



ALL NET-ZERO PATHWAYS BEGIN WITH A LOCAL STEP

A Literature Review of Research Informing Net-Zero Transition Policy in Canada

October 2021

QUEST

**The Conference
Board of Canada**

TABLE OF CONTENTS

Acknowledgements	2
Introduction	4
Key Findings – the role of local systems on the path to net-zero emissions	6
Finding 1. We need to account for behaviour changes and social acceptability to quickly scale up the net-zero solutions we have	6
Finding 2. What we have is not enough. We need to cultivate the conditions to accelerate the deployment of policies and technological solutions	7
Finding 3. We need sound and tailored workforce transition programs based on growing sectoral needs associated with the net-zero transition	8
Finding 4. We need to fill the financing gaps	9
Finding 5. Policy must align across all levels of government	10
Finding 6. Net-zero transitions are an opportunity to promote equity and advance Reconciliation	10
Finding 7. We need to better stress the positive health impacts	11
Conclusion	14

ACKNOWLEDGEMENTS

Authors

Aida Nciri, Manager, Policy & Research, QUEST

Jesse Steinberg, Research Associate, The Conference Board of Canada

Helda Renyaan, Project Assistant, QUEST

Reviewers

Tonja Leach, Executive Director, QUEST

Richard Laszlo, President, Laszlo Energy Services

Ruseh Oghenekaro, Energy Business Analyst, Laszlo Energy Services

Roger Francis, Director, Sustainability, The Conference Board of Canada

Research was funded by The Conference Board of Canada's Clean Energy Growth Economy Centre (CEGE). CEGE's investors comprise: Bruce Power, Capital Power, CNRL, SaskPower, Scotiabank, Suncor, TD Bank, and TransAlta.

Copyright © QUEST - Quality Urban Energy Systems of Tomorrow and The Conference Board of Canada, 2021.

These materials may be reproduced in whole or in part without charge or written permission, provided that appropriate source acknowledgements are made and that no changes are made to the contents. All other rights are reserved.

The analyses/views in these materials are those of QUEST and The Conference Board of Canada, but these analyses/views do not necessarily reflect those of QUEST or The Conference Board of Canada affiliates (including supporters, funders, members, and other participants) or any endorsement by QUEST or The Conference Board of Canada affiliates.

These materials are provided on an "as is" basis, and neither QUEST, The Conference Board of Canada, nor their affiliates guarantee any parts or aspects of these materials. QUEST, The Conference Board of Canada, and their affiliates are not liable (either directly or indirectly) nor accept any legal responsibility for any issues that may be related to relying on the materials (including any consequences from using/applying the materials' contents). Each user is solely responsible, at the user's own risk, for any issues arising from any use or application of the materials' contents

QUEST

QUEST is a national non-government organization that works to accelerate the adoption of efficient and integrated community-scale energy systems in Canada by informing, inspiring, and connecting decision-makers. The organization commissions research, communicates best practices, convenes government, utility, and private-sector leaders, and works directly with local authorities to implement on-the-ground solutions.

The Conference Board of Canada

The Conference Board of Canada is the foremost independent, not-for-profit applied research organization in Canada. We are objective and non-partisan and do not lobby for specific interests. Funded exclusively through the fees we charge for services to the private and public sectors our business is convening and research. We are specialists in economic trends and public policy issues, as well as on organizational performance. While not a government department or agency, we provide services for all levels of government, the private, and not-for-profit sectors. We are independent from, but affiliated with, The Conference Board, Inc. of New York, which serves nearly 2,000 companies in 60 nations and has offices in Brussels and Hong Kong.

1. INTRODUCTION

The Government of Canada committed to achieving a net-zero emission target by 2050. As part of the strengthened climate plan, many measures are being put in place to meet this target. Yet, top-down policies and programs won't be enough given the level of effort and transformations required.

To ensure the transition to net-zero is quickly and widely implemented, strong support and buy-in from communities on the ground is essential, and there is a need to equip them with the resources and capacity they need.

