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STABILITY AND CLIMATE POLICY?

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-Discussion Paper-

Stability and climate policy?

Harnessing insights on path dependency, policy feedback, and transition pathways to help accelerate the low-carbon transition

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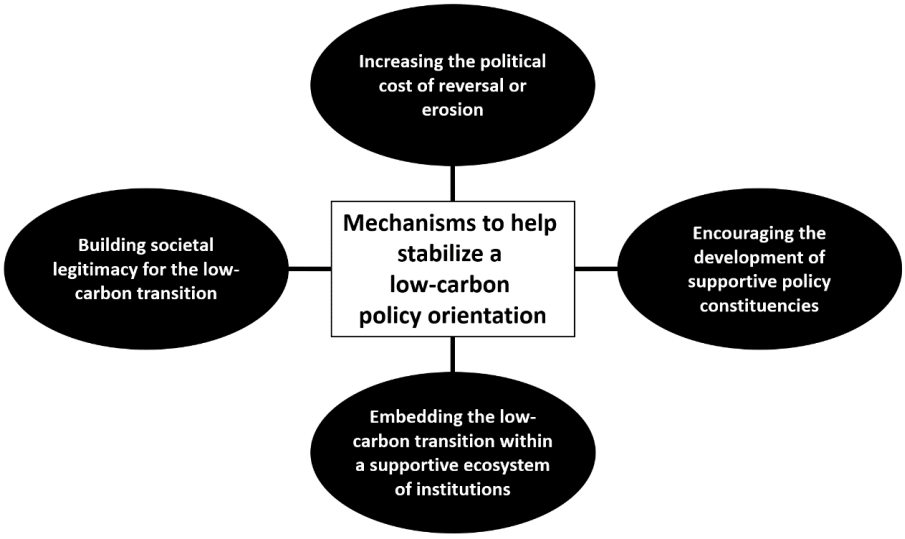
Executive summary

Climate policy stability is often considered to be instrumental in redirecting significant financial flows toward climate action by minimizing risk and uncertainty for investors. The logic is that uncertain climate policies create too many risks for private sector actors seeking to engage in low-carbon ventures. There are, however, many sources of instability that complicate the enactment of enduring responses along with tensions between policy stability and adaptability in the context of multidecadal processes of low-carbon innovation. And so, instead of emphasising policy stability, we adopt a somewhat more modest goal: *stabilizing the overarching orientation of climate policy as a transition towards a low-carbon economy*. That is, we are principally concerned with the role of policy in making the low-carbon course of development durable, signalling continuous movement in this direction. It is this goal that motivates our analysis and raises two central research questions. First, how can the overarching direction of low-carbon change be stabilized, avoiding the reversal or erosion of the low-carbon course of development? Second, through which specific *mechanisms* might this policy orientation be instilled with greater "stability, coherence, and integrity as time passes, achieving its basic promised goals [i.e., decarbonization] amid the inevitable vicissitudes of politics" (Patashnik, 2003, p. 207)? In order to address these interrelated questions, this paper surveys the diverse literature on policy stickiness, drawing on three concepts of particular relevance for this discussion: path dependency, policy feedback, and transition pathways. From this, we distill four prominent mechanisms that may help stabilize the overarching climate policy orientation and entrench the low-carbon transition: (1) increasing the political cost of reversal or erosion; (2) encouraging the emergence and development of supportive policy constituencies; (3) embedding the low-carbon transition within a supportive ecosystem of institutions; and (4) building societal legitimacy for the low-carbon transition. These mechanisms are summarized below.



Increasing the political cost of policy reversal or erosion encompasses several specific elements that can be integrated within policy formulation considerations. First, governments may signal their long-term commitment to the low-carbon transition through contractual obligations tied to large infrastructure projects. Sunk costs can act as a powerful deterrent for reversal or erosion due to the high cost of cancellation and adopting alternatives. Second, decarbonization priorities may be linked to other commitments and institutional arrangements. These entanglements can make it very difficult to unwind a low-carbon policy orientation without significantly adjusting other more rigid structures and priorities. Third, research from the United States suggests that there may be value in exploring the use of automatic triggers and penalties for failing to implement policies or meet objectives. Fourth, authoritative and transparent monitoring processes may also help stabilize a low-carbon policy orientation by making choices more explicit, revealing moves to reverse or erode commitments and creating opportunities for actors to intervene.

Encouraging the emergence and development of supportive policy constituencies involves activating supportive interest groups through the use of program resources and interpretive effects. The aim is for climate policy to deliberately target actor groups who will develop an interest in the low-carbon transition and defend this course of development in subsequent rounds of policy debate. This can be realized most directly by allocating incentives to targeted actor groups but may also be carried out by building government and societal capacities or by reshaping stakeholder engagement and deliberative processes to provide certain actors with greater access to policymaking functions. The way in which a problem is framed may also help to crystallize the political identities of actor groups and create additional space for supportive networks.

Embedding the low-carbon transition within a supportive ecosystem of institutions relates to strengthening the institutional arrangements surrounding the low-carbon transition. There are many different ways to go about this and different models have been proposed, spanning from a carbon budgeting process to a ‘central bank’ for carbon. Either would involve building new

capacity around climate change policy and planning, implementation and alignment, monitoring and reporting, as well as data collection and communication. Some of these functions could be housed within government, whereas others may be located with nongovernmental organizations or arm's length bodies, lengthening the time horizons under consideration and partially insulating elected officials from politically unpopular decisions. Other possibilities could include expanding opportunities for judicial review, more formally networking existing actors engaged in climate action, creating new funding streams to fulfill additional functions, along with establishing one or more climate-related research institutes. Taken together, institution building represents an important social complement to material forms of sunk costs (building infrastructure) given that institutions become increasingly difficult to dismantle the longer they have been in place.

