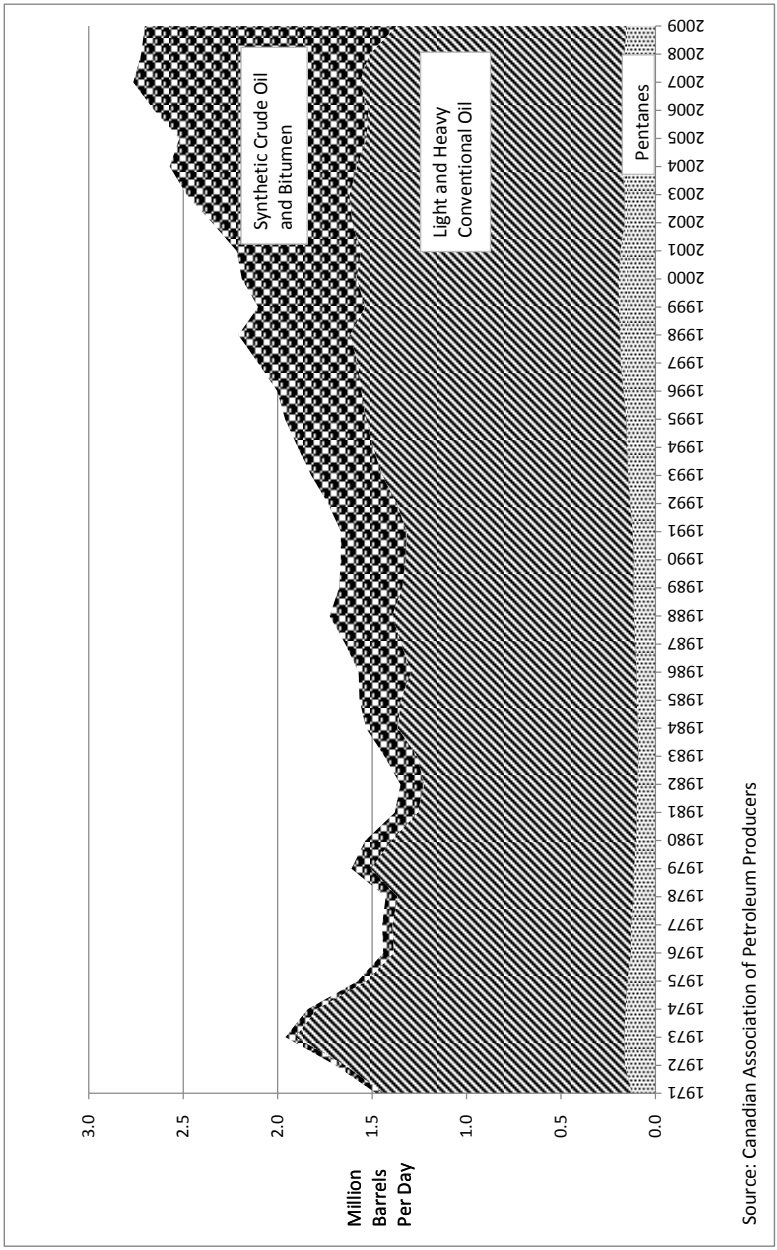
century, a boom in the petroleum sector at the beginning of the twenty-first century has triggered a structural shift back towards resource dependency. However, a slightly new staple leads these changes. Figure 3 illustrates that conventional oil extraction has remained steady, while growth of a thick, tarry substance called bitumen has taken off.

Since its early days, the oil industry viewed the bitumen resource as its next frontier. Alberta estimates that it has the third largest global crude oil reserve, next to Saudi Arabia.[79] Federal and provincial governments developed the initial technology to separate bitumen from sand. The first commercial plant opened in 1967, and the Syncrude project launched in 1978 after receiving considerable support from government.[80] In the 1990s and 2000s the history of technical improvements, new reserve estimates, an attractive royalty regime, and higher global oil prices fuelled a takeoff.[81] While production has accelerated noticeably in recent years, the industry has barely tapped the resource.

The Innisian lens encourages us to situate the oil sands within the context of international economic paradigms, or, using Innis's terms, the expansionary dynamics of the price system. Activities to extract the bitumen staple exist on the frontier of an economic paradigm that utilizes oil as its core input—what Freeman and Perez have labelled the fourth economic paradigm and Innis identified as "neotechnic" industrialization. Today's growing scarcity of conventional oil necessitates a further expansion into new geologic formations, with the use of new and more elaborate technology, in a manner similar to inland expansions witnessed in the histories of the fur, timber, and wheat staples.[82]

The rigidities installed with the oil staple are likely to be hardened even further with the shift to bitumen. The exploitation of the oil sands demands a higher degree of technological sophistication, developed by decades of government-supported research and development. Oil sands projects are capital intensive and have long lifespans.[83] The overhead costs and unwillingness to accept obsolescence of previous investments crystallizes rigidities. Vested interests have also evolved since the launch of Canada's oil industry, and have most firmly installed themselves within the Alberta government and the federal Conservative Party.[84] Aggressively exploiting Canada's "ocean

Figure 3. Canadian Crude Oil and Bitumen Production



of oil soaked sand" is at the core of the federal government's "energy superpower" vision, articulated by Prime Minister Harper in 2006.[85] National economic policy carries the historic weight of the inhibiting export mentality, identified by Watkins, which promotes the preference for resource extraction strategies.

The expansion into new geological frontiers demonstrates the continuity of the oil-based paradigm. Yet, the oil-based development trajectory is under pressure because of the growing scarcity of conventional oil supplies and the problem of greenhouse gas emissions, triggering some political and economic actors to call for a transition to a green economy. Historians of global technoeconomic change patterns suggest that the successful emergence of a green economic paradigm is now possible. Carlota Perez envisions that information and communication technologies could enable the improvement and diffusion of green technologies.[86] Chris Freeman sees this potential as well, but goes further in suggesting that a sixth technoeconomic paradigm, based on sustainability, could emerge in the twenty-first century.[87] Others have outlined visions of green industrial revolutions and ecotransformations, with varying political economic implications.[88]