There is an obvious pattern in the published research to date that is informing Canada's transition to net-zero – it takes a national lens.

Yet, Canada's communities are diverse. A rural community in Ontario, an urban community in Alberta, a coastal community in New Brunswick or an Indigenous community in Nunavut face different challenges and opportunities. Canada needs to build an understanding of the magnitude and implications of a net-zero energy transition for its diverse communities.



Only then will better local decisions and actions be taken that support the net-zero target in a way that creates more local jobs and economic opportunities and is sustainable and equitable for all Canadians. This report is part of the Diverse Pathways to Net-Zero initiative that focuses on granular policy options that reflect communities' unique socio-economic contexts, energy resources, and capacity to implement the transition. The objectives of this report are threefold:

- **To present the key policy and program-related findings identified in the reviewed literature;**
- **To explore the need for a community-oriented approach to inform policy and accelerate the transition to net-zero; and**
- **To define a methodological framework for a community-oriented approach to achieving the net-zero transition**

Twenty-two reports published over the past 3 years looking at informing low-carbon or net-zero transition policies were reviewed (Appendix 1). Both technical modelling reports and qualitative analytical reports targeted at decision makers or at informing net-zero policies and deemed relevant to the Canadian context were selected.

The review focused on policy-oriented research on net-zero pathways, produced in Canada and the United States, as well as select reports from international agencies. Reports were analysed using a community perspective, in order to understand how communities' roles and responsibilities were accounted for, and how local bottlenecks were assessed in slowing down or accelerating the transition.

Because little consideration about the roles of, and implications for, communities were found in these reports, additional publications that considered the role of local governments in the transition were included.

CORE DEFINITIONS

COMMUNITIES. The term ‘communities’ represents more than municipal governments. It refers to the network of individuals, institutions, and organizations that interact within a territory whose boundaries can be loosely delineated by a smaller-than-provincial/territorial form of government, a coherent economy, and a network of infrastructure. Communities are characterized by their size, a form of local government (may include regions, cities, townships, hamlets, reserves/settlement areas, etc.), as well as resources and capacities the individuals, institutions, and organizations, possess and manage to deliver services and goods to this community. This means that Canada’s communities are diverse.

When we focus on energy transition, communities include any organizations that control or influence energy use, delivery or supply at the local level such as utilities, energy service providers, real estate developers, industrial users, investors, federal and provincial agencies such as regulators and policy-makers, and many more. Through this energy lens, communities are characterized by their energy sources, infrastructure, regulation, etc.

COMMUNITY PERSPECTIVE. A community perspective to net-zero transitions embraces the above definition of communities to inform net-zero policies and programs. It acknowledges the diversity of Canada’s communities, including their differentiated capacity and resources, their specific needs, challenges and opportunities, and their diverse energy systems. In this report, we argue that a community perspective is needed if we want to achieve Canada’s net-zero target. A community perspective enables communities and policy-makers at all levels of government to identify a suite of policy and pathway options that consider the diverse challenges faced by a rural community in Ontario, an urban community in Alberta, a coastal community in New Brunswick or an Indigenous community in Nunavut. It focused on granular policy options that reflect communities’ unique socio-economic contexts, energy resources, and capacity to implement the transitions.

NET-ZERO emissions mean that anthropogenic emissions of greenhouse gases (GHGs) into the atmosphere are balanced by anthropogenic removals of GHG from the atmosphere over a specified period. Canada’s net-zero commitment includes all GHGs and is geographically bound to emissions generated within Canada across all sectors. This definition is consistent with international GHG accounting standards in which each country accounts for emissions produced within its borders. Emissions from GHG-producing exports are accounted for in the country of use.¹

A PATHWAY connects where we are today with where we want to go. But it is not just a line on a graph. A pathway captures all the elements required to transform a system to better respond to societal needs and meet net-zero emission goals (e.g., the character, magnitude, and sequence of changes in technologies; infrastructure; business models societal practices; mindsets; governance structures; investments; reporting requirements; and, policy or regulatory frameworks). A pathway has a clear beginning and end, with connecting steps that will be refined over time based on learning.²

2. KEY FINDINGS – THE ROLE OF LOCAL SYSTEMS ON THE PATH TO NET-ZERO EMISSIONS

Finding 1. We need to account for behaviour changes and social acceptability to quickly scale up the net-zero solutions we have.

