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Preface

The report presented here was originally commissioned by a number of Canadian charitable foundations interested in exploring new approaches to the challenge of climate change. In developing this analysis, the authors have drawn from their own experience with research and practical engagement around climate, energy and sustainable development over several decades. We also consulted widely with individuals and groups across Canada who are active on the climate and energy files. This included academics from various disciplines, independent researchers and consultants, government officials at various levels, political staffers, business leaders and environmental groups.

The report outlines a 'transition pathways approach,' which we believe can empower innovators, improve policy design and implementation and shift the terms of debate around climate change in a more constructive direction.

It outlines a basic philosophy that emphasises linking climate concerns to broader efforts to improve society, and steering disruptive and transformative currents that are reshaping the world around us. It points to the importance of visions and pathways to inspire and orient efforts for change. And it elaborates a methodology that can bring together researchers and societal stakeholders, from business, governments at various levels and societal groups, to co-design and build out such transition pathways. Finally, the report proposes the establishment of a new not-for-profit organization – the Transition Accelerator – which can work to implement this perspective.

Thanks to the enthusiastic reception the ideas developed in this report have already received, the Transition Accelerator has now been established. It is starting to work with groups across the country to develop regional and sector-based pathways for transformative change. And we hope to expand these activities rapidly in years to come.

This report provides an intellectual foundation for the activities of the Transition Accelerator, explaining its underlying rational, core goals and methods. Over time, and with the accumulation of experience, we expect the approach and methods presented here to be developed, amended and refined. But the report provides a starting point to understand the work and mission of the Transition Accelerator.

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July 2019

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James Meadowcroft, PhD is a professor in the School of Public Policy and Administration at Carleton University. From 2005 to 2019 he held a Tier 1 Canada Research Chair in Governance for Sustainable Development. He has written widely on environmental politics and policy, democratic participation and deliberative democracy, national sustainable develop-ment strategies and socio-technical transitions. Recent work focuses on energy and the transition to a low-carbon society and includes publications on carbon capture and storage (CCS), smart grids, the development of Ontario's electricity system, the politics of socio-technical transitions and negative carbon emissions.

David Layzell, PhD, FRSC is a professor and director of the *Canadian Energy Systems Analysis Research* (CESAR) initiative at the University of Calgary. He began his academic career as a professor of biology (cross-appointments in the Schools of Environmental Studies and Public Policy) at Queen's University (Kingston), generated an inter-national reputation and was elected as a fellow of the *Royal Society of Canada (FRSC)*. Over the past 20+ years his interdisciplinary research efforts have focused on explor-ing and defining transition pathways capable of moving Canada to a more sustainable future. His work has led directly to the activities of The Transition Accelerator.

Normand Mousseau, PhD is professor of physics at Université de Montréal and Academic director of the Trottier Energy Institute at Polytechnique Montréal. His re-search includes the study of complex materials, energy and natural resources. He is actively involved with energy and climate policy, having co-chaired the Quebec Commission on Energy Issues in 2013, and published a number of books in this field.

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Executive Summary

If Canada is to reduce its greenhouse gas (GHG) emissions and achieve its long-term climate change commitments, transformative changes are required in the systems that we use for social provisioning, including the way we generate and consume electricity, move people and goods, construct urban spaces, organize the agri/food system and operate industries.

However, for many Canadians today climate change is not a sufficiently compelling reason to endorse such large-scale change. And yet we live in a time of rapid and disruptive change driven by technological and social innovation. What if it were possible to harness these transformative forces to achieve outcomes that met an array of societal aspirations while also addressing the climate issue? By integrating climate mitigation more closely to the attainment of other societal goals – including the provision of new economic opportunities, improved health outcomes, increased comfort or convenience it is possible to build a better Canada while also meeting climate goals.

"Pathways are narratives, grounded in data, analysis and shared aspirations, and co-created with societal groups. They integrate the technological, economic, social, cultural and policy insights that are essential in the movement to a better future."

To encourage such transformative systems change we need to develop clearer visions of what constitutes a better future, and to define transition pathways that establish how to get from where we are today to a more desirable future.

Transitions are long-term processes of change that result in major adjustments to societal systems. Pathways describe the routes that can be taken to achieve such transitions. They are narratives, grounded in data, analysis and shared aspirations, and co-created with societal groups. Pathways integrate the technological, economic, social, cultural and policy insights that are essential for movement to a better future.

Developing such shared visions and pathways, and working to realize them in practice, can help re-frame the discussion of climate change, energize forces interested in progress, and encourage the adoption of more effective policy measures. In the Canadian context, regional approaches are particularly important, since visions and pathways will reflect differences in resource endowments, economic development trajectories, regulatory institutions and politico-cultural traditions.

To meet this challenge, a systematic methodology has been developed that can be applied to various sectors, regions and problems to accelerate the co-development

of credible, capable and compelling pathways. The four stages of this methodology which links researchers and innovative stakeholders involve:

1. **Understanding** the system that is in need of change, including: its strengths and weaknesses; the forces disrupting existing ways of doing things; connections to related systems; and potential avenues for positive change.
2. **Co-developing** with innovative stakeholders (drawn from industry, government, academia, environmental organizations and other societal groups) transformative visions and pathways to address societal challenges, including GHG reductions.
3. **Analyzing** and modelling candidate pathways to assess costs, benefits, trade-offs, public acceptability, barriers and bottlenecks. These insights allow the adjustment of visions and pathways to ensure they are credible, capable of achieving societal goals and compelling to key stakeholders.
4. **Advancing** the practical build-out of promising pathways by informing innovation strategies, engaging decision makers in government and industry, participating in public debate, and above all by consolidating coalitions of parties enthusiastic about pathway implementation.

This methodology is particularly appropriate for deployment in systems that:

- **Have substantial GHG emissions**, so that their transformation can make a significant contribution to dealing with the issue of climate change;
- **Manifest major problems other than GHG emissions**. The quest for efficiency or convenience, improved service or economic outcomes, enhanced community or fairness, or quality of life are currently more compelling drivers for transformative change;
- **Are being disturbed by disruptive technology, business model, policy or social innovations** that can feed into processes of defining and deploying transition pathways.

To identify candidate pathways and implement the methodology described here, we propose the creation of a national, not-for-profit Transition Accelerator. The Accelerator would build diverse networks of innovators interested in developing a shared vision and one or more pathways to achieve that vision. It will engage researchers to conduct socio-technical, techno-economic and environmental analyses, and work to create and accelerate deployment of transition pathways. Such an Accelerator would contribute to public debate, inform policy, provide advice to decision-makers and spin off 'consortia' practically engaged in implementing the envisaged pathway.

1. Introduction

Over the past 10 years Canadian governments have introduced a range of initiatives to address climate change. Some of these measures – including policies to phase out coal-fired power generation, implement clean fuel standards, encourage the deployment of renewable power, and introduce carbon pricing – have already made, or if fully implemented could make, a significant contribution to meeting the country's climate objectives.

"...there are serious problems with the state of public discussion and policy making around climate change in Canada."

Yet, there are serious problems with the state of public discussion and policy making around climate change in Canada. Despite more than two decades of argument, policy initiatives remain fragmented, unstable and largely related to short-term incremental reductions in GHG emissions. Policies and programs seem to shift with each incoming government. We lack compelling and shared visions of what a future low-carbon society might look like, and of the steps needed to get there. Broad statements of policy intent are seldom matched with clear plans. And most analysts agree that Canada is not on track to meet its long-term climate commitments.[1]

Polling data suggests Canadians take the climate threat seriously and want their governments to act.[2] But they are uncertain about particular policy approaches, remain wary of new taxes and are concerned about rising energy prices. Political argument and media coverage are dominated by two issues: pipelines and carbon pricing. Both are important, but conflict around these issues is obscuring more substantive engagement with the broader challenges of climate change. Above all, the scale of the societal adjustments that will be required to address the climate issue are not well understood or accounted for in current policies.[3]

"We lack compelling and shared visions of what a future low-carbon society might look like, and of the steps needed to get there."

There is no doubt that climate change presents a difficult problem for Canadian decision-makers. Different parts of the country have different resource endowments and regional political economies. Canada is a major fossil fuel exporter, with the oil and gas sector generating substantial revenues and supporting thousands of jobs. We have a decentralized political system that makes country-wide action challenging.[4]

Moreover, Canada is economically tied to the United States and is inevitably influenced by the on-again/off-again swings of U.S. climate policy.

That said, how we approach the issue can make a big difference. That is why this report offers an alternative perspective on engaging with the climate issue. It argues that in Canada a transition pathways approach can help re-frame public discussion of the climate issue, strengthen political support for tackling climate change, encourage the adoption of more effective policy measures, motivate industry-led clean growth initiatives, and energize forces interested in building out change.

The argument for such an approach is developed in some detail over the coming pages. But it is useful to summarize the key elements of our perspective right at the outset.

"...a transition pathways approach can help reframe public discussion of the climate issue, strengthen political support for tackling climate change, encourage the adoption of more effective policy measures, motivate industry-led clean growth initiatives, and energize forces interested in building out change."

First, addressing climate change will require a fundamental transformation of key systems of social provisioning including the way we generate and consume electricity, move people and goods, design our agricultural and food systems and build our cities. Avoiding open ended climate change will ultimately require the virtual elimination of net global GHG emissions.[5] This implies major shifts in technologies, business models, and social practices. The emissions driving climate change come mainly from the production and combustion of fossil fuels used in transport, electricity generation, heating, industry, food production, etc. So, dealing with climate change is not just about energy systems change, but about transforming the operation of multiple systems that use energy to provide diverse societal services.[6]

Second, climate solutions need to be more closely integrated with broader efforts to build a better Canada. Climate change is not the only problem confronting our communities. And, taken on its own, the climate problem cannot today motivate transformative change across multiple societal systems. Instead, there is a need to highlight positive benefits that can be secured by reconfiguring these systems – new economic opportunities, improved health and welfare, convenience or lower cost, a cleaner environment, and so on. Moreover, since there are many possible low-carbon futures (involving

alternative technologies and practices, and with different patterns of costs and benefits), engaging with the substantive issues of societal improvement in multiple systems is unavoidable for consequent climate policy.

Third, societal systems are already undergoing widespread change, including disruptive change, so the challenge is really to harness or steer these changes to realize positive social outcomes including GHG emissions reductions. Change is happening all around us and the pace of change today is more rapid than ever before. Think of the dramatic shifts flowing from the digital information and communications revolution, which has implications for everything from manufacturing techniques to health care, entertainment to mass surveillance. The choice is not between stasis or change, but rather among different patterns of change, and more and less desirable futures. So, the real challenge is orienting emerging technological and social currents to promote desirable system transformations that deliver positive societal values including low carbon emissions.[7]

Fourth, transition visions and pathways provide a critical starting point to engage with system change, link climate mitigation to other social goals, and harness disruptive currents to bring about a better world. Transitions are long-term processes of change that result in major adjustments to societal systems. Visions present images of a desirable future, motivating and coordinating movements for change.[8] Pathways link the present with the future, allowing the evaluation of alternative trajectories, avoidance of 'dead end' trajectories, and the definition of steps that advance towards societal goals.[9] As we understand them, pathways are not simply defined by a declining

Our Perspective

- Addressing climate change will require a fundamental transformation of key systems of social provisioning;
- Climate solutions need to be more closely integrated with broader efforts to build a better Canada;
- Societal systems are already undergoing widespread …disruptive change, so the challenge is …to harness …these changes to realize positive social outcomes;
- Transition visions and pathways provide a critical starting point to engage with system change;
- Regional approaches are particularly important;
- A systematic methodology can accelerate the development of credible, compelling and capable pathways.

We propose the creation of a Transition Accelerator to apply and champion this approach.

emission trend on a graph, or by the choice of a technological option or policy instrument. Instead, they are narratives, grounded in data, analysis and shared aspirations, and co-created with societal groups, which engage with the technological, economic, social, cultural and policy dimensions of movement towards a more sustainable future. Developing such shared visions and capable and compelling pathways, and working to realize them in practice, can help re-frame the discussion of climate change, energize forces interested in progress, and encourage the adoption of more effective policy measures.

Fifth, in the Canadian context regional approaches are particularly important. Visions and pathways will look different in one part of the country than in another. Contrasting resource endowments, economic development trajectories, regulatory institutions and politico-cultural traditions matter.[10] The drive for change needs to be suited to local circumstances and taken up by local actors. More generally, visions and pathways will be multiple, because of the importance of exploring diverse alternatives at different scales in the face of plural values and multiple uncertainties.