This battle over a future based on the persistence of an economic trajectory with oil as a key input versus one that realizes the emergence of a green economic paradigm to reduce GHG emissions creates a series of vulnerabilities, uncertainties, and instabilities for oil sands interests. As a frontier resource, oil sands projects are vulnerable to international price fluctuations. The International Energy Agency (IEA) noted that when prices plummeted from their peak with the onset of recession in 2008, the oil sands accounted for the bulk of project delays and cancellations in the global oil industry.[89] The sands are also vulnerable to international policy changes. Global energy scenarios that anticipate meaningful climate action predict that the oil sands will be one of the first resources to drop out of production.[90]

The right side of the chart in Figure 4 displays global demand for oil sands from three global energy scenarios. Two come from the IEA's World Energy Model. The IEA's Current Policies scenario assumes that governments take no more climate change action, even to meet the commitments they have made. In this scenario, global energy demand and world oil prices

rise steadily. Canadian oil sands help meet global demand by producing 4.6 million barrels of oil per day (mbpd) in 2035. This scenario could produce catastrophic climate impacts by pushing global average temperatures above 6°C.[91]

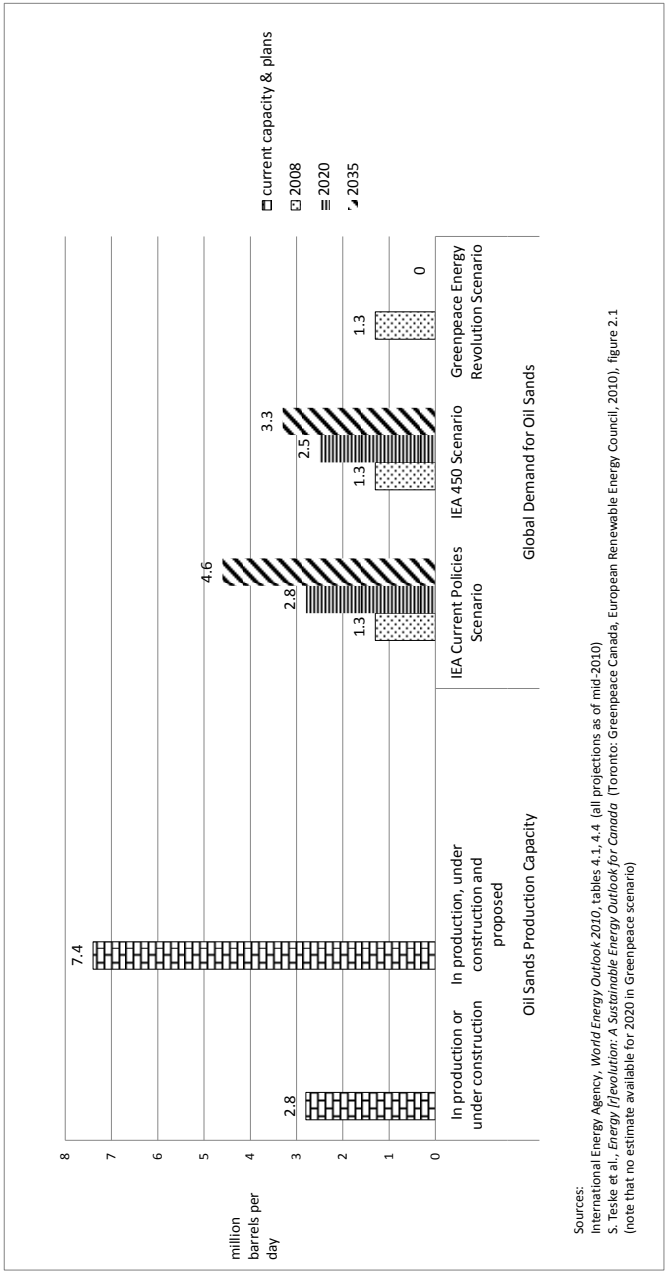
The second IEA 450 Scenario assumes that governments take action consistent with the most aggressive interpretation of existing policy commitments. This includes the goal of limiting global warming to 2°C, as committed to in the Copenhagen Accord. Policy actions include the removal of fossil fuel subsidies, carbon prices rising from $45/tonne in 2020 to $120/tonne in 2035, and high growth rates for renewable energy and nuclear power. By 2020, the United States would make a 17 percent reduction in GHG emissions compared to 2005, with access to offset credits. Oil demand peaks before 2020 at only 4 mbpd above current levels and then reduces. The price of oil levels off at $90/barrel in 2020. This scenario would make "the economics of new oil-sands projects marginal."[92] It also relies on reductions in the GHG intensity of the oil sands by using more efficient extraction technologies and carbon capture and storage (CCS).[93]

Greenpeace's scenarios achieve deeper GHG reductions with a greater focus on renewable energy and energy efficiency, instead of more centralized energy technologies such as nuclear and CCS. They project larger decreases in oil demand through a rapid diffusion of electric and plug-in vehicles, public transportation and transport efficiency, as well as greater use of renewable energy for heating. An estimate of oil sands production for 2020 is not available, but the Greenpeace scenario would fully eliminate the need for unconventional oil by 2030.[94]

The left side of the chart displays the oil sands production capacity that currently exists, that the industry is currently constructing and proposing to construct.[95] The Current Policies scenario envisions enough global demand by 2020 to fill the 2.8 mbpd of production capacity already installed or under construction, and no scenario comes close to using the 7.4 mbpd of capacity currently proposed.[96] The industry is also predicting excess pipeline capacity out of the western sedimentary basin up to 2022.[97]

The large buildup of production and transport capacity demonstrates

Figure 4. Capacity vs. Demand for Canada's Oil Sands



Sources:
International Energy Agency, *World Energy Outlook 2010*, tables 4.1, 4.4 (all projections as of mid-2010)
S. Teske et al., *Energy [r]evolution: A Sustainable Energy Outlook for Canada* (Toronto: Greenpeace Canada, European Renewable Energy Council, 2010), figure 2.1 (note that no estimate available for 2020 in Greenpeace scenario)

the extent of the physical rigidities that the development of the oil sands is currently creating. Yet, as has occurred many times within Canadian economic history, such rapid expansion could introduce problems associated with high overhead costs or unused capacity. Once capacity is built, the oil sands product will flow if prices correspond with variable costs, but there is no guarantee that the international price will remain high enough to support the fixed costs, or that environmental policies will not result in quantitative restrictions on production or export markets.