Building societal legitimacy for a low-carbon transition concerns socially and culturally embedding the transition to a low-carbon Canada within the public consciousness. While Canadians care about the environment, the need for a large-scale transformation of the economy in order to address climate change has yet to be broadly accepted. Given the scale and scope of this challenge, there is an important role for engaging the public and building further understanding and acceptance surrounding decarbonization. As a first step, this would involve reframing the debate in terms of a long-term low-carbon transition. Rather than focusing on carbon pricing regimes or pipeline development, thinking in terms of the low-carbon transition frames the challenge as a multidecadal and system-wide change involving not only technologies but also policies, actions, and investments grounded in Canada's distinct regional political economies. More specific actions could include: (1) enhancing citizen engagement around the low-carbon transition (e.g., community-level and citizen-driven low-carbon innovation projects); (2) integrating learning about the transition as part of basic education; and (3) creating national conversations and focusing events that revolve around the transition (e.g., Natural Resources Canada's Generation Energy).

These mechanisms are likely to be more effective when deployed in combination rather than individually. There is also a temporal dimension to each of the mechanisms that should be considered as some will have near-term effects (e.g., entering into a contractual obligation to develop infrastructure will have more proximate impacts), whereas others have more distant influences (e.g., investing in education and training may take much longer). Perhaps most importantly however, harnessing the abovementioned mechanisms is not a neutral process as it can create the conditions for policy capture and lock in. So, while stabilizing a low-carbon policy orientation holds much promise, it is not without its risks.

1. The challenge of climate policy instability

In order to avoid the most catastrophic impacts of climate change, the rapid mobilization of significant financial capital is needed to reconfigure transport, electricity, agriculture, and other societal systems in a low-carbon fashion. Figueres et al. (2017), for instance, suggest that investors will need to deploy more than $1 trillion (USD) per year by 2020 to meet the goals set by the Paris agreement. Credible and stable climate policy, in this view, is considered to be essential for the reorientation of financial flows toward climate action (Bassi et al., 2017). The logic is that uncertain climate policies create too many risks for private sector actors seeking to engage in low-carbon ventures. Internationally, large institutional investors have called for "stable, reliable and economically meaningful carbon pricing that helps redirect investment commensurate with the scale of the climate change challenge" (GIC, 2016, 2014). In Canada, investors have made similar arguments, pointing to the need for "sound policy certainty" to allow the long-term investment strategies of businesses to take hold (Chapman et al., 2017). In principle, governments have understood that clear and enduring policy signals are required to address climate change (Stern, 2007) and redirect individual behaviour and business models toward low-carbon alternatives. Indeed, "durability is perceived to be *the* Holy Grail of climate policy design" (Jordan, 2017).

Yet, despite this recognition of the importance of providing stable and credible signals, climate policy frameworks continue to undergo considerable and unpredictable change. National climate policies and targets appear to be particularly susceptible to what Cashore and Howlett (2007) refer to as "faux paradigmatic change" – such as when a new administration is elected and reverses the major climate policies of the previous administration. Consider, for instance, the ongoing reversal of the Obama-era Clean Power Plan under the Trump administration in the United States (Gustin, 2017). This creates uncertainty for investors by undermining the rationale for new renewable energy projects already in the pipeline and minimizing the potential of new investments. Complete reversal is, however, not the only way in which climate policy uncertainty manifests. Defunding critical programs, failing to move to implementation, and not enforcing rules, among other issues may also seriously weaken policy signals and objectives (Patashnik, 2008; Rietig and Laing, 2017). For example, clean electricity policy in Ontario, which has been subject to almost continuous policy revision over the past two decades, has exposed energy investors and developers to substantial uncertainty as technological preferences and targets, programs and incentives, and underlying market rules are altered (Rosenbloom et al., 2018). Other similar experiences can be found in many other jurisdictions.

Often characterized as a "super wicked" policy problem (Levin et al., 2009, 2012), discussion of the inherent difficulty of addressing climate change forms a staple of the policy literature. Different analyses and theoretical traditions may highlight slightly different elements of the problem, but structural features which are typically given prominence include:

- *Operative timeframes*: this is a problem that plays out over decades and centuries. Greenhouse gases have been accumulating since the industrial revolution; impacts of current emissions will be felt far into the future, particularly if the climate system passes critical thresholds. Policy action requires costs be borne today in order to avoid ever more serious consequences in the future. Yet, political systems oriented towards short-term economic and political cycles are poorly adapted to address this challenge.

- *Global reach*: emissions from all over the world contribute to the problem, so a cooperative response is required. Each country requires some assurance that other nations will do their share. But in the absence of a global sovereign, and considering the great diversity of national circumstances (where countries have different responsibilities for generating the problem, vulnerabilities to the changing climate, and resources to adapt and support mitigation), cooperation is elusive.
- *Distributional implications*: the impacts of climate change, and of the climate policy response, will vary across states, regions, economic sectors, firms, and social strata. This relates to the distribution of costs and benefits as well as risks and opportunities across rich and poor countries and multiple generations. So, shifting arrays of economic, social, and political actors seek to influence the policy response in conflicts over ideas, interests, and identities.
- *Pervasive uncertainties*: climate policymaking is plagued by uncertainty. This is not just about the future of the climate system (e.g., climate sensitivity) or the impacts on humans and ecosystems of any given temperature rise, but also about the factors driving emissions growth (e.g., economic growth and demographic change) and influencing policy responses (e.g., international climate agreements, trade rivalries, economic shocks, geostrategic competition among great powers, the pace and direction of technological development, and unanticipated environmental impacts).
- *Complex normative entanglements*: while all policy issues have normative dimensions, the array of interconnected value choices implicated in climate decision-making is particularly dense. The comparative assessment of risk, the distribution of costs and benefits (across generations, regions, and social actors), and concern for human and ecosystem impacts have an irreducible normative dimension which underpin alternative approaches and policy frames. Since there is not simply one low-carbon trajectory – there are a multitude of different low-carbon futures (with different technologies, social practices, patterns of distribution, and so on) – struggles about which of these futures is more or less desirable is a permanent feature of climate politics and policy.