Sixth, a systematic approach or methodology which can be applied to various sectors, regions and problems can accelerate the development of credible, compelling and capable pathways. Key elements of such an approach include: a grounding in systems thinking and transition dynamics; an empirical focus on the collection of data and the analysis of the character of existing systems; an integration of technical, socio-economic, cultural and policy/political dimensions; co-creation through structured, iterative interactions among researchers, innovators and other societal stakeholders; quantitative analysis and scenario modelling; and a practical orientation to move from analysis to action.[11]

Finally, we propose the creation of a Transition Accelerator to apply and champion this approach. Such an organization can facilitate the development and practical implementation of visions and pathways. It would support research and training; conduct socio-technical, techno-economic and environmental analysis; develop scenarios and engage with stakeholders from business, societal groups and government. It would employ a collaborative approach, with an open architecture to empower existing initiatives and maximize collective impact. Such an Accelerator would contribute to public debate, inform policy, provide advice to decision makers and spin off 'consortia' practically engaged in building out specific pathways.

Transitions are difficult long-term processes of social change. They involve uncertainty, controversy and sometimes painful adjustments. The momentum of existing arrangements and the current economic trajectory are strong, and powerful forces are resisting change. The issues involved are not just technological or economic, but also social, cultural and political.[12]

One way to move things forward is to develop transition visions and pathways – not just as paper projects or academic modelling exercises, but as societal co-creations that are focused on practical outcomes. Efforts in this direction are already going on across Canada, for example, in community energy plans or municipal sustainability initiatives.[13] We want to give this process added impetus by setting it on a firmer theoretical and empirical footing, and linking the research community more closely with change agents among societal stakeholders.

In preparing this report we engaged in extensive consultation with individuals and groups across Canada active on the climate and energy files. This included academics from various disciplines, independent researchers and consultants, government officials at various levels, political staffers, business leaders and environmental groups. And we intend to talk to many more in the coming months. Indeed, the approach we are proposing implies direct and focused interaction with stakeholders and publics in many different spheres.

The remainder of this report is divided into four substantive sections. Section two draws pertinent insights from the academic literature on transitions in large scale societal systems. Section Three discusses what we mean by a transition pathways approach. Section four presents a basic methodology for the co-development of transformative visions and pathways. And section five elaborates our practical proposal for a Transition Accelerator for Canada.

2. Transitions and climate change

Global concerns about anthropogenic climate change have been around for many decades, leading to three international agreements over the past 21 years with targets for GHG emission reductions. While Canada has 'bent the curve' on its GHG emissions, it has not achieved either its Kyoto or Copenhagen commitments. Given lost time, and the desire to constrain global climate change to less than 2°C, the Paris commitments for 2030 and 2050 are even more challenging (Figure 2.1).

Meeting Canada's long-term climate goals will require a profound transformation of contemporary systems of social provisioning. Setting aside the adaptation that a warming climate will impose on human activities, climate mitigation – reducing the GHG emissions which are driving warming – implies a significant adjustment to the ways we produce and consume electricity, move people and goods, construct urban spaces, organize the agri/food system and operate industries.

The scale of this change follows from the nature of the climate problem and the character of current systems of production and consumption. On the one hand, scientific assessments suggest that ending anthropogenic pressure on the climate system entails the virtual elimination of net GHG emissions. On the other hand, today's societies remain heavily dependent on fossil fuels and on industrial and agricultural processes that generate GHGs (see Figure 2.2 for details).

Consider, for example, transportation: cars, trucks, ships and airplanes all run on petroleum-based fuels. So, eliminating GHG emissions from transport is not about a marginal adjustment to existing arrangements. Rather it will require the substantial redesign of our systems for moving people and freight.[14] Of course, there are many ways to reduce transportation emissions. A switch to battery electric or hydrogen fuel cell electric vehicles, the revitalization of electrified public transit and high-speed rail, and the re-design of cities to reduce the need for commuting and to encourage biking and walking could all be part of the solution. But whatever combination of alternatives prevail, a low-carbon transport future will look very different from the world we know today. And the same holds true for other systems that currently meet human needs.[15]

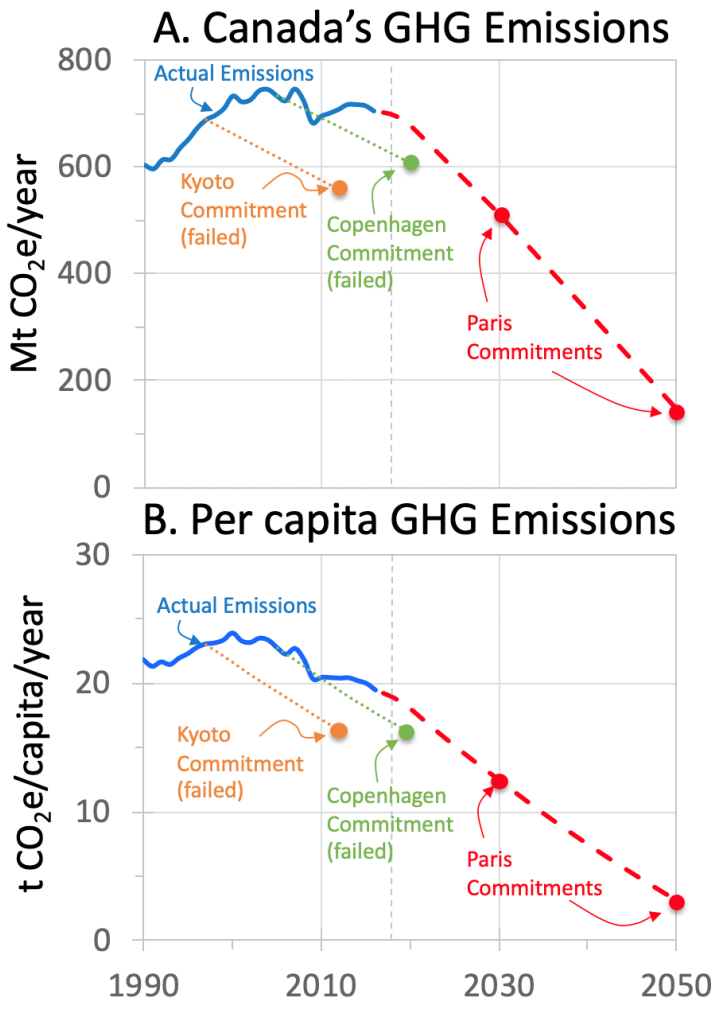

Figure 2.1 Canada's historical (blue line) and projected (red dashed line) total (A), and per capita (B), GHG emissions required to meet the nation's Paris climate change commitments.

Transformation on such a scale may appear daunting, but change to large scale systems is not new. For example, recent generations experienced massive shifts with the mechanization of agriculture, transport, the rise of mass production and urbanization, and more recently the digital revolution. Understanding how emerging technologies, ways of living, and patterns of production and consumption

replaced earlier practices is helpful as we contemplate movement towards a low-carbon emission society. It provides an intellectual underpinning for the transition pathways approach which we propose in this report. So, in this section we consider what is known about such transitions and the light this can shed on the challenge of climate change mitigation. We start by discussing socio-technical systems, systems change and transitions more broadly, before returning more specifically to the issue of climate change.

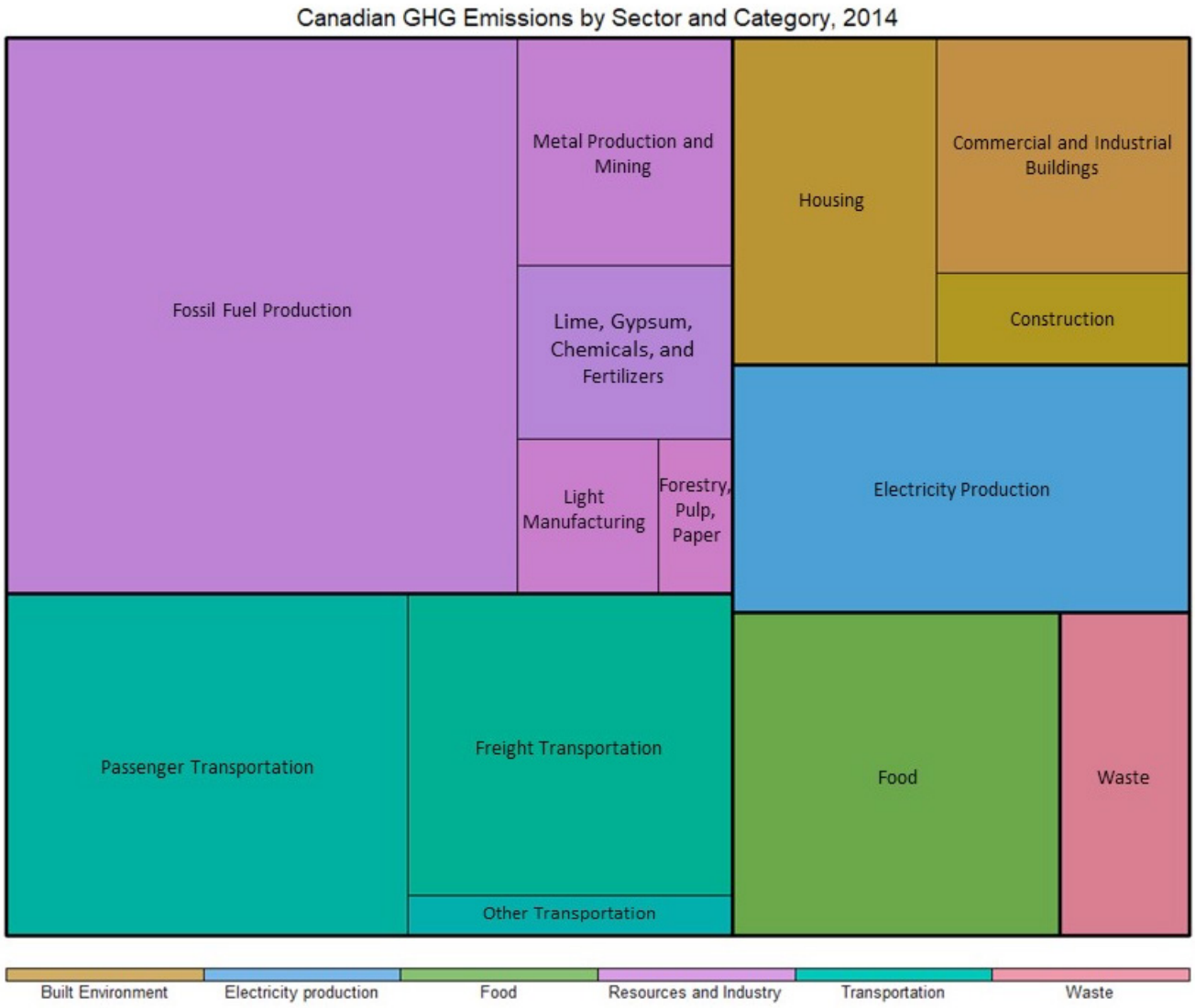

Figure 2.2 Greenhouse Gas emissions associated with sectors and categories in Canada. The area associated with each sector is proportional to its emissions.

2.1. Socio-technical systems, systems change and transitions

Modern societies are characterised by complex patterns of economic, social and technological interdependence. They include multiple interrelated and nested socio-technical systems, closely involved with material production and consumption, at different social scales.[16] We refer to systems (for example, electricity systems) because we are dealing with complex functional wholes made up of many interrelated parts. To understand the operation of such a system it is not sufficient to know the properties of its individual components, rather one must also grasp how they interact with one another in a dynamic context. The expression socio-technical captures the idea that in such systems technological elements (infrastructure, machinery, knowledge, etc). are enmeshed with social structures and practices (institutions, behaviour, cultural traditions). Thus, the electricity system involves power plants, long distance transmission grids, local distribution networks and end use devices in business and domestic settings.[17] But it also includes ownership structures, regulatory institutions, operational rules, financial flows and the practices of energy consumers. Interactions among all these social and technical dimensions determine the behaviour of the system as a whole and the conditions for change.

"In socio-technical systems, technological elements are enmeshed with social structures and practices."