It should be noted that other images of the future anticipate much higher global oil prices because of conventional oil scarcity. Canadian economist Jeff Rubin suggests that oil prices will rise much higher than those projected in the IEA scenarios, producing fossil-fuel-price-driven-recessions, and an eventual market-induced transition to a more localized and less fossil-dependent economy.[98] What Rubin does not highlight, however, is the potential for an Innisian mismatch, whereby higher oil prices further encourage the utilization and buildup of capacity in the Canadian oil sands while the global economy follows Rubin's predicted transition away from fossil fuels.

While these energy scenarios are quite different, their content and variety imply uncertainty for the bitumen staple. The historic staple trap pattern demonstrates that, faced with uncertainties and vulnerabilities, staples interests have sought to create security by crystallizing or renewing centre-margin relationships. These actions have political implications and can push Canada further and further into staples dependence. To avoid a stranding of investments in oil sands capacity and the institutional and technological resources connected to the wider development system, oil sands industry lobbyists can attempt to lock in trade policy agreements with the United States, the existing exports centre, by emphasizing the value of bitumen to energy security. They can also seek connections with new centres of the global economy, now exemplified in the attempt to increase access to Asian markets through the construction of the Northern Gateway Pipeline. They can also promote the legitimacy of the resource at home by highlighting its role in the economy, or promoting concepts such as "ethical oil."[99]

Maintaining some form of centre-margin relation demands not only formal agreements with the centre, but also assurance with respect to what techno-

economic trajectories those centres will follow. Canadian bitumen interests and the Canadian state could seek to sustain their development trajectories by taking actions to stall the momentum towards a green economic paradigm on the international scene. Environmental organizations have accused Canada of undertaking such actions during international negotiations.[100]

A reality that informs the behaviour of the Canadian state is that the existing centre-margin relation has the weight of historic rigidities on its side. The successful emergence of a green economic paradigm requires the buildup of enough momentum through self-reinforcing expectations, sociotechnical developments, and political power to break the lock-in inherent in existing energy systems. A middle-power nation hoping to extend the use of fossil fuels need not directly confront fossil-competing paradigms. To avoid a backlash, more subtle actions might be preferable; for instance, actions that have the effect of limiting green technology expectations and exciting political disagreements among other nations. In this light, the Canadian state is unlikely to undertake ahead-of-the-pack environmental initiatives for fear of encouraging the wrong type of expectations and momentum.

Canada's history has demonstrated the propensity for staples interests to seek the protection of the state when faced with burdensome overhead costs and potential losses. While Innis showed how problems of adjustment provoked periods of intense state intervention, in the context of climate policy the state might decline to heed calls for policy intervention that would penalize the industry for its pollution. In the face of pressure from a strong national and international environmental movement, fossil fuel interests could also request that the state develop policy plans designed to renew the industry's "social licence" without disrupting its core functions.[101]

The state could also protect the oil sands by subsidizing and promoting GHG reduction technologies such as CCS, processes that find substitutes for underground steam injections, and the purchase of carbon offsets.[102] Low-carbon technological trajectories that preserve dependence on fossil fuels uphold the promise of exploiting the oil sands and reducing carbon. While such a policy strategy would hold out the chance of triggering development of fossil-based, low-carbon technologies through backwards linkages, political strategies aiming to slow momentum towards a green economic

paradigm can hollow out and co-opt these plans. Fossil vested interests use the promise of fossil-based, low-carbon technologies as a reason for not taking immediate policy action on climate change.[103]

Repeating the circular staple trap pattern, where Canadian staple interests seek the renewal of centre-margin relations in the face of rigidities, volatility and uncertainties, and potential problems of adjustment has both domestic and global implications. The staple mentality implies a defensive nature of domestic entrepreneurship. With only a few notable exceptions, Canada's business class has failed to develop innovative, globally oriented, value-added firms, and has taken a conservative position with respect to support for new economic transformations. The historic pattern explains some of the problems with Canada's national system of innovation, highlighted in reports by organizations such as the Council of Canadian Academies.[104] One implication of this is the truncated development of a domestic clean-tech sector that could produce radical innovations.

A lack of domestic coordination can also hold back the clean-tech sector. Stanford has demonstrated how a lack of national coordination results in a failure to alleviate the detrimental effects that the booming oil sands have on other sectors through the rise of the Canadian dollar.[105] In addition, the buildup of regional interests makes it difficult to use resource rents or fiscal linkages from the oil sands to promote national clean-tech development. Finally, the fear of contributing undue momentum to a competing green economic paradigm appears to hamper national policymakers from implementing aggressive national climate policies.

This staples trap is also a carbon trap because of the manner in which Canada's institutional dependence on increasing global demand for bitumen triggers domestic sociotechnical trajectories focused on fossil resource extraction that crowd out the development of technological systems consistent with a green energy paradigm. Immediate extraction of the staple has even taken precedence over developing fossil-based, low-carbon technologies that could enable lower GHG development in the future. With the historical weight of the factors that cause the staples trap behind it, the carbon trap is Canada's peculiar form of carbon lock-in. The trap has the corollary effect of truncating the development of the domestic clean-tech sector because it

stalls the implementation of the national climate policies needed to give low-carbon technological systems enough momentum to counter Canada's historic tendency to underperform in technological innovation.

The oil sands' relevance is not restricted to Canada. The sands are a "storm centre of the international economy." Their rapid development indicates that global fossil-based paradigms retain significant strength and momentum. The implications of the oil sands go beyond the immediate GHG emissions they produce. Their development promotes persistence in fossil-based production and consumption systems across a much wider geographic reach, since the bitumen resource links up with a global economic system configured to use oil as its core input. The real ecological danger of the carbon trap is that Canadian rigidities also contribute to the maintenance of global carbon lock-in.

Canadian Climate and Industrial Strategies It is important to understand Canada's form of carbon lock-in in order to develop policy strategies to escape from it. After understanding today's staples trap as a carbon trap, we can explore its implications for climate and industrial policies in Canada.

Policy activists have traditionally used the staple trap concept as a justification for industrial policy in the Canadian context. It explains how market forces could further exacerbate resource lock-in. Escaping the staple trap requires policies that intervene more directly to reorient Canada's economic trajectory and encourage the build-up of industrial capabilities. In regions linked to resource development, Watkins' Staples Theory of Economic Growth demonstrates that industrial capabilities could evolve from the exploitation of forward, backward, and final demand linkages stemming from the staple itself. As depicted in Figure 1, the final goal is a form of "advanced industrialism."