In Canada, existing technologies – what the Canadian Institute for Climate Choices refers to as ‘safe bets’ – are crucial in the short term and should contribute 89% of required emissions reductions by 2030.³

Yet, the scale-up of existing solutions aligning with the net-zero target is still slow and will not reach full potential in the short term. There is a need to change behaviour to reduce emissions and increase local buy-in for the transition.

The reviewed reports, however, tend to neglect the challenges associated with the real-world adoption of new technical systems.

Social acceptability and social behaviours can accelerate or slow down the uptake of existing and emerging technologies, and the acceptance of new policies.

This disconnection between deployment on the ground and projection is a common limitation of modelling, which often fails to “address the issues of imperfect information, quality of technology service, and risk of technology failure in their methodologies implying that many real-life behaviours are likely to be ignored in climate policy projections, resulting in underestimated mitigation costs and overly optimistic GHG reductions.”⁴

⇒ **A community perspective incorporates community concerns into net-zero programs and contributes to positive, locally-grounded net-zero narratives**

The net-zero literature emphasizes that technological changes on their own will not be sufficient to achieve transition objectives. Behavioural changes, combined with much broader levels of social commitment, will also be needed. According to the IEA’s net-zero pathway model, cumulative emissions between 2021 and 2050 will be 10% higher without required shifts in individual behaviour and consumption patterns.⁵

By integrating local concerns into policy design, a community perspective approach can help to increase the social acceptability of transition programs and support new consumer behaviours. Community awareness campaigns, for example, can play an important role in the roll-out of electricity demand-management programs, explaining the value of programs at both the household and community level.

More importantly, a community perspective approach can support the development of positive local transition narratives and discourses. Positive narratives can be more effective than economic and regulatory levers in driving behavioural change.⁶

Local governments are uniquely positioned to convene local stakeholders to identify community needs, share educational resources, and align stakeholders around a shared transition vision.

1. Definition borrowed from Net-Zero Advisory Body 2021, p3.

2. Definition borrowed from Net-Zero Advisory Body 2021, p3.

3. Dion et al.

4. Rhodes et al. 2021 p33

5. International Energy Agency 2021

6. Hoicka et al. 2021, p53.

Finding 2. What we have is not enough. We need to cultivate the conditions to accelerate the deployment of policies and technological solutions.

There is a consensus that existing policies and technologies are not sufficient to meet net-zero targets by 2050. According to the International Energy Agency’s (IEA) net-zero pathway, half of emissions reductions to 2050 require technologies that are at the demonstration or prototype stage.⁷ In Canada, the ‘safe bets’ will only contribute 66% of required emissions reductions by 2050.

To reach net-zero, still-emerging ‘wild card’ solutions will be needed, especially in hard to abate industrial sectors like steel and cement production. These technologies include green hydrogen, biofuels made from second-generation feed stock, and negative emissions technologies like nature-based solutions, direct air capture, and carbon capture and storage. The rapid scale-up of existing technologies and the deployment of emerging technologies require additional programs than those currently in place.⁸

⇒ A community perspective can help accelerate local support for deploying policies and technological solutions

Stakeholder engagement at the community level can help to identify local barriers to technology deployment and policy implementation. For example, communities will be integral to mapping opportunities for nature-based climate solutions and emission offset programs, as well as identifying biodiversity and ecosystem implications.

Less than half of the economy-energy models used in Canada incorporate land use, and even fewer models include the agricultural and forestry sector. Community engagement is critical to filling these knowledge gaps.⁹

Local governments influence many policy levers that are critical to accelerating the implementation of federal and provincial programs, as well as deploying technologies needed for a net-zero transition. In addition to traditional responsibilities related to land use planning, transportation, construction, and waste management, local governments are also developing new tools and responsibilities related to the networked integration of energy and mobility systems in the built environment.