Examining the development of socio-technical systems over the long-term reveals that most change is incremental: improvements are the result of an accumulation of many small advances that increase functionality and efficiency. Think how refrigerators have become more efficient and personal computers more powerful, over time. Periodically, however, there are more dramatic shifts – system changes – brought about by transformations in technologies, social practices and business models. Consider, for example, the large-scale changes associated with the initial introduction of refrigeration (which impacted the structure of agriculture and food industries, trade patterns, diets and household routines) or personal computing (which has transformed the ways business, households and governments operate). Transitions refer to these periods of significant reconfiguration, which for major systems can be spread over several decades, such as the switch from sailing ships to steam ships, from gas lighting to electric lighting, and so on.[18]

Typically, such system change involves a more or less protracted period of experimentation with novel technological, social and business models. Well-established systems possess considerable momentum as they

mesh together complex elements, and tie in to other systems and social practices. Initially, emerging solutions have functional disadvantages: new technologies are immature and expensive, and social innovations and business models require further development. Novelties usually gain purchase first in niches where early adopters are willing to pay over the odds (or put up with other inconveniences) for prized attributes. Think of the first LEDs which were expensive and only produced light of one colour (red), but which found an early application as computer indicator lights.[19]

Ultimately, price reductions and functional improvements in emerging alternatives, combined with external circumstances which weaken the attractiveness of traditional ways of doing things, can lead to a more or less rapid transformation of the system. This is why transitions are often described by an 'S' curve, with slow beginnings, but a (relatively) rapid development once critical conditions are in place. In reality, however, things are often more complex. Since transitions require development on multiple fronts (technologies, societal norms, business models, etc.) they can stall or change direction. Innovations may fail to pan out or be overtaken by other developments.[20]

The history of the automobile provides a classic example of such a transition. The roots of automotive technologies lie deep in the 19th century as inventors wrestled with the goal of creating a 'horseless carriage.' Between 1880 and 1914 there was intense competition to establish just what the motor car would look like, and the basic design that emerged – with four wheels and an internal combustion engine running on gasoline – is still with us today. Ford's introduction of the mass production 'Model T,' with standardized parts and the assembly line, set the stage for the dramatic transformation of personal mobility (first in the United States, and then more generally). The previous transport regime (itself a complex system involving horse breeding, stables, blacksmiths, carriage and tack makers, feed production, manure removal, etc.) was more or less rapidly displaced. The new system came to include not just technological linkages (the production of oil, steel, rubber, glass, etc.), but other critical economic and social elements, including the dealer network and model cycle, insurance, repair, the training of engineers and mechanics, and regulation (traffic rules, licences for drivers and vehicles). Cars required paved roads, and over time cities were redesigned to suit, with suburbs, shopping malls, and parking lots. Indeed, the automobile came to represent the centerpiece of the twentieth century consumer economy, constituting for most families the largest purchase after a home, acquiring significance as a cultural icon with connections to status and identity.[21]

Today automobility is again entering a period of flux. The transport system based around the car is not without problems: accidents, congestion, high costs, parking, long commutes, air pollution, GHG emissions, and so on.

Disruptive forces linked to the emergence of electric and fuel-cell vehicles, the prospect of autonomous vehicles, and new business models (car sharing; Uber, Lyft) are opening up the future of personal mobility. Cultural shifts suggest young people are less attached to car ownership.[22] And this is to say nothing about prospects for a shift towards active mobility (walking and cycling), new approaches to public transport and more serious consideration of redesigning cities.[23]

Similar processes of incremental shifts in socio-technical systems, interrupted by phases of more dramatic change, can be seen at various scales in countless areas of social life. Consider the emergence of agricultural systems based around farm mechanization and artificial nitrogen inputs, the hospital-centred system of medical care, Internet-based business models, and so on.

Since movement to address climate change will require transformative change in a variety of key systems of societal provisioning, it is worth looking a little more closely at some general features of such transition processes.

2.2. Understanding socio-technical transitions

Over the decades, scholars from multiple disciplines have contributed to a rapidly growing body of knowledge about societal transitions, their histories and dynamics, and the potential to accelerate or steer their development. Some broad conclusions about how change occurs in socio-technical systems include the following:

A. ***Transitions involve complex interactions among multiple social and technical dimensions, and varied constellations of societal actors.*** Major changes in systems of social provisioning do not result from a single technical or social innovation. Rather they imply shifts across an array of technical, economic, social and regulatory parameters that adjust the overall workings of a system. Transitions involve both stability and change: existing technologies, business models, social practices, and firms may all be displaced as new arrangements come to the fore. Yet what is transformed and what persists depends on the particular circumstances. Sometimes novel elements are incorporated while important features of the system remain relatively unchanged, but on other occasions a new system almost entirely replaces the old.

B. ***Transitions take time, but under certain conditions change can come rapidly.*** Transitions in large scale systems take time to unfold. Even after the basic elements of a novel solution have been assembled it may take several decades for it to be perfected and diffuse outward to transform the system

as a whole. For example, while 20% of U.S. households had an electricity connection in 1920, it was nearly 1950 before the level reached 90% (See Figure 2.3). Some of the key factors influencing the pace of change include: the scale of investment required by the new systems (for example, to build new infrastructure); the cycles of technical and societal learning needed to 'scale up' at the enterprise and then the industry level; 'lock-in' of pre-existing technical, social, cultural norms and regulations, consumer expectations, etc.; explicit opposition from economic interests threatened by the new system (business owners, labour unions, communities). Uneven economic development means that transforming global systems may take a long time, although, paradoxically, less developed countries that have lagged in deploying an earlier socio-technical configuration can sometimes move more quickly to the new system design (for example, directly adopting mobile phones and leap-frogging land networks).

C. ***Transitions are beset by uncertainty and messiness.*** It is easy to spot a transition after the fact, but it is much more difficult to understand change that is still unfolding. Today it seems obvious that digital media would spell the end of film photography, but the change caught the manufacturers of traditional film by surprise. We know that steam successfully supplanted sail: but its superiority was not so evident in 1830. Indeed, the fastest and most efficient sailing ships were built in the age of competition with steam. Because transitions result from interactions among social and technical factors at different 'levels' – including general political and economic circumstances (the 'landscape'), evolving conditions in the specific sector (the 'regime'), and innovation within varied 'niches' – it is difficult to determine exactly how they will play out. It is not possible to know in advance how technologies will perform. Will unforeseen roadblocks emerge or public opposition to a particular approach grow? Shifting economic conditions can impact investment levels and the build-out of infrastructure. Geopolitical circumstances and political conflicts (trade disputes,

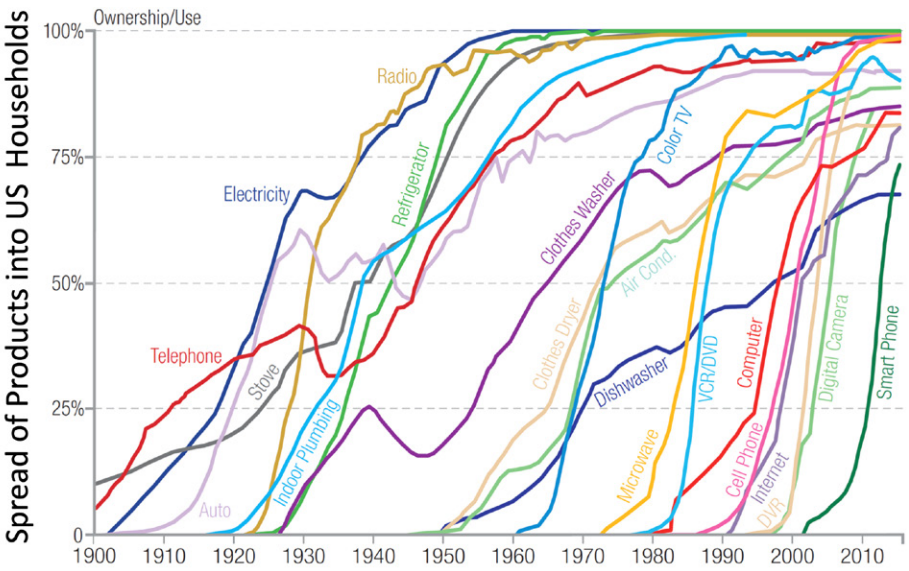

Figure 2.3 The spread of products into US households from 1900 to 2015. From Cox and Alm, 2016. Onward and Upward. O'Neil Centre for Global Markets & Freedom, SMU (https://www.smu.edu/cox/Centers-and-Institutes/oneil-center/research/annual-reports)

war, etc.) can alter outcomes. Contingent events can alter technological trajectories: consider the impact of the Hindenburg explosion on lighter-than-air flight. The turbulent history of nuclear power and the recent public backlash against wind development in many jurisdictions point to the complexity and indeterminacy of transitions.

D. ***Transitions can have significant distributive impacts.*** Although society as a whole may benefit from a change (as a system transformation offers increased service and economies), certain groups will suffer economic loss. Some enterprises or sectors contract, even as emergent firms and industries expand. Some jobs are lost even as others are created. Incumbents may fight back to resist change, and this makes progress bumpy. Moreover, there will always be multiple ways of integrating new technologies, social practices or business models – that articulate different values and/or provide alternative distributions of benefit. Take, for example, an emphasis on investor-driven deployment of large solar energy farms integrated into utility-operated electricity grids versus small rooftop solar applications championed by homeowners and supplying power at the building level. And transitions almost always have unintended consequences. As the new technologies and practices unfold there are disturbances in related systems. The pioneers of computing, for example, could not have imagined all the uses to which digital devices are put today. And while these have brought tremendous amenities, we also have negative issues such as cybercrime, Internet trolls, and privacy loss.

E. ***Visions play a critical role in systems change*** *(particularly in the early phases)* by offering an image of what a novel technology, social innovation or business model can accomplish once it has been fully deployed. Visions look beyond the present shortcomings of an emerging alternative (functional weaknesses or higher prices), to illustrate the potential benefits to individuals and society. Visions help mobilize resources (investment, human capital), coordinate action among diverse actors (innovators, potential early adopters, political supporters), and build societal support. For example, a compelling vision was critical to building the transcontinental railway in Canada in the 1880s. Typically, successful visions are not just technological ('this gizmo is really neat!'). Instead they inspire by showing how the new approach adds economic, social and cultural value, and can be incorporated into new or reformed practices. Above all, they offer a positive image of a desirable future. De-legitimizing the old way of doing things (as old fashioned, inefficient, unsafe, polluting, etc.) can be an important tactic to accelerate a transition. But the idea of improvement, of building a better tomorrow, is critical.

F. ***Politics, policy and government matter.*** Although socio-technical transitions often appear to have occurred more or less spontaneously, as private actors pursue individual advantage, it turns out that states have often played an

important role by investing in research and development, providing early markets, helping build out critical infrastructure and clearing away legal hurdles. Governments have often seen strategic, military or commercial advantage in encouraging emergent technological systems (for example, the development of steam ships, satellites or the Internet). Loan guarantees and the exercise of eminent domain spurred the build-out of the railways. Changes to property rights and regulatory systems are often essential to allow wide-scale system change. Indeed, many transitions involve acute political struggles as actors linked to opposing sides try to capture policy to serve their ends.

Because governments have significant financial resources (raised through taxation), control legal frameworks and regulatory practices, and can deploy tools to influence public perceptions and norms (through the education system, or by defining the national interest), they have power to accelerate or slow transition processes, to shape their direction and alter distributional impacts.

Box 2.1 Recent research on transitions includes:

An examination of historical transitions in a variety of large-scale socio-technical systems. An important contribution flowing from these studies has been the 'multilevel perspective', a heuristic for understanding transitions as the result of interacting factors at the 'regime', 'landscape' and 'niche' scales.[24]

The study of energy system transitions. These have explored historical shifts in energy supply from traditional biomass to fossil energy, comparing experiences of different countries over several centuries. And they have examined the evolution of energy conversion and end-use technologies including those used to power industry, transport, and provide lighting, heating and cooling.[25]

Technological innovation systems. The focus here has been on mapping institutional arrangements and critical functions that innovations systems must perform in contemporary societies if they are to move from a novel process, product or approach to large scale roll out.[26]

Transition management. A critical insight of this work is that large scale transitions cannot be governed in a deterministic top-down manner because of the complexity of the interacting factors, multiplicity of actors, and inherent uncertainties. Yet there are many avenues through which change agents can encourage movement, including: networking innovators, defining visions and pathways, developing experiments and designing appropriate policy frameworks.[27]

Practice-centered approaches. This work emphasises that making sense of human behaviour – for example, choices consumers make about their use of electricity – requires an understanding of the practices within which it is inscribed, the lived experiences which have meaning for participants. Since transitions involve changes in these social practices, perceptions of meaning and value are critical to their understanding.[28]

2.3 Transitions and progress towards a low-carbon economy

The previous section pointed to some broad characteristics of socio-technical transitions. The reader will already discern features that relate to the climate change challenge. Here, however, we want to draw out several general implications.

To start with, it is important to note that while it is common to talk of 'the low-carbon transition' or 'the energy transition,' societies will in fact be dealing with multiple transitions across a variety of systems. This is partly because systems can be defined at different scales: they can be understood to be composed of functional subsystems and/or constituted over different spatial/jurisdictional areas. The electricity systems in Alberta and Quebec are distinct. Yet they are also linked into a broader North American electricity system. And provincial electricity systems can be considered as components of a more inclusive Canadian energy system. [29]

"...energy systems are of critical importance, [but they] are closely entwined with other societal systems: with transportation, buildings and cities, and the operation of industry and agriculture."

Yet, the transitions required to respond to climate change will be multiple in a more fundamental sense. That is because the problem is not just an energy issue but relates to multiple systems of societal provisioning. On one level, climate change is clearly a problem of energy and energy systems. The extraction, refining, transport and combustion of fossil fuels account for eighty per cent of global GHG emissions. So, transitions in energy systems are of critical importance. Yet energy systems are closely entwined with other societal systems: with transportation, buildings and cities, and the operation of industry and agriculture. The provision of energy is not an end in itself, but enables the creation of amenities associated with other societal systems (transport for goods and people, the production of food or manufactured goods). And historical change in energy systems has to a large extent been driven by changing demand for energy services – for cleaner, cheaper, more convenient and higher quality ways to provide social mobility, comfortable living conditions, communication, and so on.[30] From this perspective, dealing with climate change is also about the transformation of the sectors in which energy is used. But each of these sectors has its own logics, modes of operations, dominant technological paradigms, constellations of actors and established practices. So we actually require a whole series of transitions in a number of interrelated sectors, each of

which will have different characteristics and extend over varied spatial and temporal scales.