The structural characteristics that make climate mitigation such a challenge are also the underlying drivers of policy instability (see Table 1). And, how the interplay of these features plays out in relation to particular national political systems at different points in time is variable. In Canada, for example, data suggests that there is limited recognition of the importance, scale, and scope of the climate change challenge (Environics Research, 2017). By extension, there is still room to engage further with climate change and what a robust response might constitute. To be sure, Federal interventions (e.g., the Pan-Canadian Framework on Clean Growth and Climate Change), regional approaches (e.g., the BC carbon tax), and sectoral policies (e.g., new renewable energy procurement) represent promising steps forward. However, these actions alone will not be sufficient to meet climate commitments (Environment and Climate Change Canada, 2017). Moreover, while the scientific basis of climate change is clear (IPCC, 2013), the direction low-carbon change should take is far from settled. There remain important divergences among experts and interests in this regard. Proposals for Canada's future energy systems, for instance, differ markedly on the role of new renewables, fossil fuels, and nuclear (Bataille et al., 2015; Teske and Martin, 2010; Trottier Energy Futures Project, 2016). This not only links to uncertainties about potential innovation trajectories (the relative and long-term potential of technologies) but also divergences about the guiding principles (precaution or efficiency), types

of institutional arrangements (pricing or regulatory regimes), and patterns of ownership (small-scale distributed versus large-scale investor-led) that may best orient low-carbon change. These tensions reflect cleavages between different material interests, ideologies, and regional political economies (e.g., the presence of large resource extraction industries) across Canada. Beyond this, climate action implies imposing costs on actor networks with vested interests in the current carbon-intensive system. Although these costs will span societal actors, more concentrated burdens will be imposed on distinct regions (e.g., Alberta and Saskatchewan), industries (e.g., fossil fuel extraction and processing), and communities (e.g., energy-intensive rural and remote townships). The relative distribution of these impacts may drive actors to mobilize against climate policy (Weaver, 2010).

Table 1: Prominent sources of instability in climate policy

Prominent sources of instability	Potential effects
1) Operative timeframes	Policy weakened or reversed as short-term political priorities change (e.g., retrenchment of Ontario clean energy policy in response to affordability concerns)
2) Global reach	Policy adjusted to align with international climate ambition (e.g., national climate response moderated in the face of Trump administration policy direction)
3) Distributional implications	Policy weakened or reversed as opponents of robust climate policy swamp proponents (e.g., mobilization of fossil fuel interests challenging the Clean Power Plan in the United States)
4) Pervasive uncertainties	Policy revisited based on emerging technological trends, learning, and external shocks (e.g., rapid decline in price of solar energy changes playing field)
5) Complex normative entanglements	Policy reoriented given the negotiation of underlying values (e.g., Germany's value judgement that nuclear will not play a role in the low-carbon transition)

The preceding discussion suggests that a substantial degree of instability in climate policy responses is unavoidable. Moreover, because of the scale of the societal transformation required, *excessive attachment to particular policy frameworks, targets, and instruments will in some cases be inappropriate*. Decarbonization will entail dramatic changes to systems of societal provisioning (energy, transport, agriculture, and so on) and the disruption of existing technological configurations, markets, business models, and social practices (Geels and Schot, 2007; Smith et al., 2005). Over the course of a multi-decadal *low-carbon transition*, climate policy will need to continually adapt to changing circumstances (Meadowcroft, 2016) and encourage processes of dramatic and often disruptive change (Kivimaa and Kern, 2016). And so, instead of emphasising policy stability, we adopt a somewhat more modest goal: *stabilizing the overarching orientation of climate policy as a transition towards a low greenhouse gas emission economy*.

It is this goal that motivates our analysis and raises two central research questions. First, how can the overarching direction of low-carbon change be stabilized, avoiding the *reversal* or *erosion* of

the low-carbon course of development? Second, through which specific *mechanisms* might this policy orientation be instilled with greater "stability, coherence, and integrity as time passes, achieving its basic promised goals [i.e., decarbonization] amid the inevitable vicissitudes of politics" (Patashnik, 2003, p. 207)? In order to address these interrelated questions, this paper surveys the diverse literature on policy stickiness, drawing on three concepts of particular relevance: *path dependency*, *policy feedback*, and *transition pathways*. After detailing these key concepts, we distill prominent mechanisms that may help stabilize the overarching climate policy orientation and entrench the low-carbon transition. These mechanisms are illustrated using examples drawn largely from the climate-energy space. The analysis concludes with additional reflections on these mechanisms and lessons for the design of climate policy.

2. Path dependency, policy feedback, and transition pathways

Path dependency and *policy feedback* have attracted considerable interest as useful concepts for engaging with policy stability and discontinuity. Indeed, "the related concepts of policy feedback and path dependence have become central to the study of the politics of public policy" (Jacobs and Weaver, 2015, p. 441). While these concepts can be traced back to a rich body of policy and political science literature (Béland, 2010; Campbell, 2012; Garud and Karnoe, 2001; Mahoney, 2000; Pierson, 1993, 2000; Thelen, 1999), here we principally focus on elaborating their applicability to the climate policy field (Aghion et al., 2016; Bernstein and Hoffmann, 2016; Fouquet, 2016; Giest, 2014; Lazarus, 2008; Levin et al., 2012; Lockwood, 2013; Munck af Rosenschöld et al., 2014). The complementary concept of *transition pathways* incorporates perspectives on path dependency and low-carbon transitions (Foxon, 2013; Hughes et al., 2013; Rosenbloom et al., 2018; Turnheim et al., 2015). Based on a survey of these core concepts, we distill three central lessons: (1) *early sequences of choices can set in motion self-reinforcing courses of development*; (2) *policy choices (and specific design elements) are a particularly important way in which self-reinforcing patterns of development can be enacted*; and (3) *while early choices matter, it is the cumulative sequence of choices over time that helps shape outcomes*. These lessons guide the formulation of mechanisms to strengthen the directionality of the low-carbon transition presented in section 3.