Communities and local governments play a particularly important role in developing synergies across sectors and creating opportunities for novel forms of ‘systemic efficiency.’

For example, at the local level, net-zero building policies, electric vehicle deployment, and decentralized renewable energy systems can be integrated through building-to-grid infrastructures.

7. International Energy Agency 2021

8. Dion et al. 2021

9. Rhodes et al. 2021



Finding 3: We need sound and tailored workforce transition programs based on growing sectoral needs associated with the net-zero transition.

As referenced above, successful net-zero transitions require a rapid deployment of both existing and emerging technologies and their rapid integration into commercial supply chains.

In addition to public sector support for research, development, and demonstration, the accelerated integration of low-carbon technologies will be aided by public-private sector-based strategies that help to develop new industry standards, align objectives, and create roadmaps for commercial transitions.

Examples include Sweden's strategy for 'green steel' and Germany's cross-sectoral hydrogen strategy.¹⁰ Some existing industries can be realigned with the need of the net-zero transition, with Canada's mining sector having the potential to shift to the extraction of rare earth minerals, such as lithium and nickel, as the global demand increases with the deployment of clean technologies.¹¹

There is also a consensus that transition to a net-zero economy requires a profound labour market transition in the energy, transportation, and building sectors.

Modelling from the IEA prescribes no new oil and gas development.¹² As a result, the oil and gas sector will experience a significant decline in employment.

New jobs will be created, however, in areas of clean transportation (including electric vehicles), clean power and heating, and low-carbon buildings.¹³ The energy and building sectors in particular require new regulatory expertise and capacity.^{14,15}

While these restructuring patterns will vary significantly across provinces, modelling by

Clean Energy Canada shows that with existing policies, employment in these sectors will grow by almost 50%, compensating for job losses in oil and gas and resulting in net-positive employment growth in every province. Without well-funded training programs,¹⁶ however, labour shortages will create a significant bottleneck for the net-zero transition and lead to unproductive competition between provinces and sectors.

⇒ A community perspective provides a granular understanding of sectoral and geographical training needs

As the labour landscape is transforming, there is a need to better understand the quality of the new jobs (pay, benefits, reliability), their impact on the workforce's quality of life, and their distribution across communities (whether they will be able to have people working where they live). Workforce training programs are needed to expand new economic sectors and limit unproductive competition across sectors and jurisdictions. However, there remain significant knowledge gaps with respect to where and how workforce training programs should be deployed. Most models do not consider local labour market implications and there remains limited understanding of how training resources will be targeted, organized, or funded. Local governments and stakeholders have a key role to play in identifying market opportunities, mapping the geography of training needs, and helping to ensure that training programs are accessible and appropriately targeted.

10. Woynillowicz et al. 2021

11. Clean Energy Canada 2021

12. International Energy Agency 2021

13. Clean Energy Canada 2021

14. Carlson et al. 2020

15. Lockheart and Haley 2020

16. According to the Canada Green Building Council, for example, training programs for the building sector require an investment of \$500 million/year to ensure access to skilled labour.

Finding 4: We need to fill the financing gaps.

The net-zero transition requires unprecedented investment in low-carbon technology and infrastructure. According to estimates, Canada needs to spend \$128 billion by 2030 to keep track with net-zero targets, with at least \$52.6B in the transportation sector, \$10.8B in the building sector and \$16.2B in the electricity sector.¹⁷ Other estimates anticipate up to CA\$1.5 trillion of required investment in electricity and hydrogen infrastructure by 2050.¹⁸

For example, the hydrogen economy requires new and retrofitted pipeline capacity; decarbonizing the electricity system requires investment in new generation, transmission, and distribution infrastructure, including ‘smart’ digital technologies; and the accelerated adoption of electric vehicles requires investment in charging stations and load management systems. The scale of investment needed cannot be supported by the public sector alone.