Moreover, the need to decouple societal development from GHG emissions is just one of many factors driving change in these diverse sectors. Dominant socio-technical regimes at different scales have particular strengths and weakness, and the drivers (and barriers) for change are multiple. Broader economic and social problems and goals, technological developments, as well as other (non-climate related) environmental considerations are all at play. Indeed, these factors are typically of more immediate concern to communities and decision-makers than climate change, and they are propelling the evolution of these systems. And so the challenge for those interested in climate policy is to integrate climate concerns with these broader dynamics to encourage transitions to novel system configurations which provide superior societal outcomes including on the climate front.[31]

"... the challenge for those interested in climate policy is to integrate climate concerns with these broader dynamics to encourage transitions to novel system configurations which provide superior societal outcomes including on the climate front."

Today, a number of important systems are already experiencing significant disruption. Consider electricity, where in certain jurisdictions cheap wind and solar, often deployed in a distributed configuration, have begun to threaten the viability of large centralized utilities.[32] And we have already noted how self-driving and electric vehicles, and new attitudes and business models, threaten to upend personal mobility. In such contexts, addressing climate change will inevitably be linked to steering such disruption towards new arrangements that can maximize societal benefits including securing dramatic reductions in GHG emissions.

Even in areas where disruption is not immediately evident there are latent possibilities – unmet needs, problems that have eluded solutions, and opportunities to make welfare gains. To put this another way, none of our systems of social provisioning is so perfect that it does not have room for significant improvement – for better outcomes in terms of health, economic opportunities, convenience, and so on.[33] In a real sense, the challenge for climate policy is how to harness these dynamic forces to unlock existing systems and open space for change that can meet aspirations for social improvement while simultaneously addressing climate. The term 'sustainability transitions' is sometime applied to capture this wider concern with

patterns of system change that achieve multiple societal objectives including climate mitigation.[34]

Thinking in terms of transitions therefore encourages a focus on a plurality of systems, and on the circumstances in which movement towards configurations which better meet societal needs can be secured. And it suggests the importance of linkages between climate concerns and other forces, priorities, and rationales driving change in each of these systems.

These observations have significant implications for efforts to accelerate movement towards a low-carbon society and for the design of policy. In particular, they suggest that much greater attention should be paid to:

- Communicating the scale of the transformational change to key systems that will be required to address the climate issue.
- Analysing the character of these specific systems of societal provisioning, their strengths and weaknesses and the disruptive forces and movements for change that are latent or already manifest.
- Defining possible visions and pathways that can harness aspirations for societal improvement and steer disruptive forces towards system reconfigurations that better meet societal needs (including climate mitigation).
- Implementing initiatives that can accelerate desirable system change, rather than just achieve short-term targets.

In policy terms this means reframing communication about climate change mitigation, and refocusing discussion on building desirable futures that are also low-carbon. It implies greater emphasis on the design of policies adapted to the specific circumstances of particular sectors (or systems or regions), rather than focusing efforts on a single 'all purpose' economy-wide approach. Moreover, the critical design consideration for such policies should be their ability to unlock transformation at the system-level and to mobilize innovation and creativity, rather than the achievement of short-term emissions reductions at the lowest possible cost.

To this point such considerations have not been prominent in climate debate and policy making in Canada. For political reasons, governments have been remarkably reluctant to acknowledge that dealing with climate change requires ending (unmitigated) fossil fuel combustion. The Paris climate accord was the first international agreement to explicitly designate net zero emissions as a long-term goal. Canada has endorsed this goal but politicians are hesitant to spell out exactly what this implies. But without such clarity we are failing to orient efforts in the required direction.

For too long, the climate challenge has been presented as a 'pollution control' problem, with attention directed to the incremental reduction of GHG

releases. But the emissions driving climate change are being generated by the core industrial and agricultural activities that have supported human advance over the past few centuries: burning fossil fuels, land clearances, mining, the production of chemicals, fertilisers, cement, steel, plastics and so on. So, addressing climate change requires a more fundamental transformation of existing systems of production and consumption than anything traditionally classed as 'pollution control'. And policy that engages seriously with this challenge must consider how to leverage processes of system change. From this perspective much of the argument about 'optimized emission reduction trajectories' and 'lowest cost options' has simply missed the point, obscuring more serious discussion about political feasibility and policy durability, the extent to which policy contributes to long-term goals, and the opening up of possibilities for positive system transformation.[35] After all, what is critical is that measures actually contribute towards large-scale change processes. Otherwise this is simply a wasted effort that may offer no real economy at all.

The next section considers how a 'transition pathway approach' can contribute to remedying some of these problems.

3. A transition pathways approach

A transition pathway approach is a strategy for strengthening the response to climate change by focusing on the transformation of human systems to better meet societal aspirations. It engages directly with the challenge of system change, linking decarbonization to broader processes of social adjustment. It involves developing a detailed understanding of current systems, defining attractive visions of a better future that are also carbon neutral, identifying steps that can link the present with such futures, and working to build out these changes in practice. Such an approach can help empower innovators, improve policy design and implementation, shift the terms of the climate debate in Canada, and accelerate movement on the ground.

What is a transition pathway?

A pathway identifies the timing, character and magnitude of changes in technologies, infrastructure, business models, societal practices, and policy or regulatory frameworks required to transform a system so that it can more adequately respond to societal needs.[36] Pathways link attractive futures with current circumstances. They identify promising avenues for

advance, and directions to be avoided. They are developed through analysis and societal interaction and can be built out in practice.

Notions of 'pathway' are relatively common in discussion of climate change.[37] Sometimes the emphasis is on the evolution of GHG emissions and the shape of the curve describing their rise and anticipated decline. Or the focus is on the techno-economic trajectory, and the sequences of technologies which could be deployed (as their costs decline and at different carbon prices) to achieve specified emissions reductions. Here, however, we are talking about transition pathways, which include changes across multiple dimensions required to effect the transformation of a particular system into a more desirable configuration. A description of such a pathway will therefore include novel technological options, but also the orientation and sequencing of change on many other levels – including business models, regulatory rules, social practices and public attitudes or values.[38] Pathways are based on qualitative and quantitative assessments of current circumstances, of the strength and weakness of established systems and the potential of disruptive and transformative forces. They relate to visions of a more desirable future and involve narratives about how change can evolve. They can be tested, adjusted and made more robust through scenario analysis.

Thus, we are dealing with a comparatively 'thick' conception of pathway. One often hears particular technical or social innovations (for example, installing heat pumps to displace gas for domestic heating or reducing red meat consumption) described as 'low-carbon pathways.' Yet, from the perspective being developed here these are better understood as elements or fragments of more comprehensive transition pathways that embrace interactions among technological, economic, social and policy changes required to shift a given system into a more beneficial form. And, as we saw in the previous section, such transitions are linked to multiple drivers that are transforming existing systems of social provisioning.

3.1. Credible, capable and compelling pathways

A transition pathways approach focuses on developing transformative pathways and encouraging their practical build out. To be useful, pathways must be founded on an accurate understanding of a particular societal domain and have the potential to actually deliver on promised improvements. And they must articulate visions and practical steps towards transformation that are appealing enough to mobilize societal actors today.[39] In other words, pathways must be credible, capable and compelling. Credible in the sense that they are founded on an understanding of actual conditions: the bio-physical realities of energy and material flows, the economic and social relationships that prevail

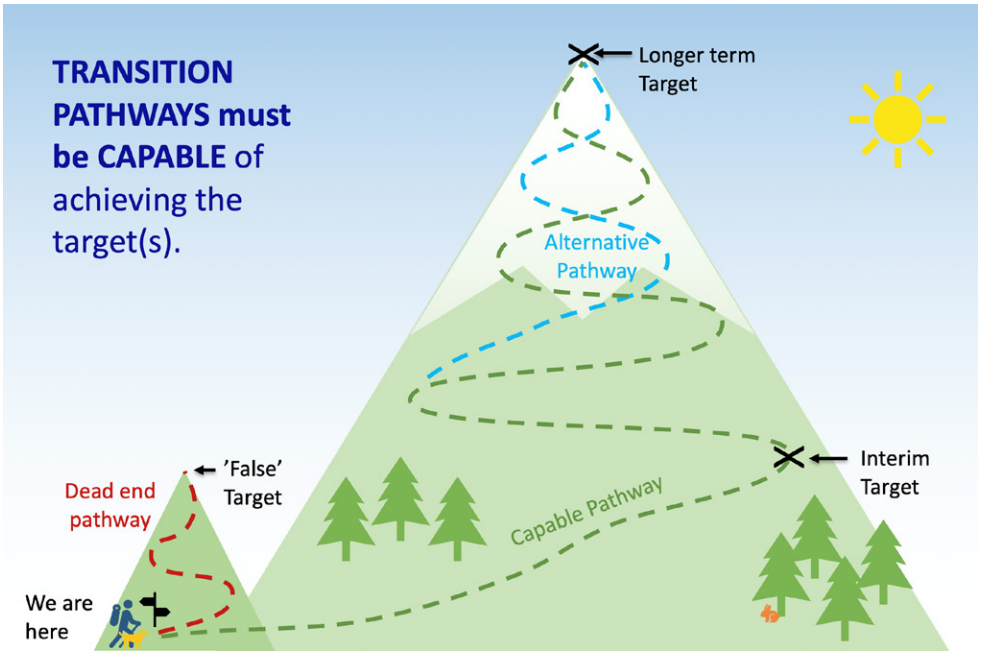

Figure 3.1 The mountain and foothill image highlights the importance of a pathway being capable of achieving long term goals. Climbing the foothill looks like it is moving in the right direction, but this pathway cannot reach long term objectives and results in a dead end. In terms of meeting a longer-term target, such dead end pathways are a waste of time, energy and resources.

in a particular societal system and the currents shaping its evolution. Capable in that they could actually deliver on promised societal improvements, including GHG reductions (Figure 3.1). And compelling in that they are attractive to innovators and the key stakeholders that will help determine whether a innovation is successful in the marketplace.

In a practical sense, the initial success of a transition pathway can be gauged by the extent to which it is able to inspire actors to attempt to build it out into practice. This begins to test the real-world viability of the pathway, establishes its robustness in face of changing circumstances, and permits adjustment and refinement that can ultimately prove its potential to meet expectations.

In the next chapter we describe in some detail a methodology which can be applied in varied circumstances to develop capable and compelling pathways. Here we specify some critical elements of a pathway approach.

First, it requires a thorough investigation of existing arrangements. A careful mapping of the way things currently work is not limited to particular technological or market conditions, but rather explores the web of interactions that make up the system, the dominant economic and social practices and embedded values, and the active and latent currents for change. Such understanding provides an essential foundation from which to develop transformative visions, elaborate potential pathways, and deploy scenarios and modelling tools to test and refine them. Without an understanding of material flows, financial arrangements and social relationships, visions

and pathways float in the air: anything appears possible, but their real capacity to guide efforts for change is limited.

Second, visions and pathways are most effectively developed though processes of co-construction involving researchers (drawn from multiple disciplines) and societal stakeholders (especially innovators) with direct involvement in the specific sector(s).[40] Of course, anyone can suggest a vision or pathway. But perspectives that are co-constructed, drawing insights from research and from societal actors steeped in the practical reality of the implicated sector can be more credible and compelling. And since it is these innovators who will actually drive change on the ground, it is important that they participate in the analytical and discursive interactions through which change narratives are elaborated, and the key features of specific pathways are refined. Mechanisms to secure co-creation can vary from context to context, and at different stages in the process of pathway development. Some of the techniques that can be employed are discussed in the next chapter.

Third, the elaboration of pathways is not an end in itself. The idea is not to produce 'pathways' as logical constructs or to generate reports that will be lost in the pages of academic journals or buried in the files of a government agency. The purpose is to co-create pathways which can live in the real world, that can be championed by societal actors and built out into practice. In other words, pathways are understood as part of a strategy for transforming existing conditions – where innovators in businesses, societal organizations and government can apply the analytical findings and emerging narratives, and introduce new technologies, social practices and business models to alter established patterns of production and consumption.

Finally, we refer throughout to pathways in the plural. This is not just because we are dealing with multiple transitions. But also because, even within a single system, there will be differing visions of the character of the desired transformation as well as multiple routes to realize improvement. Furthermore, because human ability to anticipate the future is necessarily limited, we cannot know for certain how technologies will evolve, economic and political circumstances shift, or preferences and values mutate. Envisaging multiple pathways is a way to open up the discussion/decision space, allowing for the exploration of varied possibilities involving different orientations and different constellations of societal actors.[41]

Thus a deep understanding of existing systems, processes of co-creation, a focus on accelerating change in the real world, and on the plurality of potential transformative pathways, are all critical elements of this perspective.