2.1 What is path dependency?

Path dependency relates to the notion that choices taken at an earlier point in time can set in motion a particular course of societal development that can affect choices far into the future (Mahoney, 2000). This process often manifests as a kind of historical inertia, whereby early choices close down the envelope of future choices in such a fashion as to reproduce established societal arrangements (Munck af Rosenschöld et al., 2014). Stated differently, "preceding steps in a particular direction induce further movement in the same direction" (Pierson, 2000, p. 252). This process can appear to "lock in" certain technological and institutional arrangements given: (1) the sunk costs associated with the current system, (2) the accumulation of experience around established technologies and institutions, (3) self-fulfilling expectations about the persistence of these arrangements, and (4) increasing benefits of moving in the established direction – e.g., standardization and access to financing (Unruh, 2000). Beyond these four drivers of path dependence, patterns of self-reinforcement also occur because specific institutions and technological arrangements tend to become accepted as natural the longer they are in place (Pierson, 2000), possible alternative institutional and technological trajectories are not equally viable at any point in time (Giest, 2014), and there are often positive feedbacks between an

institutional setup and its beneficiaries – i.e., vested interests (Pierson, 1993). Figures 1 and 2 provide a schematic illustration of a path dependent process (Figure 1) and potential drivers (Figure 2) encouraging further movement in the same direction.

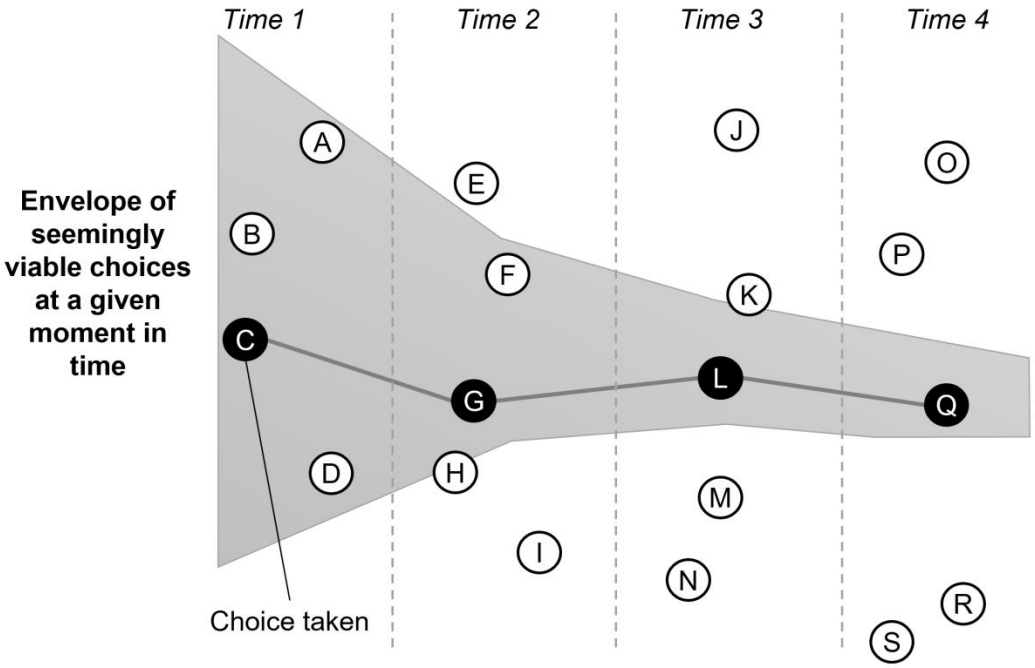


Figure 1: Schematic illustration of a path dependent process

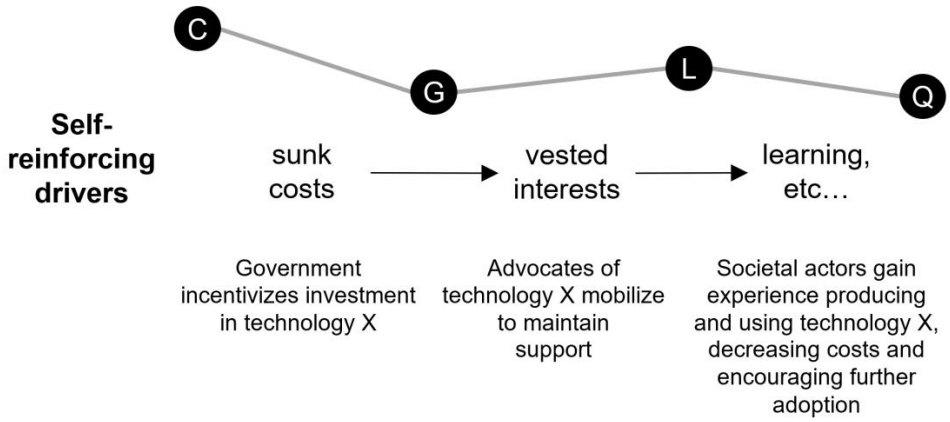


Figure 2: Examples of drivers underlying a path dependent process

The central idea here is that *early sequences of choices can set in motion a course of events that becomes self-reinforcing over time*. Numerous historical cases of societal and technological development reflect this self-reinforcing pattern. The diffusion of the light water nuclear reactor, QWERTY keyboard, and VHS recording standard, among other innovations were driven not by their technological superiority but because early choices and events created self-reinforcing trajectories that made selecting alternatives increasingly difficult (Cowan, 1990; David, 1985).

Consider, for example, the case of the light water nuclear reactor, which has captured the majority of the market for nuclear power in the United States despite the presence of competitors (e.g., heavy water reactors) considered to be arguably more efficient (Cowan, 1990). This dominance can be traced back to the early post-war period, when the United States Navy made a choice to pursue the adoption of the light water reactor in submarine applications. In light of national security considerations (nuclear technology dominance), they rapidly committed to the light water reactor and drove their commercial partners (Westinghouse and General Electric) toward its development, desiring to produce a nuclear submarine as quickly as possible. This created the conditions for Westinghouse and General Electric to gain experience with the light water reactor and bring these capabilities to the development and subsequent rollout of civilian nuclear power. Incentives for Westinghouse and General Electric along with agreements with European jurisdictions (through Euratom) helped to secure broader markets and further steer adoption of light water designs. Beyond this case, path dependent processes have helped explain how different political and economic arrangements (from resource-based economies and high-tech sectors to specific forms of labour relations and market structures) have emerged and persisted given early choices and events (Haley, 2011; Kenney and Von Burg, 2001; Mahoney, 2000; Thelen, 1999). Even the rise of particular political parties appears to be marked by path dependent dynamics (Skocpol, 1999). With respect to policy, the entrenchment and stability of longstanding social programs (Béland, 2010; Skocpol, 1995) as well as economic subsidy programs and market deregulation initiatives (Patashnik, 2008) have also been linked to patterns of path dependence.