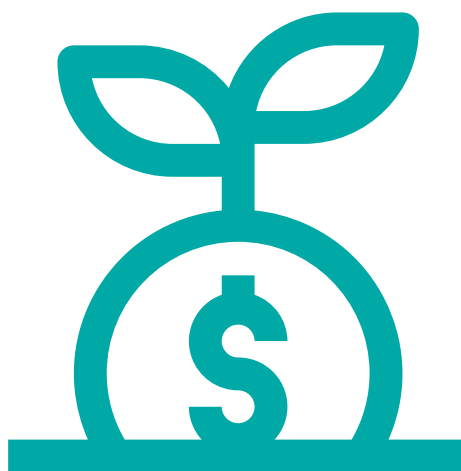
Governments will need to invest strategically, but the reallocation of private sector resources will also need to accelerate. Scaling up sustainable finance requires improved data collection and dissemination systems, including enhanced climate-related disclosure practices, as well as innovative approaches to risk-sharing and blended finance.¹⁹

The creation of the Canada Infrastructure Bank is a positive step in this regard.

⇒ A community perspective can help to build a bridge between large investors and local investment opportunities

Much of the infrastructure required for net-zero transitions is being developed at the community level. This includes buildings, distributed energy resources (DERs), EV charging networks, public transit, and active mobility infrastructure.

The need for new community infrastructure, however, risks compounding an already-existing local infrastructure gap. Local governments own and operate 60% of Canada’s public infrastructure, but their ability to maintain, renew, and reinvest in these capital assets is extremely limited.²⁰ Local budget constraints and the limited capacity to generate new revenues is thus one of the principal barriers that local governments face in scaling up their net-zero agenda.



In addition to public sector investment, local communities require access to new forms of sustainable finance. But accessing this finance for local projects is challenging. It can be difficult, for example, to connect small and disaggregated local projects to institutional investors, who are typically only interested in large projects.

Local engagement and capacity-building is needed to help communities map local investment opportunities and access funding support through bundling and aggregation.

17. Martin and Riordan 2020

18. PricewaterhouseCoopers, 2021

<https://www.pwc.com/ca/en/industries/energy/publications/how-can-canadas-energy-and-utility-companies-prepare-for-a-net-zero-future.html>

19. Expert Panel on Sustainable Finance 2019; Net-Zero Advisory Body 2021

20. Canadian Infrastructure Report Card 2019

Finding 5: Policy must align across all levels of government.

The net-zero transition requires coordinated action across all levels of government. To successfully deploy electric passenger vehicles, for example, federal vehicle regulations must work in concert with EV purchase incentives, the decarbonization of provincial electricity grids, and the local roll-out of charging networks and grid-connected infrastructure. The need for policy coordination is particularly acute for municipalities, who have a critical role to play in Canada's low carbon transition but are often constrained by a lack of resources and policy authority.²¹

For example, constrained resources and insufficient municipal regulatory authority have been highlighted as key transition barriers in both the building and energy sectors.²²

⇒ A community perspective ensures that actions taken by higher levels of government support and empower communities

Local governments have a critical role to play in the net-zero transition, but they lack the powers and resources needed to be effective. According to a survey conducted by the Federation of Canadian Municipalities, only 37% of local governments have internal funding sources that are dedicated to climate-related initiatives.²³

A community perspective is needed to help to identify local resource gaps and highlight opportunities to enhance local policy making-capacity. Communities should be empowered to pursue more ambitious climate policies through, for example, the development of tiered building codes and enhanced planning authority. A community perspective can also highlight the need for innovative local financing tools, like revolving loan funds, municipal green bonds, and blended finance programs.²⁴



Finding 6: Net-zero transitions are an opportunity to promote equity and advance Reconciliation.

Net-zero transitions will cause significant disruptions in a range of sectors, including labour markets, the housing sector, transportation networks, and energy and electricity systems. These disruptions will have implications for household spending, and the costs are likely to be borne disproportionately by already disadvantaged households and communities. To mitigate these effects, net-zero policies need to incorporate an equity lens to ensure that all Canadian households and communities can access the benefits of a low-carbon transition.²⁵ Canada's net-zero agenda also provides an opportunity to advance Reconciliation.