However, scholars created these notions of industrial policy during a heavy industrial, oil-based economic paradigm and the paradigms that preceded it. The carbon trap is a different kind of staple trap because its primary drawback is its obstruction of a sustainability transition. Such a transition is a normative/political goal that is very different from previous economic development goals. A green paradigm shift is not solely concerned

with ushering in a new period of growth, but redirects the conception of economic progress itself. The implication of this is that some of the strategies found in the traditional tool kit on how to escape the staple trap might come into conflict with sustainability transition goals and push Canada deeper into its carbon trap. Examples could include some linkage-building policy proposals that encourage domestic upgrading and refining of bitumen, utilization of its byproducts for petrochemical industries, and R&D for hydrocarbon extraction techniques.[106] Initiatives such as these could enhance carbon rigidities by creating more overhead costs and installing manufacturing interests tied to an energy- and carbon-intensive form of development that is anathema to a low-carbon paradigm shift.

Concerning nonresource sectors, there is danger in the fetishism that traditional strategies can exhibit for the manufacturing industries of earlier paradigms. Firing up the Fordist industrial engine will not help Canada escape from its carbon trap. Furthermore, since the wise management of resources and the biosphere will be integral to a sustainable future, an overly reified staple vs. manufacturing dichotomy could sever the conceptual link between industry and resources at a time when it is most needed.

Understanding Canada's climate problem as a carbon trap also calls for alternative climate policy approaches. Neoclassical approaches, emphasizing so-called technology-neutral policies, have dominated Canadian climate policy discourse.[107] Most prominent is the call for a carbon price through a tax or cap and trade system. Yet the carbon trap is a form of systemic lock-in. It occurs not only because of differences in relative prices, but also because of a series of institutional and economic rigidities: overhead costs, infrastructure, vested interests, bounded knowledge fields, and fixed policy mentalities. Without other forms of intervention, a carbon price will primarily encourage incremental sociotechnical changes within the dominant fossil fuel paradigm. Moreover, the political dimensions of the carbon trap underscore the difficulty associated with implementing meaningful carbon prices in the first place, due to the political strength of fossil staple interests and the weakened state of the political coalitions that usually evolve alongside low-carbon technological systems.

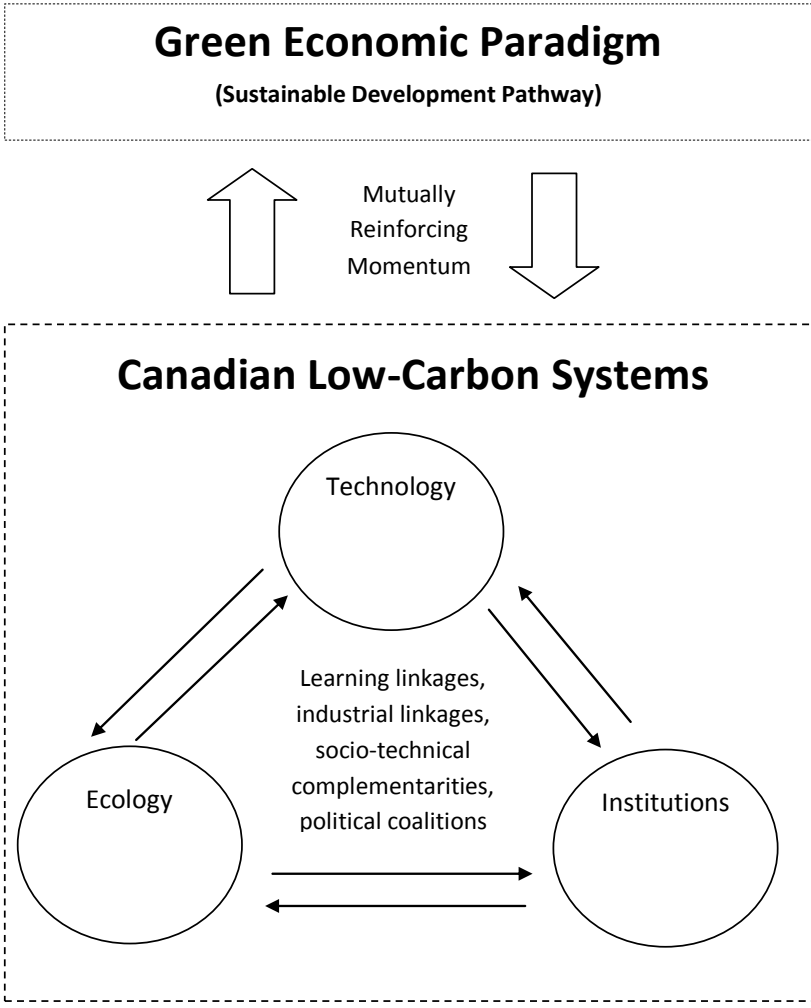
Policies to escape the carbon trap must focus on producing structural

change by challenging the legitimacy of the dominant oil sands development trajectory in company with encouraging the momentum of alternative technological systems. This will require an analysis of the specific low-carbon technological configurations that could evolve in the context of Canada's unique ecology, political institutions, and economic structure. Policy intervention must focus on the variety of systemic processes that must occur to promote new technologies.[108] This includes the development of political coalitions that promote new sociotechnical visions.

Canada's tradition of staples political economy can aid in the endeavour. The staples approach articulates the historic context of Canadian development and establishes ecological, institutional, technological guideposts that can form a basis for examining a series of potential low-carbon futures (see Figure 5). The latest thinking on structural change and sustainability transitions can update the staples framework to meet today's challenges. Systems of innovation thinking highlights that it is important to consider learning processes and broader complementarities between different technologies and social systems in addition to the industrial linkages emphasized in the original staple theory of economic growth.

We can now briefly discuss examples of research and policy strategies that this approach would use to encourage low-carbon transitions in Canada. In the Canadian context, the power of the bitumen staple itself makes it hard to neglect an exploration of the potential low-carbon futures connected to this resource. Making fossil fuels sustainable is a demanding proposition, fraught with pitfalls. The industry itself has explored new technologies to reduce GHG intensity through a variety of process improvements and CCS. Yet it would be insufficient to achieve upstream emission reductions that make Canadian oil exports as carbon intensive as conventional oil. Such an incremental achievement would maintain global dependence on oil as a key input and hamper the development of a green economic paradigm. The staples trap pattern teaches us that low-carbon futures are unlikely to evolve if the petroleum industry's core business continues to be export to the oil-based consumption systems of the present paradigm. In this case, entrepreneurship within the oil sands will view carbon-reducing technologies as overhead costs. These overhead costs could exacerbate the carbon

Figure 5. Framework for Canadian Climate Strategies



trap by truncating low-carbon technological development opportunities by producing a bias towards cheaper, off-the-shelf technology and increasing absolute GHG emissions by encouraging even greater staple extraction to pay off the overhead.