Understandably, path dependent processes are traditionally considered to be a barrier to the adoption of low-carbon innovations. They explain how early policy choices and investments in carbon-intensive technologies have helped lock in further movement in this direction despite the subsequent availability of more environmentally desirable alternatives (Unruh, 2000). Yet, while early choices have set in motion self-reinforcing sequences of carbon-intensive development, there is now a growing body of research suggesting that it is equally possible to harness path dependent processes to make low-carbon policy frameworks more durable (Bernstein and Hoffmann, 2016; Jordan and Matt, 2014; Lazarus, 2008; Levin et al., 2012).

2.2 What is policy feedback?

A particularly important way in which path dependency can manifest is through policy. In marked contrast to models of policy development which view policy as the unidirectional result of politics, *policy feedback* is concerned with the "impact of previously enacted policies on future political behavior and policy choices" (Béland, 2010, p. 570). Put differently, "[e]xisting policies define the political environment, shaping the capacities, interests, and beliefs of political elites and states and therefore the outcomes of subsequent rounds of policy making" (Campbell, 2012, p. 334). Policy and politics, in this view, have a bidirectional relationship with early policy choices influencing later rounds of political debate and policy selection.

Pierson (1993) has helpfully outlined two prominent ways in which policy feedbacks manifest: (1) resource and incentive effects and (2) interpretive effects. With respect to the former, policies provide incentives and resources that may modulate the creation or expansion of particular groups. Policies, in this view, can "activate" or "empower" different constituencies and interests by building government capacities (e.g., enhanced monitoring capabilities) and augmenting

resources (e.g., access to decision-makers and creating forums for actor organization). Similarly, government can also more directly advantage particular interest groups through policy (e.g., research funding, attractive financing arrangements, tax measures, and procurement). The beneficiaries of a policy – also commonly referred to as "instrument constituencies" – can, in turn, be expected to mobilize during subsequent rounds of political debate in order to support and attempt to expand their favoured programs and institutional arrangements (Béland et al., 2017; Voß and Simons, 2014). Consider, for instance, the way in which particular industrial strategies around nuclear power have created powerful networks of interests that now mobilize to protect their endowments and favoured positions in policymaking processes. Indeed, policies "create powerful packages of resources and incentives that influence the positions of interest groups, government elites, and individual social actors in politically consequential ways" (Pierson, 1993, p. 610).

Interpretive effects, on the other hand, relate to the more cognitive implications of policies (Pierson, 1993). In this understanding, policy frameworks can activate particular interests by framing problems in certain ways. Take, for instance, the difference between framing climate change in terms of "climate justice" versus a shift to a "green economy". The former emphasizes the distributional impacts of climate change and presents a greater role for actors concerned with equity and marginalization. The latter, in contrast, frames the challenge as one of reconfiguring the economy and creates much larger openings for incumbent firms in driving low-carbon change. Through framing, policies can therefore play a role in constructing and constituting the political identities of the groups they impact (Patashnik and Zelizer, 2013).

Importantly, these effects can be positive (self-reinforcing) but also negative (self-eroding). A policy may, for instance, have latent but gradually rising fiscal commitments that limit its continuation (Béland, 2010; Weaver, 2010). Equally, policies may activate groups that mobilize around its reversal in subsequent rounds (Jordan and Matt, 2014). Consider, for example, the backlash against wind development in Ontario from rural residents when policy frameworks encouraged large-scale developer-led projects and curtailed the authority of local planning bodies (Fast et al., 2016). Still others point to interpretive effects associated with emphasizing the adverse impacts stemming from a policy (Jacobs and Weaver, 2015) or that prevent groups from identifying with a policy (Campbell, 2012). Take, for example, how the stigma of "welfare" may limit the formation of coalitions willing to link their identities to this program. In this way, it is not only appropriate to consider how a policy (and climate policy, in particular) might help perpetuate itself, but also how it might undermine its continued implementation over time.

2.3 What are transition pathways?

Path dependence and policy feedback reveal how an early set of choices can have long-term repercussions for the pursuit of decarbonization and that these repercussions merit attention as part of policy design. Literature on *transition pathways* complements this thinking, emphasizing that the low-carbon transition embodies: multiple directions and processes of change – some more orderly and others less so (Geels and Schot, 2007); interactions among technological, social, and natural dimensions; and, cumulative choices spanning several decades (Rosenbloom, 2017a). Drawing on these ideas, different modelling communities have applied transition pathways to contemplate alternative possible low-carbon futures and identify robust responses (Bataille et al., 2016; Li et al., 2015; Turnheim et al., 2015). While individual approaches and

perspectives vary (Geels et al., 2016), it is understood that multiple choices (e.g., the adoption of particular institutional commitments or investments in specific technologies and infrastructure) at distinct moments in time will need to be strung together to realize a low-carbon transition and that this process can be encouraged by attending more carefully to the trajectories suggested by alternative choices (Foxon, 2013; Hughes et al., 2013). In this fashion, transition pathways can be thought of as being constituted by self-reinforcing sequences but also *punctuated by branching points* (Foxon et al., 2013), which offer actors the opportunity to reinforce the original trajectory or veer toward alternative directions (Rosenbloom et al., 2018). This highlights that while early choices may create self-reinforcing courses of development that close down or open up certain possibilities in the future, later choices may still undermine (or further reinforce) these directions. Recognizing the existence of certain self-reinforcing processes may also help in breaking away from rigidities and opting for alternative trajectories (Berkhout, 2002; Kemp et al., 2001). And so, it is *the cumulative interaction among early and later choices that help define a low-carbon transition pathway* (see Figure 3).