3.2. Benefits of a transition pathway approach

Approaching climate mitigation in terms of transition pathways presents a variety of advantages (Figure 3.2).

Analytically, it allows mapping of the scale and orientation of change desired in particular sectors, bringing to the fore interconnections among different sorts of reform required to move a system to an improved configuration.[42] It allows identification of forces driving change and of critical obstacles that prevent desirable movement (perpetuating 'lock-in') at particular points in time. It can reveal potential bottlenecks – constraints on technology, infrastructure, capital or human resources – that may slow progress in the future, but which could be neutralized with preventative action. It can provide insight on the appropriate sequencing of reform elements: which changes are required to facilitate subsequent movement on other dimensions.[43] It can also reveal potentially 'dead-end pathways' – trajectories which may seem to make sense in the short run (meeting limited objectives, say a particular reduction in GHG emissions), but which would be incapable of delivering over the longer term because they do not contribute towards more fundamental system reconfiguration. Such dead-end pathways waste resources and can delay more significant change.[44] Pathway analysis can also identify social and technical innovations that may be robust across multiple pathways: for example, infrastructure investments or policy initiatives that can advance several potential pathways. And it can reveal implications for other (related) systems: for example, consequences for electricity provision, if transport is electrified.[45]

Practically, a transition pathway approach empowers innovators. It generates knowledge that can contribute to the establishment of priorities, guide investment, identify favorable conditions for experiments, and so on. The process of pathway development promotes networking that breaks the isolation often experienced by innovators, making connections among groups and individuals who otherwise might not meet.[46] The approach can provide a sounder basis for policy formulation. It generates a more accurate portrait of the dynamic circumstances in different sectors, and a system-scale understanding of drivers and obstacles, feedback and countervailing forces, which are not typically available to decision makers. It favors a more successful integration of climate mitigation with other policy objectives. And it provides a foundation for the design of sector-specific policy frameworks. A pathway approach can build societal support, acting as an anchor for discussions with media, societal organizations, and broader publics. Above all, by encouraging engagement with societal stakeholders, and creating new constellations of societal actors as specific pathways begin to be built out in practice, such an approach can add new voices and perspectives to the discussion of the climate issue, shift the social and political calculus, and open the way for more ambitious policy action and societal initiatives in the future.

	TRADITIONAL APPROACHES	PATHWAY APPROACHES
Goal	Incremental GHG reductions over time (an abstract number: megatons or per cent reduction)	Improve human systems to deliver human desires (convenience, comfort, lower costs, enhanced quality of life) as well as GHG management (a compelling story).
Approach	Climate change policies (carbon pricing, regulations, incentives) narrowly focused on meeting short term GHG targets	Co-develop credible, compelling visions and pathways for systems change that will harness disruptive forces to address shortcomings in existing systems (including GHG management).
Tools	Either data & analytics without societal input, OR societal input without data & analytics	Integrate analytical and human dimensions to inform the processes of change.
Outcome	Paralysis and political polarization around pricing and pipelines	Emergence of Pathway Consortia using socio-technical and economic reasoning to drive for systems change that also aligns with environmental and other societal goals.

Figure 3.2 The difference between the traditional and transition pathways approaches to address climate change.

3.3. Addressing some potential objections

To conclude this discussion it is worthwhile considering some possible objections to the strategic perspective offered here.

In the first place, could widening the issue – from a short term focus on GHG emission reductions to system change delivering improvement across multiple fronts – not make progress more difficult? Is it not counterintuitive to suggest that a broader problem, that requires more profound change, will be easier to resolve than a more narrowly framed issue of GHG management?

There are several elements to an answer here. In the first place, it is well established that altering the framing of a problem – adjusting its definition, the way its boundaries are set, and the range of players brought to the table – can shift the available solutions. In international conflicts for example, changing the scope of issues under discussion can open up new possibilities for trade-offs, create novel areas of common interest, and facilitate the construction of win/win solutions.[47] In fact, a transition pathways approach both broadens and narrows the focus. It narrows it by breaking the issue into a series of discrete problems: of steering transformative change in an array of distinct systems of provisioning. So, the goal is not to shift the whole economy in a single movement, but to develop change strategies adapted to the particular circumstances of various societal sectors. And it

widens it by linking climate to other issues and seeking to harness transformative forces which are already active in society. This reframing brings the scale of the climate issue, and of the forces that can be brought to bear to resolve it, more closely into alignment.

In any case, more than 30 years of experience suggests that it is difficult to address climate change successfully by treating it primarily as an emissions control issue. Eliminating GHG emissions will require system change across a variety of sectors. And since climate on its own is not currently a strong enough driver to provoke such change; since system changes are in any case being independently driven by other technological and social forces; and since any system reconfiguration that can dramatically reduce GHG emissions would necessarily alter the delivery of societal amenities in many other ways – there is simply no way to avoid tackling broader societal issues. Indeed, confronting them directly, and seeking to steer latent and manifest forces of transformation, is the most effective way to accelerate movement on the climate file.[48]

"The future cannot be predicted, but futures can be invented."

– Dennis Gabor, Nobel Prize (Physics) 1971

Second, what about uncertainty? Since we cannot know the future, how can we talk seriously about defining pathways that link present and future. Is it not best simply to implement general policies (that discourage GHG emissions and favour innovation of all types) and let markets and day to day political bargaining determine what gets done?

The fact that we cannot completely know the future does not mean that we know nothing about it. Nor has this stopped societies from formulating goals and plans and achieving desired objectives in social, economic, or environmental domains. Indeed, uncertainty does not negate the imperative of acting now to secure more desirable outcomes. A great strength of the transition pathways approach is that it acknowledges uncertainty, but focuses on maximizing opportunities for better societal outcomes in periods of turbulent change. A transition pathway approach is not predicated on an image of an ideal society or an integrated plan for the future. Pathways are not blueprints that are implemented like the construction plans for an office tower. They are guides that can inspire and orient action but that will certainly require adjustment as events unfold, or may ultimately be abandoned in favor of alternative trajectories if that proves advantageous.[49]

Experience with climate policy over past decades establishes that there is no guarantee that the short term operation of private actors in markets, or the everyday operation of political bargaining, will achieve the most desirable

societal outcomes. In fact, societal groups, governments and entrepreneurs are already planning and propelling forward change. And a transition pathways approach can help coordinate efforts and align them in more fruitful directions.

And finally, if a transition pathway approach offers so much potential why has it not been taken up before? In fact, elements of such an approach have been tried – but not necessarily in such an integrated and self-conscious manner. Modelling and scenario analysis are staples of climate policy discussion. Sector-based stakeholder consultations have been used to try to chart a way forward. And efforts to link climate mitigation with other societal issues have become increasingly common: think of the Ontario coal phase-out, where health and clean air concerns initially drove the effort,[50] as well as sustainability and energy planning in many Canadian municipalities. Yet modelling has rarely been connected to the co-creation of visions and pathways, and stakeholder processes have often been captured by incumbents more interested in protecting existing arrangements than stimulating real change. A systems approach, that explores disruptive and transformative currents, and links decarbonization to the attainment of positive goals has not yet been consistently applied.

The reluctance of governments to publicly discuss the scale of the change required to address climate change, and the short term and fragmented nature of much political decision making, have clearly hampered the uptake of more integrated and long-term approaches. Many economic interests remain hostile to acknowledging the nature of the necessary adjustments.[51] So the appeal of a transitions pathways approach is not obvious. Other factors that have so far hampered the uptake of this approach include the way climate change emerged onto the international agenda (where a strong analogy was made to the international process through which emission of ozone-depleting substances was brought under control), the fragmentation of expert communities, and the relative isolation of academics from real world decision contexts.

But it must also be admitted that applying a pathways approach is not easy. It requires integration of researchers with different skill sets and disciplinary backgrounds, and protracted interactions with innovative stakeholders. And this requires time, resources and a longer-term perspective. This poses a funding challenge, and may require new ways of working for all participants in the process. All of which may be hard to secure. But the fact it is challenging does not mean it is not worth trying.

4. A methodology for pathway development

In this section we outline a methodology that can be applied in different contexts to develop and build out capable and compelling transition pathways. The discussion has already established the fundamental features of a transition pathways approach, but here we will tie them together and examine how they can be implemented in practice. The detailed application of this methodology will vary according to particular circumstances. What we present here are the basic stages and procedures, together with a discussion of some key challenges and considerations.

4.1. The process of pathway development

The fundamental elements of the pathway development process are summarized in Figure 4.1. This includes a sequence of four stages that move from investigation, through visioning and pathway design, to refinement and validation, and practical build out. The approach involves iterative interactions among researchers and stakeholders that constitute a shared journey to co-develop visions and pathways. Starting from a desire to achieve change, it involves analysis, critique, collaboration, and co-creation to prepare the way for practical action. Let us look at each of these steps in a little more detail.

Stage one: Understand

The starting place for pathway development is an initial investigation of the system of interest. Without a thorough understanding of how things work today, how can one explore credible possibilities for change? Key elements involved in building this initial knowledge base include:

- *System definition:* a closer identification of the system with which the exercise is concerned, its boundaries and major components, the societal functions it is understood to perform, and its linkages to other systems.[52] It is important to note that the focus at this stage is the boundary and features of the existing system. As more is learned in subsequent stages of the process the system boundaries may be redefined.
- *Historical evolution:* the emergence of the system over time, its origins and development, previous episodes of transformation, including technological and economic changes and regulatory and governance reform.[53]
- *Current configuration:* the existing state of play, including: energy, material and economic flows; the firms and other societal actors;

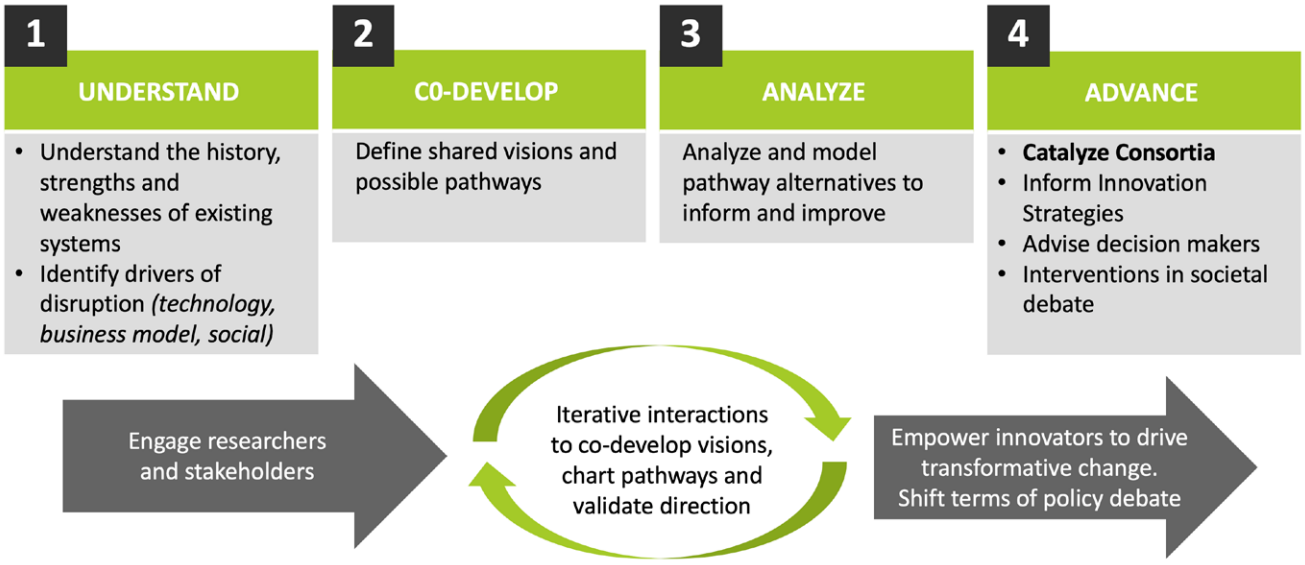

Figure 4.1 Iterative process in a methodology to develop and implement transition pathways that will achieve societal objectives, including greenhouse gas management.

established interests; regulation and governance; dominant norms, routines, and expectations; critical social practices; and so on.

- *Strengths and weaknesses:* the benefits and costs of the current system, including the unintended consequences (e.g. GHG and air emissions), less desirable by-products of the system; the efficiency (or lack thereof) in the use of energy, infrastructure or other resources (e.g. land); the extent to which the system meets societal expectations; and how these differ from various vantage points. Important perspectives will vary with circumstances but can include, for example: insiders (the 'regime,' including incumbent players and dominant practices) versus outsiders (niche competitors and novel models); producers versus consumers; employers/workers/investors; young or old; rich and poor, and so on.
- *Disruptive and transformative forces:* the technology, business model, policy or social innovations that are disturbing or threatening to disturb the established functioning of the system. While often driven by new technologies, other forces include shifts in political orientation or regulatory style, public attitudes or consumer tastes, and so on. Some may already be widely appreciated, while others remain latent (reflecting emergent developments or longstanding problems that have not yet burst into the open).[54]
- *Alternative futures:* imagining different configurations of the system, suggestions for doing things differently, possibilities for system transformation that could point the way towards vision and pathway development.[55]

Carrying out this work requires an integration of knowledge drawn from different sources, including academic studies, government and industry documents, statistical databases, newspaper and media reports, interviews with stakeholders, and so on. A combination of quantitative and qualitative data, interpretation and analysis is essential for a study which aims to capture dynamic processes in a particular system.