To lend momentum to a green energy paradigm, the oil sands will need to shift focus away from export of the staple towards low-carbon technological development capable of achieving radical GHG reductions. If a green economic paradigm continues to use fossil fuels, it will have to reduce and capture emissions along all points of the production and consumption life cycle. In such a future, export to existing consumption systems becomes unlikely because it is difficult to capture carbon when combustion is decentralized. Full carbon capture upstream could necessitate exports utilizing non-carbon energy carriers, such as electricity and hydrogen.

A second form of evolution would enable individuals, businesses, and regional economies to eventually leave the bitumen staple in order to complete the full transition to a low-carbon economy.[109] The use of oil sands revenues to promote green technology (i.e., exploiting a fiscal linkage) is no doubt part of such a strategy. However, a comprehensive transition strategy will also need to manage a restructuring of the many substructures that make up the oil production system: its workforce, regional economy, industrial artifacts, and knowledge resources. Such a strategy could aim to redirect the organizational systems and technical knowledge that currently exist in the oil industry towards renewables, hydrogen, different applications of CCS, and other low-carbon technologies.

Of course, the exploitation of a high-carbon resource in an age when radical carbon reductions are required is likely pointing Canada towards the "wrong kind of staple."[110] It is also possible to encourage the development of systems rooted in clean energy staples, such as solar, wind, tidal, hydro, and bioenergy. Canada's diverse geography and its decentralized political structure produce a variety of sociotechnical systems relatively disconnected from the oil sands trajectory. As previously noted, Canada's decentralized nature has enhanced the staple trap tendency by enabling regionalism and discouraging national coordination. However, the same set of circumstances also creates the potential to create subregimes within the

Canadian federation that will provide an environment for the growth of different industries that could gain enough strength to challenge the oil sands-dominated trajectory. Provinces disconnected from the oil sands boom and with emerging low-carbon industries could become important political actors within Canada. Today, low-carbon technological systems are struggling to evolve within different regions: witness The Green Energy Act in Ontario; the more aggressive climate policies found in the hydro-based provinces of British Columbia, Manitoba, and Quebec; and policies to promote energy security in the Maritimes.[111]

Canada has an abundance of clean energy resources. The principal barrier to low-carbon transitions, however, does not stem from a shortage of renewable resource potential,[112] but from technical and social systems ill adapted to the effective and sustainable use of these resources. The staples approach demonstrates how overemphasizing resource abundance and extraction can retard social and economic progress. It counsels the development of Canadian strategies that aim to maximize low-carbon innovation by developing configurations that link Canada's clean energy resources to institutional, political, and technical innovations.

In conclusion, this paper has outlined the staple trap pattern in Canadian economic history and argued that this pattern has gained new relevance in the context of the bitumen staple and the political demand for a transition to a low-carbon economy. By updating the staples approach with systems-of-innovation concepts, we can understand the complex nature of Canada's climate policy pitfalls and the durable form of Canada's carbon lock-in, whereby today's staple trap is also a carbon trap. Escaping the staples trap has always called for interventions aimed at shifting Canada's economic structure. Similarly, escaping the carbon trap will require uniquely strategic and aggressive climate strategies, which can search for opportunities within Canada's ecological context, economic structure, and institutions to build technological and political momentum for a green energy future.

Notes

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1. H. Innis, "Snarkov Island," in R. Neill, (ed.), *A New Theory of Value* (Toronto: University of Toronto Press, 1972), p. 149. This is one of Innis's unpublished manuscripts published by Neill. [ ] indicates an unintelligible word.
2. Dion quoted in R. Collier, "Fuelling America Oil's Dirty Future," *San Francisco Chronicle* (22 May 2005).
3. H. Innis, "The Teaching of Economic History in Canada" in M.Q. Innis, (ed.), *Essays in Canadian Economic History* (Toronto: University of Toronto Press, 1956), pp. 3.
4. A.J. Watson, *Marginal Man* (Toronto: University of Toronto Press, 2006).
5. See H.A. Innis, *The Cod Fisheries* (New Haven: Yale University Press, 1940); H. Innis, *The Fur Trade in Canada* (Toronto: University of Toronto Press, 1930); W.T. Easterbrook and H.G.J. Aitken, *Canadian Economic History* (Toronto: Macmillan, 1956).
6. Introduction by Alexander John Watson in H.A. Innis, *The Bias of Communication* (Toronto: University of Toronto Press, 2008), pp. xvi–xvii.
7. H. Innis, "The Political Implications of Unused Capacity," in *Essays*, p. 382.
8. H. Innis, "The Penetrative Powers of the Price System," in *Essays*. On page 259, Innis references L. Mumford, *Technics and Civilization* (London: Routledge, 1934), but attributes the use of the term to the Scottish theorist Sir Patrick Geddes, who influenced Mumford.
9. "The price system operated at a high state of efficiency in the occupation of the vacant spaces of the earth." Innis, *The Penetrative Powers*, p. 260.
10. See R. Neill, *A New Theory of Value* (Toronto: University of Toronto Press, 1972), chapters 3 and 4 for discussion on cyclonics theory.
11. In addition to periods of mismatch and painful transitions, Innis also described times when the overlapping of two technoeconomic systems produced complementary institutions and a flowering of development on the margin. This includes the completion of capital projects and new transport routes in the 1920s and Nova Scotia's capturing of the British shipping trade after the American Revolution in the final years of commercialism. See Innis, *The Cod Fisheries*, pp. 486–490, and *The Penetrative Powers*, pp. 261–262.
12. In the 1850s, the St. Lawrence region's economic strategy centred on the construction of canals to attract traffic from the export of timber and wheat to England. The strategy received a shock when canals faced competition from railroads and Britain abolished its commercial preferences to finalize an evolution towards free trade that it initiated decades earlier. Timber interests called for annexation to the United States, but the Canadian provinces adjusted by negotiating a reciprocity treaty with the United States, and eventually undertaking Confederation of the provinces to launch a strategy of westward expansion, railroads, tariffs, and wheat. In the 1930s, the wheat-specializing regions confronted a bust and railroads faced competition from roads and the automobile. See *Ibid.,* and Easterbrook and Aitken, *Canadian Economic History*.
13. "A study of the elasticity of demand for autarchies is significant to a study of the elasticity of demand for wheat." Innis, *The Penetrative Powers*, p. 272. On the role of government ownership in Canada as a buffering mechanism against instabilities, see H.A. Innis, *Problems of Staple Production in Canada* (Toronto: Ryerson Press, 1933).
14. M. Watkins, "A Staple Theory of Economic Growth," *Canadian Journal of Economics and Political Science* 29 (1963), pp. 141–158.
15. D. Drache, "Harold Innis and Canadian Capitalist Development," *Canadian Journal of Political and Social Theory* 6/1–2 (1982).
16. Neill, *A New Theory*, especially chapters 3 and 4.