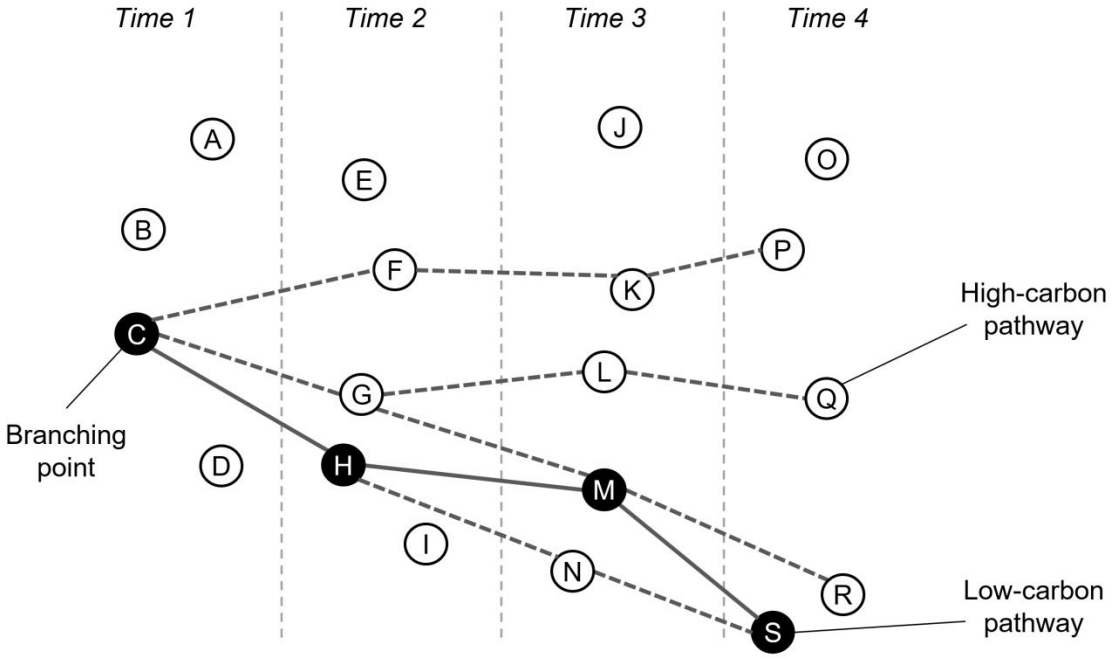


Figure 3: Sequences of choices, branching points, and low-carbon pathways

This sequential pattern of development is reflected within a number of historical experiences such as Ontario's coal phase-out. At the outset of the coal phase-out, an initial policy decision was taken by the newly elected Liberal administration in 2003, which framed the issue in terms salient environment-health impacts (Rosenbloom, 2017b). This effort was reinforced by mounting environmental concerns as well as earlier choices (e.g., the decisions to retain public ownership of coal-fired facilities and to shutdown the Lakeview coal-fired generating station near Toronto by 2005) but these forces were insufficient to drive full implementation on their own. Early on, the phase-out encountered challenges tied to reliability and economic concerns (e.g., employment losses at the affected plants). Alternative options were proposed such as the installation of scrubbing units to remove particulate matter and keep the coal plants in operation. In response, successive choices were taken to deactivate these concerns – delaying the shutdown

of coal units until other sources could be brought online, along with converting some coal units to burn biomass. In this fashion, there were challenges at each step and opportunities to begin to veer away from the initial policy direction despite its momentum. Later choices helped lend strength to the initial plan and defuse resistance, promoting the stepwise shutdown of the remaining coal-fired units (Harris et al., 2015).

Thinking in terms of transition pathways, therefore, not only underscores the importance of cumulative policy and technological choices for the overarching low-carbon transition but also illustrates that there are multiple possible ways to get from current systems to a variety of low-carbon futures. While path dependent processes may make certain choices more or less viable at any given time, transition pathways are far from determined based solely on initial choices. In this fashion, there is merit in continually monitoring and evaluating the implications of specific policy and technology decisions for particular directions of low-carbon change.

3. Mechanisms to help stabilize a low-carbon policy orientation

Based on a review of the literature on policy stickiness, we identify four particularly promising mechanisms to help stabilize the overarching climate policy orientation: (1) *increasing the political cost of reversal or erosion*; (2) *encouraging the emergence and development of supportive policy constituencies*; (3) *embedding the low-carbon transition within a supportive ecosystem of institutions*; and (4) *building societal legitimacy for the low-carbon transition* (see Table 2). These mechanisms are not meant to be mutually exclusive and may in practice function together to lend strength to a low-carbon course of development. Importantly, it is not the specific climate policies that we are interested in making sticky but rather the overarching directionality of policy – that it continues to be aimed at decarbonization. The following discussion details each of the mechanisms and provides some illustrative examples.

Table 2: Prominent mechanisms to help stabilize a low-carbon policy orientation

Mechanisms	Examples
Increasing the political cost of reversal or erosion	Procurement and infrastructure spending Linkages and entanglements Automatic triggers and penalties Increased transparency
Encouraging the emergence and development of supportive policy constituencies	Resources and incentives Problem framing
Embedding the low-carbon transition within a supportive ecosystem of institutions	Strengthened institutions and functions
Building societal legitimacy for the low-carbon transition	Education and engagement

3.1 Increasing the political cost of reversal or erosion

Increasing the political cost of policy reversal or erosion encompasses several specific elements that can be integrated within policy formulation considerations. First, governments may signal their long-term commitment to the low-carbon transition through contractual obligations tied to large infrastructure projects. Sunk costs can act as a powerful deterrent for reversal or erosion due to the high cost of cancellation and adopting alternatives. Consider, for instance, how the recently elected NDP administration in British Columbia decided to carry on with the development of the Site C hydroelectric dam near Fort St. John despite the project's ties to the previous Liberal administration as well as anticipated cost overruns of more than $1.5 billion

(McElroy, 2017). The province had already spent $2 billion on the project, reinforcing further movement in the same direction.