In relation to this first – 'understand' – stage, three additional points should be kept in mind. First, the goal is not the preparation of an academic report (although participating researchers may of course author contributions based on their work) but an analysis that is widely accessible and that can serve as a foundation for action. Second, this is not an attempt to learn everything possible about a system, but to acquire understanding sufficient to ground the next stages of pathway development. Indeed, at a certain point more comprehensive knowledge depends on a detailed exploration of alternatives and ultimately on attempts to realize change in practice. Third, while the exercise starts from a particular system, linkages with other systems may be a critical consideration, particularly in relation to disruptive forces (which may 'spill over' across established domains) and alternative futures, were reconfiguring boundaries among systems may be essential to defining sustainable solutions.

Stage two: Co-develop

The focus here is the co-construction of visions for the improved configuration of a particular system, and development of one or more pathways which can connect these futures to today's world.

Visions are high-level statements that capture long-term aspirations and sketch an attractive future.[56] Important characteristics of such visions are that they:

- Are not predictions of what will be, but imaginaries of what might be;
- Relate to a system (or multiple systems, or perhaps a fragment of a system) with a goal of attaining multiple societal objectives that include, but are not limited to, substantive GHG emission reductions;
- Are cast one or more decades into the future (to insulate stakeholder from immediate concerns and allow time for the unfolding of significant change);
- Are social or collective in orientation (aiming at the 'common social good', and not just the success of an individual firm or technology), and potentially have wide societal appeal.

Pathways provide steps to move from current conditions and realize one or more of the visions described above.[57] They:

- Involve sequences of inter-related technological, business model, policy and societal changes that can contribute to achieving long-term outcomes;
- Start from present circumstances but are explicitly directed at securing large scale change in a system or subsystem;
- Must be **credible** (bio-physically, economically and socially), **capable** of achieving societal objectives, and **compelling** to the key stakeholders that will ultimately drive the desired systems change.

Both visions and pathways are co-created through interactions among researchers and innovators, so participants share a sense of joint ownership. Their development draws on material already present in societal debate: key elements will have been identified in the initial investigation and will also be brought to the table by stakeholders. Much of the visioning phase consists in setting these elements in a broader system context, knitting them together, and establishing a sense of collaborative ownership among diverse participants. But it may also involve re-imagining the links across sectors and practices and re-drawing system boundaries to open up creative solutions. Pathway definition can start by exploring the implications of one or more critical threads identified in the vision – perhaps related to a technological innovation or a shift in social practice – and then filling out interconnections across other domains.[58]

A rich variety of techniques exist to facilitate visioning, including facilitated discussions, deployment of visual aids and qualitative scenarios, role playing games, expert elucidation, and so on. Key considerations are to keep the exercise grounded and yet not overly constrained by existing circumstances; to consider the system and its components; and to accommodate a diversity of perspectives. The result will typically be a relatively short statement encompassing shared values and goals that should be ambitious in orientation.

Pathway development draws on the detailed understanding of current conditions as well as the image of an aspirational future. A combination of forecasting and backcasting can link imagined futures with current circumstances, and an iterative engagement among researchers and stakeholders allow progressive filling out of the steps to achieve change.[59] Pathway design demands an integration of knowledge about different societal spheres (technology, business practices, policy, consumer choice, etc.) and may require detailed studies of specific techno-economic, environmental, socio-cultural and legal-regulatory issues.[60] It involves consideration of alternative trajectories, the identification of decision nodes or branching points, the analysis of barriers and enablers, and of more or less desirable

approaches. The objective is the construction of compelling narratives of transformational change that are grounded in material circumstances. They should be supported by analysis and data, but above all present a compelling story-line for advancing practical change.[61] At this stage the goal is not an exhaustive understanding of a potential pathway, but a grasp of the contours of one or more routes to positive system change that have no obvious disabling features, and that incite the interest and enthusiasm of participants.

It should be noted that visioning and pathway work necessarily involve normative engagement – not just a commitment to positive change, but also judgement calls about what does and does not work, the ranking of more or less appealing outcomes, determining which perspectives to privilege, and so on. Normative assumptions are a feature of all research, but this is particularly true for applied research directed at transforming the real world.

Stage three: Analyze

This phase focuses on the detailed evaluation of the proposed pathways, further elaborating key elements, identifying strengths and weaknesses of each, and adjusting particular pathways to increase their viability. It involves systematic techno-economic and environmental assessments (TEEAs) of key pathway components, as well as social and political analyses, while engaging with societal stakeholders of different kinds.[62] The goal is to establish whether the pathway is really credible, capable and compelling and has the potential to live up to its promise.

This implies 'stress testing' key elements. The TEEA work involves quantifying and modeling the flows of energy, materials, pollutants and economic value through key components of the new envisaged system(s). The insights from this work are then combined into a systems level scenario model that begins with a detailed, technology-rich, regional-based (for example, by province) model of the current system and projects how it could be transformed over the next few decades.

This scenario modeling work forces consideration of the timing and magnitude for the deployment of technology, business model and social innovations to achieve the desired transition. In effect, it helps the creation of a transition pathway narrative, or the scenario modeling work can be used to convert a pre-existing narrative into a quantitative representation showing the system level implications for the deployment of the envisaged changes.

Critically analyzing the results of the scenario model and its associated transition pathway narrative assists with identification of critical elements such as:

- The perceived drivers for (and barriers to) systems change at each step along the transition pathway process;
- The timing needed for changes in existing policies or regulations that currently act as barriers to the envisaged changes;
- The timing and nature of the new policies, standards, taxes or communications/ outreach efforts than can facilitate the desired change;
- The timing of milestones for technology/business model development, including scale of operations, cost competitiveness, etc.
- The Research, Development and Deployment (RD&D) priorities;
- Potential impacts on other sectors of the economy including oil and gas, power generation, mining, agriculture etc;
- Other possible impacts on wellbeing: social, environmental and economic dimensions.

Stage three analysis also provides the opportunity to explore the appeal of the proposed pathway to different societal groups, and sensitivity to shifting national and international circumstances. Typical questions that must be examined include: What is the capacity to attract finance? What political circumstances are required for policy support? Are there potential collateral impacts, and which strategies can help remediate them? How does the pathway relate to social attitudes and values; to the aspirations and identities of different groups; to equity and justice considerations? And so on.

The results of this analysis can feed back in to the earlier phases, perhaps prompting a rethink of original assumptions, a more detailed examination of problematic elements or newly appreciated barriers or enablers, and adjustment to the parameters of the pathway. Should it become clear that a particular pathway cannot perform, its further development may at this point be suspended.

For example, modelling or technological or social assessments may reveal that it simply could not achieve desired goals. Or perhaps it cannot presently provide a compelling storyline. In some cases, analysis may suggest disruptive forces are not sufficiently mature to enable movement in the short to medium term. There may be insufficient stakeholder support to build out the pathway, and/or fundamentally unfavorable political circumstances. Note that this does not mean that a pathway is permanently disabled: future technological advances or a changed economic or political conjuncture could open up transformative opportunities. But in the short-term, attempts for its practical realization would not make sense.

Stage four: Advance

The final step involves movement towards implementation. Here the concern is to promote practical efforts to build out the pathway(s) that have been defined – by encouraging pilots and experiments and changes in policies, business models, behaviours and institutions.[63] If the steps outlined above have been successful, they will have identified and initially validated one or more capable and compelling pathways for societal improvement. And the process of interactive investigation, visioning, and pathway development will have already drawn together a nucleus of stakeholders who appreciate the potential of the proposed pathway and are willing to take steps to achieve it in the real world.

The critical objective of this stage is to develop this nucleus into a broader coalition for change, and to spin off one or more consortia focused on practical projects that contribute to the roll out of the particular pathway.

Activities in this stage include:

- Formulating an overall plan of the steps needed to initiate or accelerate the deployment of the pathway. These can relate to policy, infrastructure, investment, additional R&D, public engagement, and so on.
- Providing advice to policy makers and other stakeholders about implementation of these key steps: this includes not just what needs to be done, but also who is best placed to advance different tasks.
- Intervening in broader societal debate to engage the public about the potential of this pathway and the measures needed for its realization.

Above all, it requires the establishment of independent consortia that can take the lead in pushing for the technological, business, economic and social changes required to realize the pathway. The exact nature of these groups will depend on the particular conditions, but their activities can include: organizing pilots and experiments, supporting infrastructure build out, planning, lobbying government, education and public engagement, commissioning further research, training, establishing standards or codes of practice, and so on. With the creation of such consortia the initial pathway development process described here comes to an end, and the initiative passes firmly to the societal stakeholders – the firms, societal groups, government agencies, and other institutions who see value in building out the transformative pathway.

Although the four steps outlined above have been presented as a linear progression, in practice things may be more complex, with steps undertaken out of sequence, or only partially completed before work on the next step begins. There may be cycling back to revisit an earlier stage, because the

consequences of a previous decision are more clearly understood. Much depends on what has already been accomplished with respect to the particular sector, the state of play with stakeholders, and possibilities for funding. Sometimes work can begin on pathway 'fragments' (particular subsystems, or parts of a larger problem), because conditions are not yet ripe to address the larger system, or resources or capacities are limited. And these more limited pathways can later be connected up. Alternatively, a coalition of change agents may already have been formed even before explicit vision or pathway development have been carried out. So the approach remains flexible and must be adapted to concrete circumstances.

4.2. Starting points

The method described above can be applied in various conditions, starting from concerns with a sector, or a region or a problem, or from the intersection of these elements. 'Sectors' refers to functional systems (such as personal mobility) as well as more conventionally defined economic sub-divisions. Regions can include any territorially bounded entity including cities, provinces, Indigenous communities or a country. Starting from 'a problem' can be attractive in conditions where a particular issue is preoccupying economic or political decision makers, so a window of opportunity (and funding potential) has opened, and this can serve as an entry point into a broader system. The intersection of such elements might, for example, focus on freight transport in Western Canada or the electricity system in Quebec. Whatever starting point is selected, it is important to move to define the 'system' with which the project can engage – that bounds the analysis and ultimately serves as focus for the transformative enterprise.

Clearly, 'system' can be understood from various points of view. Here we are concerned with physical, economic and social interactions and interdependencies as well as with the availability of levers to effect change. Scale is critical in defining relevant system boundaries, and establishing priorities for the application of a transition pathway approach.[64] Typically some compromise is involved between a scale large enough to have a substantial impact but small enough to initiate action. Many of the systems of interest can be defined at multiple scales: for example, the agri-food, transport and electricity systems are local, regional, national and international with linkages across multiple levels. The auto industry is truly global, but exists also at a national, regional, and local level. Transformative potential exists at multiple scales, but acting directly at larger scales is typically open to a relatively small number of powerful actors (Figure 4.2).

Politics is an important dimension here as political units (countries, provinces, territorial and Indigenous governments, and cities) establish legal

boundaries, influence patterns of economic development, and provide policy instruments than can be applied to induce change. Because of Canada's large size, diverse regional political economies, and decentralized political arrangements, it will often make sense to focus at a provincial or provincial/sector scale.