17. In *The Penetrative Powers*, Innis argued that economic theories created during the pinnacle of one economic period and used to justify the toppling of previous vested interests can be ill suited to new economic periods and lead to the entrenchment of their own vested interests.
18. On the extension of Innis's concept of rigidities to communications, see I. Parker, "Harold Innis: Staples, Communications, and the Economics of Capacity, Overhead Costs, Rigidity, and Bias," in D. Cameron, (ed.), *Explorations in Canadian Economic History* (University of Ottawa Press, 1985), pp. 73–94.
19. Watkins, *A Staple Theory.*
20. Innis, *The Fur Trade*, p. 5.
21. Easterbrook and Aitken, *Canadian Economic History*, pp. 196, 278–279. This history should also include the collapse of the cod fisheries in the late twentieth century. See R.A. Rogers, *The Oceans are Emptying: Fish Wars and Sustainability* (Montreal: Black Rose Books, 1995).
22. On the reaction of vested interests, see Neill, *A New Theory*, pp. 57–58.
23. Drache, *Harold Innis.*
24. Watkins, *A Staple Theory*, p. 151.
25. Watkins, *A Staple Theory*, p. 151. This more linear route from staples towards "advanced industrialism" is consistent with Mackintosh's staple theory; see G. Williams, *Not for Export* (Toronto: McClelland and Stewart, 1983), chapter 7, for a distinction between the different staples approaches of Innis and Mackintosh.
26. See chapter 21 on "The New Industrialism" in Easterbrook and Aitken, *Canadian Economic History.*
27. H. Innis, "Decentralization and Democracy," in *Essays.*
28. See C.B. Macpherson, *Democracy in Alberta* (Toronto: University of Toronto Press, 1962); J.R. Mallory, *Social Credit and the Federal Power in Canada* (Toronto: University of Toronto Press, 1954); W.L. Morton, *The Progressive Party in Canada* (Toronto: University of Toronto Press, 1950).
29. J. Richards and L. Pratt, *Prairie Capitalism* (Toronto: McClelland and Stewart, 1979). Also see J. Brodie, "The New Political Economy of Regions," in W. Clement, (ed.), *Understanding Canada* (Montreal: McGill-Queen's University Press, 1997), to see how national policies managed the tensions between regions.
30. D. Drache, "Introduction" in *Staples, Markets, and Cultural Change* (Montreal: McGill-Queen's University Press, 1995), p. xxii.
31. Innis called for political machinery to "rapidly adjust burdens and returns through the economy." H. Innis, "Some Problems of Adjustment in Canada," in D. Drache, (ed.), *Staples, Markets,* p. 239.
32. K. Levitt, *Silent Surrender* (Toronto: Macmillan of Canada, 1970).
33. Walter Gordon, "Royal Commission on Canada's Economic Prospects" (Ottawa: Supply and Services Canada, 1957).
34. M.H. Watkins and Task Force on the Structure of Canadian Industry, "Foreign Ownership and the Structure of Canadian Industry" (Ottawa: Queen's Printer, 1968).
35. W.T. Easterbrook, "Long-Period Comparative Study," *The Journal of Economic History* 17/4 (1957), pp. 571–595.
36. See R.D. French, *How Ottawa Decides* (Toronto: James Lorimer and Company/Canadian Institute for Public Policy, 1980).
37. R. Mahon, *The Politics of Industrial Restructuring* (Toronto: University of Toronto Press, 1984), chapter 1.
38. See J.N.H. Britton and J.M. Gilmour, *The Weakest Link: A Technological Perspective on Canadian Industrial Underdevelopment* (Ottawa: Science Council of Canada, 1978).
39. See M. Watkins, "The Clash of Ideas: Neoclassical Trade Theory Versus Canadian Political Economy," *International Journal of Political Economy* 33/3 (2003), pp. 90–101.
40. See M.M. Atkinson and W.D. Coleman, *The State, Business, and Industrial Change in Canada* (Toronto: University of Toronto Press, 1989); M. Jenkin, *The Challenge of Diversity* (Ottawa: Science Council of Canada, 1983).
41. J. Stanford, "Staples, Deindustrialization, and Foreign Investment: Canada's Economic Journey Back to the Future," *Studies in Political Economy* 82 (2008).