To this point, Canada's climate plans, including the Pan-Canadian Framework, have been developed without adequate engagement and in ways that conflict with Federal commitments to Nation-to-Nation, Inuit-Crown, government-to-government relations.²⁶

21. Jaccard et al. 2019

22. ICLEI and Federation of Canadian Municipalities 2020

23. ICLEI and Federation of Canadian Municipalities 2020

24. Lamberink 2021

25. Turcotte and Dusyk 2021; Net-Zero Advisory Body 2021

26. Indigenous Climate Action 2021; Woynilowicz et al. 2021



Going forward, net-zero policies should prioritize not only economic development opportunities in Indigenous communities, but also deeper forms of engagement and partnership. Diesel displacement initiatives in remote and Northern communities, for example, present an opportunity to promote skills training, community planning, and Indigenous project ownership.²⁷

⇒ **A community perspective can support equity and inclusion and help advance Reconciliation**

Indigenous communities face several common challenges in the context of the net-zero transition. Beyond these challenges, however, there is a great deal of diversity. Indigenous communities are taking a leadership position in the new energy economy, but they are engaging with these opportunities in distinct ways.

For example, some communities are prioritizing autonomy and self-sufficiency, using retrofit initiatives and renewable energy projects to encourage local ownership and independence. Other communities are focused on more immediate needs, such as mitigating environmental harm or creating employment opportunities.

A community perspective can play a key role in identifying local capacities, needs, priorities, and opportunities. An equitable transition that supports inclusion and Reconciliation will need to engage communities when planning projects and developing new economic opportunities.

As an example, the implementation of nature-based climate solutions and offset programs will need to be designed in consultation with communities and in ways that respect Indigenous rights.²⁸

Finding 7: We need to better stress the positive health impacts

There is a consensus that, in addition to environmental and economic benefits, the net-zero transition will also generate benefits related to improved health and quality of life. For example, building retrofits also improve indoor air quality, preserve green space and lead to healthier lifestyles. In Canada, air pollution is responsible for over 15,000 premature deaths each year.²⁹ In the USA, one report estimates that the transition to net-zero could prevent between 200,000 and 300,000 premature deaths between 2020 and 2050, avoiding US\$2-3T in damages.³⁰

⇒ **A community perspective can improve health outcomes**

Yet, these health impacts may not be equally distributed. For example, the shift to cleaner modes of transportation will disproportionately benefit urban areas, where congestion and transportation-related air pollution is highest. A report from the Canadian Institute for Climate Choices also emphasizes that health improvements associated with net-zero may not benefit marginalized populations equally if climate change is not addressed alongside problems of inequality and environmental racism.³¹ A community perspective will help to highlight the relationships between economic opportunity, climate change, and public health.

27. Goodwin et al. 2021

28. Indigenous Climate Action 2021

29. Health Canada 2021

30. Larson et al. 2020

31. Waldron 2021

COMMUNITIES ARE AT THE INTERSECTION OF THE ENERGY TRANSITION



TRANSPORTATION

Local governments are of course integral to efforts to reduce the role of internal combustion passenger vehicles. Intensification and integrated land-use planning can help to reduce overall demand for travel, while investments in public transit and active mobility infrastructure help to shift demand to more energy-efficient alternatives. Local governments are also at the forefront of efforts to electrify the transportation sector. Local governments are helping to plan and build out electric vehicle charging networks, investing in the electrification of public transit networks, and transitioning municipal vehicle fleets. Finally, local governments are also leading the development of new smart mobility systems that use digital connectivity to support ride-sharing and multi-modal trip planning to create more flexible and efficient travel patterns.

BUILDINGS

Local governments have a key role in supporting the development of zero-carbon buildings through both new construction and building retrofits. Local governments are responsible for enforcing building and energy codes for new construction. In some jurisdictions, local authorities are using education, regulations, and incentives to encourage developers to build to higher energy performance standards. As federal, provincial, and territorial governments move towards the development of net-zero energy ready (NZER) building codes by 2030, the introduction of energy performance tiers will give local governments more opportunities to accelerate the adoption of net-zero construction standards.