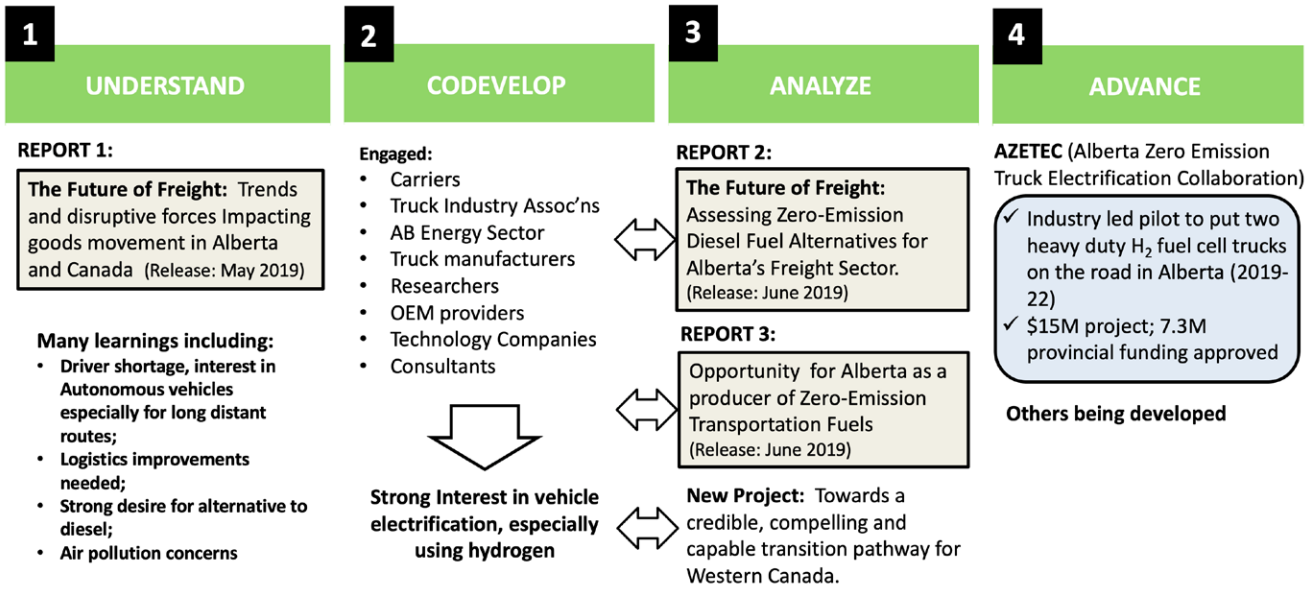

Figure 4.2 From Analysis to Action: An example of transition pathway methodology in practice

Over the past two years, researchers at CESAR (Canadian Energy Systems Analysis Research) have been applying a transition pathway methodology to the challenge of how to transform heavy freight transport in western Canada. This involved detailed analysis of the existing diesel-fueled system, interactions with societal stakeholders to define promising visions and pathways, and techno-economic and environmental assessments of alternative energy systems.

The work identified the potential for hydrogen fuel-cell electric vehicles not only to provide a solution for the freight sector, but also to provide a compelling opportunity for Alberta's energy sector to become North America's leading source of hydrogen as a zero-emission transportation fuel. The expansion of the problem space from its initial focus on the freight sector to include a more lucrative opportunity for the diesel-producing Alberta energy sector was key to the development of a credible, compelling pathway. The freight sector was empowered by the idea that they could be the anchor tenant in the emergence of a new vibrant, 'Made-in-Alberta' clean energy economy, and the energy sector is now coming to the table because the freight sector is there with an interest in products that they can provide.

This has opened the door to a range of pilot projects backed by different consortia, as well as to continued pathway development around a hydrogen economy which will be taken up by the Transition Accelerator. For example, the CESAR-initiated $15M AZETEC (Alberta Zero Emission Truck Electrification Collaboration) project recently received provincial support to build and test two heavy-duty fuel cell trucks.

Schematic representation of outputs from the CESAR pathways development work on freight and hydrogen.

4.3. The contribution from researchers

Researchers (from universities, but also independent institutes, industry and government) have the potential to make a major contribution to pathway development. They can draw on extensive bodies of knowledge – from the natural and social sciences and the humanities – and can apply sophisticated research techniques to understand existing systems, identify opportunities and barriers to change, and develop solutions across multiple societal dimensions (technical, social, business, and so on). Moreover, the relative independence of the university sector means academics are less closely associated with established interests and maintain a larger reservoir of social trust than do many other societal groups.[65]

On the other hand, not all researchers will be suited to participating in the sorts of interactive process described here. Generally, it will be those interested in applied research directed at answering societal problems, who are prepared to engage with, and learn from, a variety of societal partners. The interactions involved with pathway development are challenging and time consuming. They are different from the more technically focused relationships between researchers and firms sometimes encountered in engineering and science departments, or the almost exclusively 'critique oriented' role assumed by some social scientists. Instead, the process requires research collaborators who are rigorous in their techniques and critical thinking and who adopt a positive, collaborative and solutions-oriented approach.

While researchers and societal stakeholders are involved throughout pathway development their respective contributions will evolve as the process advances. In the early data collecting and analysis phase researchers will do much of the work, with selected stakeholders acting more as informants and interviewees. As the process moves to visioning and pathway definition researchers can help structure the process, but stakeholders will play a more central role helping to co-define the perspectives. Researchers will take the lead on the technical aspects of modeling, but stakeholders will inform scenario development. Researchers can play a critical role in the technical evaluation of pathways, but stakeholders views are essential to establish what is credible and compelling. As the work heads towards practical implementation and consortium spin out, stakeholders are expected to take the lead with researchers providing support and assessment.

4.4. The contribution from stakeholders

Critical to this approach are structured interactions among researchers and societal stakeholders. 'Multi-stakeholder processes' have long been a feature of climate and sustainable development policy. In Canada examples

include the 'Project de société' of the early 1990s, 'sector-tables' of the Kyoto Protocol era, and numerous other consultative or collaborative exercises across varied jurisdictions and industries.[66] Moreover, there is substantial international experience with such processes at different scales, as well as a voluminous academic literature on topics ranging from 'participatory planning' and 'adaptive management' to community climate strategies.[67] Important issues in the design of such initiatives relate to the framing of the exercise, selection of participants, modes of interaction and anticipated outputs.

In this case the frame centers on the development of capable and compelling pathways to a better future. Critical to the selection of participants is their desire and their capacity to produce positive change. The nature of the interactions among parties evolves as the process of pathway development matures. And the desired outputs are constructive narratives and positive action to build out the pathway. At the core of this process is a notion of 'co-design', where different groups collaborate to envision and then realize a shared transformative project.[68]

Such co-design is quite different from typical 'participatory' processes. Some initiatives, for example, simply assemble interested stakeholders and try to hammer out a consensus. All too often this leads to stalemate (as some groups are unwilling to abandon important interests), or a lowest-common-denominator outcome. Other processes are not sufficiently anchored in the attainment of practical objectives and degenerate into 'talking shops'. Alternatively, real decisions are made by public or private authorities, but stakeholders are involved too late in the process, so participation is no more than a formal 'consultation' which can only adjust a pre-determined outcome at the margins. This is one of the most common criticisms of government-led initiatives.

A genuine co-design process is oriented towards a practical goal, and steers contributions from collaborating parties towards co-construction of a shared outcome. For developing capable and compelling pathways the initial focus will be with innovators, with a gradual integration of wider layers of stakeholders to test the capability and compelling nature of the emerging pathway. Note that the goal is not primarily to satisfy all the existing players in a sector. This is almost by definition impossible for transformational projects which necessarily disturb existing expectations and entitlements. Nor is it the production of a pathway that appeals only to technical experts, or to one particular set of interests, while leaving other participants cold. Rather it is the co-development of a pathway that is 'fit for purpose': that can meet the objectives for improved outcomes and has the potential for wide societal appeal. But in the first instance such a pathway must attract a sufficiently diverse and energized coalition of actors who are willing to champion its potential in the real world.

Developing such genuine co-design processes necessarily takes time and requires the building of trust among collaborators.

4.5. Scenarios and quantitative modelling

Scenarios and quantitative modelling can play an important role in pathway development. Scenarios allow the exploration of different possible future worlds, and when combined with quantitative modelling they facilitate examination of the implications of technological and societal changes and policy choices. Modelling has played a central place in the development of international climate research and policy: building understanding of climate change driven by human GHG releases, of the potential consequences of this changing climate on human activities, and the results – for the climate but also for the economy – of various mitigation strategies and policy approaches. The largest and most complex models are Integrated Assessment Models (IAMs) used by scientists to track interactions among natural and human systems at a global scale over a century or more.[69] In the Canadian context a number of different approaches have been used to model links among energy systems, emissions, the economy and climate policy options.[70] Broadly speaking there is a distinction between 'bottom-up' models that start from energy and material flows and 'top-down' whole-of-economy models, but there are also various hybrid approaches.[71] Different models are better suited to answering different types of question.[72]

When considering modelling approaches suited to the pathway development process outlined here it is important to keep in mind a number of issues:

- *The ability to envisage large scale system change*. Some models are well suited to tracking incremental adjustments to existing relationships, but have trouble accommodating large scale disruptive change or major demand shifts that alter structural conditions. Since transitions are about these sorts of change such models may be less helpful in the exploratory phases of pathway development (although they may shed useful light on implications of specific policy steps taken as a pathway is initiated[73]).
- *Accessibility to stakeholders*. Many established models are highly complex and can only be manipulated successfully by individuals with extensive specialist training. Moreover, their assumptions, and the functions that link (literally thousands of) variables may be opaque or unavailable for scrutiny. This makes them cumbersome and difficult to deploy with stakeholders. International experience with participatory modelling confirms the importance of accessibility of

quantitative tools in order to build trust, explore options and co-design pathways.[74]

- *The demands of integrating multiple dimensions*, including technologies, economic conditions, social practices, public attitudes, policy initiatives, and so on.[75]
- *Applicability to different kinds of pathway projects at different scales*. Since pathway development can start from a sector, region, problem, or some intersection of these, modelling approaches need to be adaptable to many different kinds of circumstance.[76]
- T*ransparency and reasonable cost*. While university researchers played a role in model development in Canada, the most commonly used models are now owned by private consultants or governments. Even when the model itself has been put in the public domain, it may require private consultants to adapt and run the model. Building sophisticated models, collecting and inputting data, and designing scenario runs can quickly absorb very large amounts of money. [77]

No one kind of model can meet all these requirements. So pathways development will typically involve a suite of approaches, with different modeling approaches being appropriate for different projects (say for a particular sector or for a city), and for different phases of the project (initial pathway development versus the assessment phase). In general it will be necessary to adopt a pragmatic approach, adapting tools that are available – as specific research teams (and sometime-stakeholder groups) may already have access to, and familiarity with, different modelling approaches. Whatever tools are deployed it is important to make the assumptions, methods and limitations as clear as possible.

Initial stages of pathway development are generally best served by relatively straightforward and flexible modelling tools that map energy and material flows, facilitate conceptual clarity and tracing causal linkages, and have good visualization potential – all features which facilitate engagement with stakeholders. Such basic models can be purpose-built (on an existing platform) to answer the needs of a particular visioning and pathway process. This allows a direct focus on key relationships, the exploration of alternative ways to reconfigure the system, and the integration of potentially disruptive forces and levers for change. Although such models are necessarily rather simple, they can avoid rigidities and biases that can come from arriving with a complex and opaque pre-existing model which may be difficult to use in exploring major structural adjustments to existing relationships through iterative interactions with stakeholders.[78] As the process advances, to the third (assessment) phase of the process outlined above, more detailed work can be carried out, using more elaborate modeling approaches to explore relationships with adjacent systems, introduce the evolution of costs, explore macro economic impacts, evaluate alternative policy regimes, and so on.

5. Building a Transition Accelerator

This report has presented an alternative approach to engaging with the climate issue in Canada, one that focuses on steering change to improve key societal systems and harnessing the disruptive and transformative forces that are already sweeping our economy. To this point, we have discussed the findings of ongoing research on socio-technical transitions, considered the features and advantages of a transition pathways perspective, and outlined a basic methodology that can be applied to co-develop visions and pathways. In this final section we explain how the creation of a new organization – the Transition Accelerator – can contribute to implementing this approach in Canada.

5.1. What is the Transition Accelerator?

The Transition Accelerator is a not for profit organization that collaborates with groups across the country to develop transformative visions and pathways. It works to apply and further elaborate the perspective and methodology presented here, engaging with researchers and stakeholders in varied regions and sectors to co-develop and build out innovative pathways for societal improvement. As the name suggests, the organization is an 'accelerator.' Its purpose is to nurture new ideas, build coalitions of innovators, enhance promising alternatives, and spin out consortia interested in generating change. It acts as a 'force multiplier', focusing efforts, speeding the construction of attractive and viable alternatives to existing ways of doing things, and catalysing processes of change. It works by drawing together change agents from industry, governments, universities, environmental groups and the broader not-for profit sector. Above all, it seeks to change narratives from the negative ('what we don't want') to the positive ('what we do want').

The central activity of the Accelerator is the co-construction of transformative visions and pathways across multiple regions and sectors. As outlined in the previous section, this involves substantive, collaborative and iterative engagement with stakeholders centered on specific pathways. At any given time, a number of such exercises will be underway, as the organization shifts its attention from one area to another. In addition to this practical focus on pathway development, the Accelerator works to popularize its approach and further elaborate its methodology, building tools for use in pathway design and assessment, and synthesising lessons from experience with different development exercises. The Accelerator also takes an active role in public debate, sharing findings from its analytical and engagement work and formulating recommendations for policy.

Key characteristics of the Accelerator's activity include the emphasis on:

- building collaborative links among researchers and societal stakeholders
- analyzing social, economic and policy dimensions of transformative pathways and not just technological possibilities
- integrating quantitative and qualitative perspectives, including modeling and scenario development, forecasting and backcasting approaches, and visualization techniques
- combining imaginative thinking with an evidence based analytical approach
- striving to move from critical analysis to practical action.

The Accelerator is an open-structured organization, with a small core of staff and an array of active groups working with collaborators in different regional and sector contexts to develop pathways process.