42. See J.N.H. Britton et al., "Technological Change and Innovation: Policy Issues," in J.N.H. Britton, (ed.), *Canada and the Global Economy* (Montreal; Kingston: McGill-Queen's University Press, 1996), pp. 433–444.
43. P. Cross, "The Role of Natural Resources in Canada's Economy," *Canadian Economic Observer* (2008), p. 3.9.
44. Stanford, *Staples, Deindustrialization*; J. Stanford, "Hewer of Wood, Pumper of Oil," *The Toronto Star* (2007).
45. M. Watkins, "Staples Redux," *Studies in Political Economy* 79 (2007), p. 217.
46. Some describe The New Canadian Political Economy School (NCPE) as a mixing of Innis with Marx. Others argue that the NCPE School, and Innis himself, used Schumpeterian and Veblenian concepts that created incompatibilities with Marxist interpretations. See L. Panitch, "Dependency and Class in Canadian Political Economy," *Studies in Political Economy* 6 (1981), pp.7–33; D. McNally, "Staples Theory as Commodity Fetishism: Marx, Innis and Canadian Political Economy," *Studies in Political Economy* 6 (1981), p. 6.
47. See Jeroen C.J.M. van den Bergh et al., "Environmental Innovation and Societal Transitions: Introduction and Overview," *Environmental Innovation and Societal Transitions* 1/1 (2011), pp. 1–23.
48. Note that Innisian and Systems of Innovation schools of thought share common intellectual foundations in the evolutionary approach of Veblen. F. Baragar, "The Influence of Thorstein Veblen on the Economics of Harold Innis," *Journal of Economic Issues* 30/3 (1996), pp. 667–683.
49. See C. Edquist, "Systems of Innovation: Perspectives and Challenges," in J. Fagerberg et al. (eds.), *The Oxford Handbook of Innovation* (Oxford: Oxford University Press, 2005), pp. 181–208.
50. T.P. Hughes, "The Evolution of Large Technological Systems" in W.E. Bijker et al., (eds.), *The Social Construction of Technological Systems* (Cambridge, Mass.: MIT Press, 1987), pp. 51–82.
51. G. Dosi, "Technological Paradigms and Technological Trajectories," *Research Policy* 11/3 (1982), pp. 147–162.
52. C. Freeman and F. Louçã, *As Time Goes by* (Oxford University Press, 2001).
53. C. Perez, "Structural Change and Assimilation of New Technologies in the Economic and Social Systems," *Futures* 15/5 (1983), pp. 357–375. ; C. Perez, *Technological Revolutions and Financial Capital* (Cheltenham, UK: Edward Elgar, 2002).
54. See especially Freeman and Louçã, *As Time Goes by.*
55. A. Rip and R. Kemp, "Technological Change," in S. Rayner and E.L. Malone, (eds.), *Human Choice and Climate Change* (Columbus: Battelle Press, 1998), pp. 327–399.
56. G.C. Unruh, "Understanding Carbon Lock-in," *Energy Policy* 28/12 (2000), pp. 817–830.
57. Dosi, *Technological Paradigms*, pp. 147–162.
58. C. Freeman and C. Perez, "Structural Crisis and Adjustment," in G. Dosi, (ed.), *Technical Change and Economic Theory* (London: Pinter Publishers, 1988).
59. F.W. Geels, "Technological Transitions as Evolutionary Reconfiguration Processes," *Research Policy* 31/8–9 (2002), pp. 1257–1274.
60. See F.W. Geels and J. Schot, "Typology of Sociotechnical Transition Pathways," *Research Policy* 36/3 (2007), pp. 399–417.
61. J. Schot and F.W. Geels, "Strategic Niche Management and Sustainable Innovation Journeys," *Technology Analysis & Strategic Management* 20/5 (2008), pp. 537–554.
62. C. Freeman, "A Green Techno-Economic Paradigm for the World Economy?" in *The Economics of Hope* (London: Pinter, 1992), p. 197.
63. Watkins expressed hope that improving and applying the staples approach will cause "us to take 'nature' more seriously as an object of study and to understand a central way in which it is degraded in Canada." Watkins, *Staples Redux*, p. 224.
64. "It is impossible to understand the characteristic developments of the trade or of Canadian history without some knowledge of its [the beaver's] life and habits." Innis, *The Fur Trade*, p. 3.

65. Baragar contrasts Innis's notion of backwardness and dependent development with Veblen's notions of technological borrowing and catch-up. Baragar, *The Influence of*, pp. 677–678.
66. See McNally, *Staples Theory*; C. Berger, *The Writing of Canadian History* (Toronto: University of Toronto Press, 1986).
67. A. Rotstein, "Innis: The Alchemy of Fur and Wheat," *Journal of Canadian Studies* 12/Winter (1977), pp. 6–31.
68. See D. Drache and W. Clement, (eds.), *The New Practical Guide to Canadian Political Economy* (Toronto: James Lorimer and Company, 1985).
69. E.S. Andersen, "Approaching National Systems of Innovation from the Production and Linkage Structure," in B. Lundvall, (ed.), *National Systems of Innovation* (London: Anthem Press, 2010), pp. 71–96.
70. See B. Carlsson et al., "Innovation Systems: Analytical and Methodological Issues," *Research Policy* 31/2 (2002), pp. 233–245; D. Rodrik, "Industrial Policy for the Twenty-First Century," in *One Economics—Many Recipes* (Princeton: Princeton University Press, 2007).
71. P. Kellogg, "Kari Levitt and the Long Detour of Canadian Political Economy," *Studies in Political Economy* 76 (2005), pp. 31–60.
72. Centre-margin is a relative concept. It is possible for Canada to be in a marginal position with respect to one country, but a centre with respect to another, and for a variety of centres and margins to exist within Canada.
73. T.A. Hutton, "Contours of the Post-Staples State," *Policy and Society* 26/1 (2007), pp. 9–29.
74. Baragar, *The Influence of*, p. 678.
75. Neill, *A New Theory of Value.*
76. Watson, *Marginal Man.* See especially the interpretation of Minerva's Owl on pages 306–312.
77. For history, see G. Toner, *The Politics of Energy and the N.E.P* (Ottawa: Carleton University, 1984), chapter 2.
78. Easterbrook and Aitken, *Canadian Economic History*, pp. 495–496.
79. Government of Alberta, "Facts and Statistics," <http://www.energy.alberta.ca/OilSands/791.asp> (accessed 5 December 2011).
80. D. Crane, *Controlling Interest* (Toronto: McClelland and Stewart, 1982); L. Pratt, *The Tar Sands* (Edmonton: Hurtig, 1976).
81. International Energy Agency, *World Energy Outlook 2010* (Organisation for Economic Co-operation and Development, 2010), p. 148.
82. It is important to not mistake the use of technology in staple extraction with the radical technological change required to shift to new economic paradigms. Innis always discussed Canada's use, adaptation, and creation of new technology (e.g., salt cod, York Boat, railroad). Yet Canada's technological trajectories have tended to be heavily linked to mature technological systems and focused on technology for the purpose of resource extraction.
83. "Unconventional sources of oil are among the more expensive available: they require large upfront capital investment, which is typically paid back over long periods," International Energy Agency, *World Energy Outlook 2010*, p. 49.
84. See T. Clarke, *Tar Sands Showdown* (Toronto: J. Lorimer & Company, 2008), pp. 80–85, 104–108.
85. See address by the Prime Minister at the Canada-UK Chamber of Commerce (14 July 2006), <http://pm.gc.ca> (accessed 15 October 2011). The "energy superpower" vision also includes exploitation of arctic oil and gas, uranium, natural gas, and hydroelectricity. Biofuel investments were the only mention of renewable energy in the Prime Minister's speech.
86. C. Perez, *Towards a Sustainable Global Golden Age* (2008); C. Perez, *ICT and Green a Natural Partnership to Nurture* (2008), <http://www.carlotaperez.org/indexofpapers1.html> (accessed 17 October 2011).
87. C. Freeman, "The Greening of Technology and Models of Innovation," *Technological Forecasting and Social Change* 53/1 (1996), pp. 27–39; Freeman, *A Green Techno-Economic Paradigm.*
88. See, for example, W. McDonough and M. Braungart, *Cradle to Cradle* (New York : North Point Press, 2002); P. Hawken et al., *Natural Capitalism* (Boston: Little, Brown and Co., 1999); J. Kovel, *The Enemy of Nature* (Halifax: Fernwood, 2002).