Second, decarbonization priorities may be linked to other commitments and institutional arrangements. These entanglements can make it very difficult to unwind a low-carbon policy orientation without significantly adjusting other more rigid structures and priorities. Consider, for instance, how revenue-neutral carbon pricing may act as a substitute for income tax revenue and erosion or reversal would entail recovering lost revenue through increased income taxes. British Columbia and its carbon tax provide a useful case in point as revenues have not only gone toward reducing income taxes but also to school boards and municipalities committed to decarbonization (Harrison, 2013; Levin et al., 2012). With this, reversal would involve upsetting several streams of funding linked to different organizations and individuals (Giest, 2014). Multi-lateral and international agreements represent another form of institutional entanglement (Rietig and Laing, 2017). Take, for instance, how Quebec and Ontario have linked their cap-and-trade systems with California through the Western Climate Initiative. While this linkage has been insufficient to deter the Ontario Progressive Conservative Party from proposing to withdraw from the initiative, doing so will come with a reputational cost. More importantly however, linkages can involve bridging different policy priorities so that the pursuit of climate objectives simultaneously unlocks improvements in housing, health, economic development, transport, and so on (Shaw et al., 2014). Reversal or erosion, in this instance, would also imply undermining engagement around other critical societal objectives.

Third, research from the United States suggests that there may be value in exploring the use of automatic triggers and penalties for failing to implement policies or meet objectives on time (Lazarus, 2008). Lazarus cites the example of the US Environmental Protection Agency's hazardous waste standards. While previous standards had been held up in court by regulated industries, harsh penalties for missing implementation deadlines (limiting the disposal of waste on land) were incorporated within more recent legislation to deter court challenges that would lead to delays. Similarly, built in triggers can be linked to objective data that transparently identifies failures. The US EPA, under the Clean Air Act, objectively identifies regions according to nonattainment provisions for air quality. A more extreme example from the US context involves tying the negotiation of budget bills to politically damaging government shutdowns. This, however, reveals that statutory triggers can also backfire, further politicizing and destabilizing issues as actors strategically use penalties to lay blame on political opponents.

Fourth, authoritative and transparent monitoring processes may also help stabilize a low-carbon policy orientation by making choices more explicit, revealing moves to reverse or erode commitments and creating opportunities for actors to intervene. The use of transition pathways as an assessment tool has been proposed not only to plan steps to reach low-carbon futures but also to monitor and communicate progress (Bataille et al., 2016; Rosenbloom, 2017a). In the United Kingdom, the Committee on Climate Change plays this role (Lockwood, 2013).

3.2 Encouraging the emergence and development of supportive policy constituencies

This mechanism relates to the development of supportive interest groups through the use of program resources and interpretive effects. The aim is for climate policy to deliberately target actor groups who will develop an interest in the low-carbon transition and defend this course of

development in subsequent rounds of policy debate. With respect to resource effects, more concentrated and targeted benefits to core constituents rather than thin and diffused benefits are argued to provide greater incentive for actor mobilization (Downie, 2017). Despite this, there is also a need to broaden support over time by expanding the pool of beneficiaries (Levin et al., 2012). This can be realized most directly by allocating incentives to targeted actor groups (e.g., procurement, research funding, and subsidies for cleantech industries) but may also be carried out by building government and societal capacities (e.g., establishing new governmental units and funding for training and education in low-carbon industries) or by reshaping stakeholder engagement and deliberative processes to provide certain actors with greater access to policymaking functions (e.g., shifting decision-making authority to Environment and Climate Change Canada). Through green industrial policy, Germany has been quite successful in developing a renewable energy industry that has mobilized and helped secure political victories in later rounds of policy debate (Jacobsson and Lauber, 2006). Over the past two decades, it has adopted renewable energy deployment programs (e.g., feed-in tariffs and more recently auctions), set ambitious renewable energy targets (100% of electricity supply from renewables by 2050), and placed greater control over renewable energy decision-making with the Ministry of Environment, Nature Conservation, Building and Nuclear Safety (as opposed to the Ministry of Economics and Technology). Meckling et al. (2015) corroborate the centrality of green industrial policy, suggesting that it has been instrumental in building momentum for more ambitious decarbonization strategies such as the adoption of carbon pricing. To be sure, there are also risks if the benefits of a policy appear overly generous or are allocated to an ostensibly undeserving recipient. The feed-in tariff in Ontario, for instance, has been the target of controversies relating to windfall profits for new renewable energy developers from out-of-province as well as undue financial burdens for domestic energy users (Stokes, 2013), which has weakened momentum for decarbonization.

Interpretive effects are also not to be ignored as the way in which a problem is framed will help structure how the problem is addressed (Fischer and Forester, 1993) along with the political identities of actor groups (Pierson, 1993). As mentioned earlier, the coal phase-out in Ontario was framed in terms of salient environment-health issues that resonated with the public and created considerable space for local health advocacy groups to mobilize (Rosenbloom, 2017b). Ontario's support for renewable energy technologies, in contrast, was tied to climate and industrial development priorities yet was left largely undefended by the Liberal administration following adoption despite assertions that renewables had become a drain on the economy through rising electricity prices (Rosenbloom et al., 2016). Research suggests that the competitiveness impacts of rising electricity prices (much of which do not stem from climate policy) have been fairly minor in key sectors such as auto manufacturing, adding between $2 and $11 to the cost of producing a vehicle (Mordue, 2017). In this way, the strategic narratives that emerge around climate policy (in the media, among the public, and within businesses) are of equal importance to its design.