5.2. Why a purpose-built organization?

In principle the methodology presented in the previous chapter could be deployed directly by different kinds of organization – public sector bodies at various levels, civil society groups or business firms or alliances. And our hope is that that over time such initiatives will flourish. In practice, however, a number of factors make this difficult today – particularly the political polarization and lack of trust around the climate issue which render convening in this area a challenge. Public officials are preoccupied with immediate problems and with accommodating conflicting political demands; there is suspicion of businesses for advancing their own commercial interests; while environmental organizations may not be best placed to initiate processes that seek system transformation encompassing broader societal goals. Precisely because the approach proposed here is rather different from much of what has gone on under the climate action banner to date, it makes sense to start with a purpose-built organization which can work with others to deploy the methodology across the country, while also adding a distinctive voice to public discussion.

Two critical advantages of a purpose-built organization are that it can:

- *Specialize in accelerating pathway development*. This is a specific task that requires particular skill sets: for example, for analysing the character of existing systems, facilitating visioning and pathway design, evaluating the potential of proposed pathways, and drawing together consortia for practical action. A dedicated organization can concentrate on building networks of collaborators and recruiting and

training staff with the required competences. It can develop a strategic approach, applying resources where they can make the most difference. It can adopt organizational values, structures and modes of working that are best suited for the specific analytical and engagement practices required for pathway development. And it can facilitate learning as multiple exercises are conducted over time, as well as cross-fertilization among process in different regions and sectors.

"The Accelerator catalyses interactions among innovators to generate shared understandings of promising avenues for change and to build enthusiasm to carry them forward in practice."

- *Maintain (and be seen to maintain) independence from established political, economic, regional or societal interests.* While the Accelerator seeks to work closely with governments, businesses, and civil society, it is politically non-aligned and organizationally autonomous. Organizational independence provides a foundation for its claim to provide unbiased and critical assessments, and to act as a bridge and facilitator for the elaboration of transformative visions and pathways. Moreover, the Accelerator has no a priori commitments to any particular technology, business model or social practice: it remains open to considering a variety of potential contributions to transformative pathways that improve societal systems while meeting climate goals. But it is committed to evaluating claims on the basis of evidence and critical analysis.

The Transition Accelerator does not intend to duplicate the functions of existing organizations, but to focus on a task which is not being undertaken systematically today. For example, there are many federal and provincial agencies and programs intended to support technology development at different stages of the innovation chain (Sustainable Development Technologies Canada, Alberta Innovates, and so on). We have business, technology and social innovation incubators (such as the MaRS Discovery District in Toronto); alliances focused on particular technologies (the Ontario Smart Grid Forum), as well as think tanks that distill policy advice for governments (such as the Smart Prosperity Institute). Environmental organizations actively engage the public and seek to influence government, and many businesses and community organizations are experimenting with promising products and services on the ground. What the Transition Accelerator adds to these efforts is something quite distinct: it catalyses interactions among innovators to generate shared understandings of promising avenues for change and to build enthusiasm to carry them forward

in practice. In other words, the Accelerator facilitates a particular kind of generative activity that can help seed transformational processes in specific sectors and regions, while also contributing to shifting the nature of the debate around climate issues. It makes sense, therefore, to establish a purpose-built organization to carry forward this activity.

5.3. Organizational values, principles and structure

The values, operational principles and structure of the Accelerator flow from its basic approach and core mission. Its orientation is positive and constructive, building momentum for change by generating attractive visions and pathways for societal advance. It seeks to deploy creative imagination that is anchored in a firm grasp of practical circumstances. Collaboration – among researchers at different institutions and with stakeholders from government, industry and civil society lie at the core of its activity. The Accelerator works with existing groups to deploy its visioning and pathway development process. Throughout, emphasis is on innovators – individuals and groups committed to securing real change. Its initiatives are evidence-based, involving investigation of existing systems and detailed analysis of potential change vectors. It mobilises insights from multiple disciplines – including science and engineering, social sciences, the humanities, law and policy studies. And academic research findings are combined with the practice-oriented knowledge of different stakeholders (including where appropriate traditional knowledge). Finally, the Accelerator is resolutely pluralistic, acknowledging that there are multiple viewpoints on social problems related to different identities, interests, institutional positions and values. Accounting for varied perspectives and acknowledging difference is an essential element of vision and pathway development.

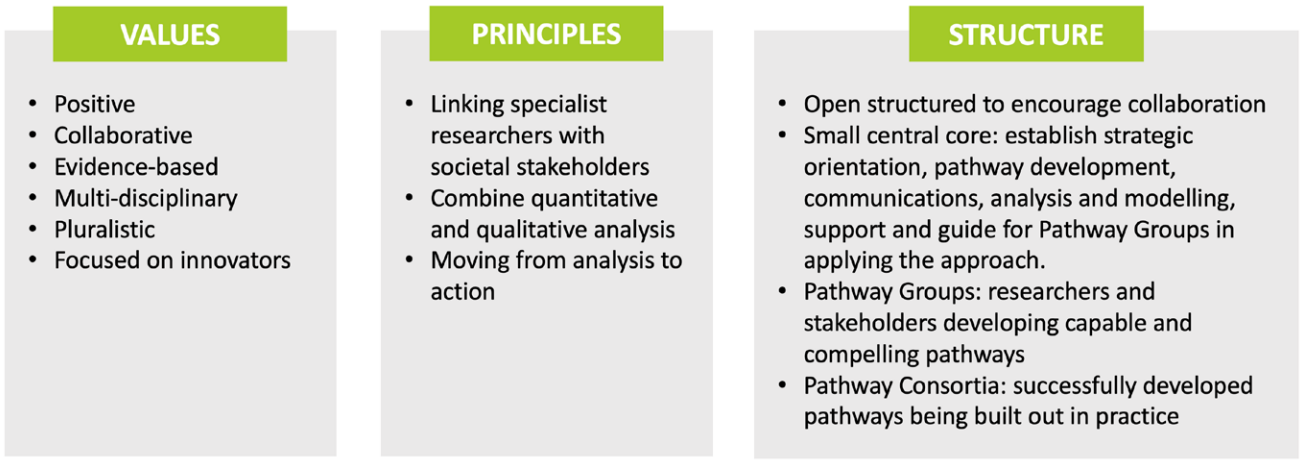

Figure 5.1 The organizational values, principles and structure for the Transition Accelerator.

Key operational principles include the encouragement of constructive interactions between researchers and stakeholder groups; combining quantitative and qualitative approaches in narrative development and pathway assessment; recognizing the uncertainties and indeterminacies that are inherent in attempts to understand and shape the future; and a commitment to move from research and analysis to action that achieves practical outcomes (Figure 5.1).

The work of the Accelerator involves three basic organizational elements:

- First, a small group of dedicated staff focused on overall activities. These include establishing the strategic orientation, selecting and championing pathway development projects, managing networks of collaborators, commissioning specialist studies, developing tools (protocols, modelling, etc.), supporting ongoing pathway processes, and external communications. Although this represents the 'core' of the Accelerator, it is in fact physically dispersed in different regions of the country.
- Second, groups of researchers and stakeholders involved with the detailed work of developing pathways in particular regions/sectors. These will be at different stages in the design process, which can take several years.
- Finally, 'consortia': practically focused coalitions of stakeholders engaged in building out pathways through a range of activities, including research and development, pilots or experiments, public communication, lobbying for policy reform and so on. While the Accelerator helps launch such Consortia, and can provide continuing support with assessments and analysis, ultimately they determine their own way forward.

In addition to these three main groups, the Accelerator has wide networks of researchers, stakeholders and funders that can provide support and advice on various projects. It works closely with universities in different parts of the country which serve as hubs for coordinating research activities. It also has governance bodies of various kinds, including an independent Board with fiscal and strategic oversight, a Pathway Oversight Committee that supervises pathway development projects, and specialist stakeholder Advisory Committees constituted around particular pathway development projects.

5.4. How does the Accelerator work?

The Accelerator's central activity is pathway development and build-out across multiple sectors and regions. Typically work will be focused on a number of distinct pathways which are at different phases of elaboration. So, over time, the methodology can be applied across a range of promising areas. Key issues in conducting this work include the selection of areas for work, the organization of pathway development, and the funding of activities.

Selecting areas for work

Here, the Accelerator employs three fundamental criteria:

- First, the system must have a substantial GHG footprint, so that its transformation would be significant from a climate point of view. Of course, work can start with part of a larger system that is more analytically or practically manageable. But the effort should in principle open access to emission reductions that are meaningful at a regional or national scale.
- Second, there must be problems with the existing system that go well beyond its climate profile. If things are humming along smoothly (with content consumers, complacent governments and businesses that are making money hand over fist) it will be difficult to open the door to significant change.
- Third, there needs to be some evidence of disruptive or transformative forces – if not already directly impacting the system, then at least identifiable on the horizon. Again, it is not enough that there are perceived shortcomings with existing arrangements, there must also be some evidence that existing ways of doing things are likely to be called into question and the search for alternatives will become pressing.

These fundamental criteria point to the areas where transformative pathways are likely to be most accessible and where progress along these pathways will really matter from the climate perspective.

In addition to these basic considerations related criteria that will influence the choice of priorities include:

- The enthusiasm of innovative stakeholders to undertake a pathway development process. After all, these are the forces that will be called up on to drive change on the ground, if a pathway is to be deployed in practice;
- The opening of a political window, where policy makers are willing to consider a shift in established policy frames. These sometimes emerge

in the wake of a change of government or after a scandal or policy fiasco where existing policy regimes are called into question.

- The availability of resources (particularly funding) to actually support the visioning and pathway development process described here.

The pathway development process

Pathway development involves applying the general methodology outlined in the previous chapter to the specific circumstances. For the work on freight, the hydrogen economy and personal mobility, the Accelerator has been able to draw on analysis and engagement which CESAR (the Canadian Energy Systems Analysis Research) has carried out over the past few years. Typically, the Accelerator will open a 'call for proposals' for contributions to potential pathways, commission 'white papers' to provide background and sketch out promising avenues of advance, and convene workshops to refine alternatives. Pathway facilitators work to map developments in the area and to network innovators in the research and stakeholder communities. Once the broad lines for the pathway development exercise have been clarified, a pathway group can be established which can take the lead on the more detailed elaboration of the work.

Funding activities

The Accelerator draws funding support from a variety of sources. Its initial funding has been provided by a number of philanthropic foundations eager to see deployment of a novel approach to the climate change challenge in Canada. Support for groups working with the organization can also come from government agencies at all levels, businesses, not-for-profit organizations and research funding bodies. Some are particularly interested in a specific sector or region, and their contributions go to support relevant pathway development exercises. Other bodies may fund specific kinds of activity linked to pathway development such as research or stakeholder engagement. Contributions to the Accelerator are spent either to support core staff and activities or to fund the pathways groups carrying out detailed development work on specific pathways. Pathway groups can then leverage this funding to secure support from other sources. Once established, consortia are assumed to be financially independent, and can draw on a much wider pool of funding from government, industry and civil society.

6. Conclusion

This report makes the case for approaching the problem of climate change in a different way. It emphasises the scale of the change that will ultimately be required to address the issue, and the need for the transformation of major societal systems including the way we generate and consume electricity, move people and goods, design our agricultural and food systems and build our cities. It notes that for most Canadians today concerns over the climate issue are not sufficiently compelling to drive change at the pace and scale required. Climate initiatives are therefore only likely to be successful when integrated more closely with broader efforts to build a better Canada. And since many of the systems implicated with the climate problem are already undergoing disruptive and transformative change, the issue becomes one of harnessing or steering these broader forces to achieve desirable societal outcomes that are also low-carbon.

This report also points to some of the lessons from the study of societal transitions, especially the importance of visions and pathways for galvanizing action, coordinating innovative forces, orienting investment, building public support and shaping policy initiatives. It outlines a methodology that can be used for pathway development, to co-create capable, credible and compelling pathways for change. And it champions the idea that a new organization – the Transition Accelerator – can collaborate with groups across the country to accelerate the design and build out pathways in different sectors and regions.

In concluding, it is important to emphasise that no claim is made here that this is the only way to approach the climate change challenge. Many forms of action by individuals and groups across multiple dimensions of social life will ultimately be required to drive change to find new ways of living and flourishing in a carbon constrained world. Shifts in values and social norms, individual and collective behaviour, economic and social practices, policies and politics, and institutions at multiple levels will be needed over coming decades to make progress towards a more sustainable Canada.

But we do believe that the transition pathways approach discussed here, and the Transition Accelerator designed to give it life, can make a real difference. By adding a distinctive point of view to the climate conversation in Canada. By helping to network and activate innovators. By co-developing new avenues for advance. By catalysing the practical build out of promising alternatives. And, in the largest sense, by helping transform the nature of argument and policy approaches around the climate change challenge.

7. Notes

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[60] More on the interactions between these different spheres can be found in the previously-cited literature on the multi-level perspective

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The Transition Accelerator

L'Accélérateur de transition