89. International Energy Agency, *World Energy Outlook 2009* (Organisation for Economic Co-operation and Development, 2009), p. 43.
90. Deep-water offshore oil resources will also be quickly crowded out in low GHG scenarios. Even among the two major suppliers of unconventional oil, Canada and Venezuela, the new Venezuelan projects are "expected to cost on average about one-third less than Canadian oil-sands projects on a per-barrel basis," International Energy Agency, *World Energy Outlook 2010*, p. 163.
91. International Energy Agency, *World Energy Outlook 2010*, pp. 383–384.
92. International Energy Agency, *World Energy Outlook 2010*, p. 159 and chapter 1. 450 stands for a global concentration of 450 parts per million (ppm) of carbon dioxide equivalent. It should be noted that 350 ppm $C0_2$-equivalent has also been proposed as a safe concentration level; see J. Rockstrom et al., "A Safe Operating Space for Humanity," *Nature* 461 (2009), pp. 472–475.
93. See International Energy Agency, *World Energy Outlook 2010*, p. 143.
94. S. Teske et al., "Energy [r]evolution," *Greenpeace Canada* (Toronto, 2010).
95. These figures represent capacity instead of production. Even with adequate demand, the IEA suggests that actual production is typically 20 percent below capacity due to maintenance, downtime, and incidents. International Energy Agency, *World Energy Outlook 2010*, p. 154.
96. Also note that The Alberta Chamber of Commerce established a goal of five million barrels per day from oil sands by 2030. Alberta Chamber of Resources, *Oil Sands Technology Roadmap* (2004).
97. Canadian Association of Petroleum Producers, *2010–2025 Canadian Crude Oil Forecast and Market Outlook* (2010), p. 23.
98. J. Rubin, *Why Your World is about to Get a Whole Lot Smaller* (New York: Random House, 2009).
99. E. Levant, *Ethical Oil* (Toronto: McClelland & Stewart, 2010).
100. During 2009, Copenhagen climate summit activists awarded Canada the overall "Fossil of the Year" award and accused Canada of following a deliberate strategy to "sabotage efforts to tackle climate change"; see "Canada Branded 'Colossal Fossil' at Climate Talks," *AFP* (2009).
101. For a critical explanation of why the oil industry has begun to request a national energy strategy to renew its social licence, see Teske et al., *Energy [r]evolution*, pp. 23–24.
102. See M. McCulloch et al., *Carbon Neutral 2020: A Leadership Opportunity in Canada's Oil Sands* (Pembina Institute, 2006). On carbon capture and storage, see M. Jaccard, *Sustainable Fossil Fuels* (Cambridge: Cambridge University Press, 2005). Other GHG reduction solutions could include a vapour extraction process (VAPEX) and toe-to-heel air injection (THAI). In a technology futures model, Halog and Chain depict a gradual substitution of VAPEX, THAI, and other emerging technologies for mining and steam-assisted gravity drainage (SAGD), with the result that emission increases level off to stay below 50 Mt/year and decrease closer to 40 Mt/year over a 50-year period. A. Halog and A. Chan, "Developing a Dynamic Systems Model for the Sustainable Development of the Canadian Oil Sands Industry," *International Journal of Environmental Technology and Management* 8/1 (2008).
103. J. Meadowcroft and O. Langhelle, *Caching the Carbon* (Cheltenham, UK: Edward Elgar, 2009), p. 13. The authors identify this paradox in the context of carbon capture and storage.
104. Expert Panel on Business Innovation, "Innovation and Business Strategy: Why Canada Falls Short," *Canadian Council of Academies* (2009).
105. Stanford, *Staples, Deindustrialization.*
106. For proposals such as these writings in the Canadian political economy tradition, see Clarke, *Tar Sands*, pp. 101–103. D. Gibson, "Taming the Tempest," (Parkland Institute, 2007); T.A. Turner and D. Gibson, "Back to Hewers of Wood and Drawers of Water," (Parkland Institute, 2005).
107. Notice especially the influence of J. Simpson et al., *Hot Air* (Toronto: McClelland & Stewart, 2007).
108. For a list of key processes, or functions, required for the development of new technological systems, see A. Bergek et al., "Analyzing the Functional Dynamics of Technological Innovation Systems: A Scheme of Analysis," *Research Policy* 37/3 (2008), pp. 407–429 ; M.P. Hekkert

et al., "Functions of Innovation Systems: A New Approach for Analysing Technological Change," *Technological Forecasting & Social Change* 74/4 (2007), pp. 413–432.

109. Note that even strong CCS proponents only highlight it as a "bridging technology" that buys time for the advent of more radical renewable energy based futures. See Meadowcroft and Langhelle, *Caching the Carbon*, p. 150.
110. Watkins, *A Staple Theory*, p. 151.
111. For a survey of provincial climate strategies juxtaposed to inaction at the federal level, see D. Marshall, "Provincial Power Play," (David Suzuki Foundation, 2008).
112. McDonough and Braungart, *Cradle to Cradle*, p. 32, remind us that "for the majority of our simple energy needs, humans could be accruing a great deal of current solar income, of which there is plenty: thousands of times the amount of energy needed to fuel human activities hits the surface of the planet every day in the form of sunlight."