3.3 Embedding the low-carbon transition within a supportive ecosystem of institutions

This mechanism involves strengthening the institutional ecosystem surrounding the low-carbon transition. There are many different ways one could go about this, so here we focus on a few examples. First, one could envision creating new institutional requirements modeled after the UK carbon budgeting process (Priestley and Grimwood, 2017), with obligations to plan for and

report on near-term emission limits. This would involve building new capacity around climate change policy and planning, implementation and alignment (ensuring consistency across government responses), monitoring and reporting, as well as data collection and communication. Some of these functions could be housed within government, whereas others may be located with nongovernmental organizations or arm's length bodies (perhaps akin to the UK Committee on Climate Change). Expert review panels, for instance, could help inform the calibration of the carbon levy, lengthening the time horizons under consideration and partially insulating elected officials from politically unpopular decisions. Some have even proposed developing a 'central bank' for carbon, which would monitor and adjust carbon pricing signals along with issuing reports about long-term trends (de Perthuis, 2011). Second, strengthening the institutional ecosystem could also involve creating new opportunities for broader societal actors to hold governments to account. Some have pointed to the potential of litigation and judicial review in addressing climate policy gaps (Estrin, 2016) or aligning responses with climate science (Policy Horizons Canada, 2017). Others have suggested enshrining climate priorities within an environmental bill of rights or environmental constitution (Boyd, 2014). Still, there are concerns that increased reliance on judicial bodies may not only be ineffective but may undermine democratic processes (Macfarlane, 2014). Third, efforts could be made to build institutional capacity around the low-carbon transition by more formally networking actors (e.g., HINKU in Finland, which links municipalities engaged in decarbonization) as well as creating new funding streams with mandates to support the fulfillment of climate research, monitoring, and planning functions. This could take the form of one or more low-carbon research institutes, which could conduct applied work on low-carbon economic development. From these new institutes, new data and research could emerge but also skilled policy communicators and novel messaging strategies that may help to drive climate engagement (Nisbet, 2009). Taken together, institution building represents an important social complement to material forms of sunk costs (building infrastructure) given that institutions become increasingly difficult to dismantle the longer they have been in place and as they begin to take on important roles and become interconnected with public and private sector actors at all levels.

3.4 Building societal legitimacy for a low-carbon transition

While Canadians care about the environment, the need for a large-scale transformation of the economy in order to address climate change has yet to be broadly accepted. Given the scale and scope of this challenge, there is an important role for engaging the public and building further understanding and acceptance surrounding decarbonization. In this way, the task is no less than to socially and culturally embed the transition to a low-carbon Canada. As a first step, this would involve reframing the debate in terms of a long-term low-carbon transition (Meadowcroft, 2016). Rather than focusing on carbon pricing regimes or pipeline development, thinking in terms of the low-carbon transition frames the challenge as a multidecadal and system-wide change involving not only technologies but also policies, actions, and investments grounded in Canada's distinct regional political economies. Not only must the transition be technologically and economically viable, it must also be compelling to societal stakeholders and address issues such as convenience, quality of life, financial return, and broader social issues. Specific actions that could be taken to move in this direction include: (1) enhancing citizen engagement around the low-carbon transition (e.g., Bak, 2018; Rosenbloom and Meadowcroft, 2017); (2) integrating learning about the transition as part of basic education; and (3) creating national conversations and focusing events that revolve around the transition (e.g., Natural Resources Canada's

Generation Energy). NASA, for instance, generated excitement and encouraged media coverage of shuttle launches through focusing events that helped build support for the space program (Pierson, 1993). Ultimately, the best guarantee that the low-carbon transition will proceed, is that it becomes embedded in the national consciousness – that it becomes accepted as part of how we do things here, and what it means to be Canadian. While politicians may argue about the details of the country's health system, the overriding national consensus about the appropriateness of Medicare means that no politicians want to be associated with a wholesale assault on the system. In an analogous way, the directionality and objective of the low-carbon transition can be wired into the national consciousness even as the details of policy remain contested.

4. Discussion and conclusion

This paper has surveyed diverse strands of the policy stickiness literature. In particular, it has drawn on path dependency, policy feedback, and transition pathways in order to shed light on specific mechanisms to help strengthen the directionality of policy addressing climate change and accelerate the low-carbon transition. It has identified several mechanisms that may be integrated within climate policy design to encourage self-reinforcing movement in a low-carbon direction and prevent reversal or erosion. In particular, we have highlighted the importance of: (1) increasing the political cost of reversal or erosion; (2) encouraging the emergence and development of supportive policy constituencies; (3) embedding the low-carbon transition within a supportive ecosystem of institutions; and (4) building societal legitimacy for the low-carbon transition (see Table 2). However, we also warn that while public and private sector actors may call for policy certainty to encourage investor confidence in low-carbon innovation, efforts to lock in particular policy measures or frameworks may be misplaced. Instead, focusing on stabilizing the overall orientation or directionality of low-carbon policy may be a more appropriate means through which to entrench the low-carbon transition.

Beyond this, a few more specific insights can be drawn. First, at the broadest level, this paper indicates that there is an important role for more consciously considering the implications and trade-offs of policy and investment choices for decarbonization. Yet, complexity and uncertainty remain a defining element of this challenge. Indeed, there will be disruptions, unintended consequences, second and third order effects, as well as black swan events that will help shape outcomes. Second, the mechanisms identified are likely to be more effective when deployed in combination rather than individually. And, it is through the interaction among self-reinforcing drivers and sources of instability that outcomes will be influenced. Third, there is an important temporal dimension to each of the mechanisms identified. Whereas some mechanisms will have near-term effects (e.g., entering into a contractual obligation to develop infrastructure will have more proximate self-reinforcing impacts), others have more distant influences (e.g., investing in education and training may take much longer for self-reinforcing dynamics to emerge). Fourth, it is important to remain cognizant of the potential issues in deploying self-reinforcing mechanisms. Harnessing these mechanisms is not a neutral process as it can create the conditions for policy capture, lock in, and the emergence of ever infant industries. To reiterate, there is danger in not taking seriously the need for policy adaptability. So, while the role of path dependency, policy feedback, and transition pathways in stabilizing a low-carbon policy orientation represents a promising area for further investigation, it is not without its risks and limitations.

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