Local governments have also taken a leadership role supporting low-carbon building retrofits. For example, a number of Canadian municipalities are setting targets for residential and commercial retrofits and using local improvement charges to provide low-cost financing. Finally, with responsibility for land-use planning and zoning bylaws, local governments have the ability to enable alternative energy solutions such as district energy, waste to energy, and vehicle to building solutions.

LAND USE AND PLANNING

Land use is a huge factor that influences carbon emissions directly and indirectly. Land use influences mobility options and building forms. Successful energy transition in communities is only possible if energy considerations are integrated into the entire urban planning process.

But, consideration of energy issues is missing in land use planning processes. While a natural connection should exist between urban development and energy development, a legacy of siloed urban land use and energy systems planning is a barrier to a more coordinated transition to low carbon and climate-resilient communities.

This barrier also exists among related professions including building professionals, engineers, finance professionals, and others. Planners need to play a central role in integrating local, renewable and conventional energy sources into their communities.



ENERGY INFRASTRUCTURE

Local governments have an important role to play in the transition to a zero-carbon energy system. The transformation of heating systems will require adapting existing pipe infrastructure to accommodate hydrogen and renewable natural gas as well as to safely store sufficient biomass stock.

District heating will also require the construction of local thermal plants that goes hand in hand with new planning practices. On the electricity front, the shift from centralized and unidirectional electricity grids towards more decentralized, interactive, and multi-directional grids is supported by local governments in several ways.

First, local governments are contributing to the development of renewable and decentralized electricity by incentivizing rooftop solar PV installations, encouraging solar-ready construction, and planning district energy systems. In collaboration with utilities, local governments are also deploying smart grid and advanced metering technology, which will enable a host of new network services.

For example, smart grid technology will enable 'prosumers' with distributed generation assets to exchange power and information with the grid, it will enable more effective demand management programs, and will allow the integration of electric vehicles as storage and grid stabilization assets.

3. CONCLUSION. WE NEED TO BE MORE GRANULAR IN OUR UNDERSTANDING OF THE TRANSITION

Table 1 below summarizes the key benefits of applying a community perspective to address the current gaps of research and policies on net-zero transition in Canada.

The net-zero literature recognizes that transition dynamics will vary among provinces and from one community to another. On the technological front, the competitiveness of electrified heating and transportation solutions will be conditioned by regional factors, like energy prices, climate, development patterns, and existing infrastructure. Northern, remote, and rural communities, for example, will take a longer time to adapt due to the high cost of electricity and the slower roll-out of EV charging networks.³² On the economic front, challenges and opportunities will vary according to the sectoral composition of the economy and available labour market resources.

Despite acknowledging the reality of diverse pathways in Canada, however, models and recommendations nevertheless tend to be aggregated at either national or provincial levels. As a result, dynamics at the local level are not well understood and the role that local governments will play in accelerating or impeding transitions is neglected.

A recent study³³ reviewing 24 modelling tools used by Canadian agencies and think tanks to model energy transitions found only four that applied at the municipal scale. While publications in our supplementary literature review do consider the role of local governments, the focus is overwhelmingly on the challenges and opportunities facing large cities. The experience of smaller urban areas and non-urban communities has thus received particularly little attention.

According to Canada's Net-Zero Advisory Body, Canada's net-zero agenda needs to incorporate a place-based approach to policy development that recognizes the diverse pathways communities will travel on the road to net-zero.³⁴ Our review echoes this finding. It highlights the need for research tools and engagement practices to adopt a community perspective and help us to develop more fine-grained understandings of Canada's many distinct community transitions. In turn, this knowledge can inform the development of net-zero policy and programs, and ground net-zero narratives into the reality of Canada's communities, thereby accelerating the scale up and pace of the transition. This is what the Diverse Pathways Initiative is about.

A next step in this work will be to analyze the many local net-zero strategies and plans that Canadian communities are currently implementing. Documenting these diverse strategies will provide insight into the role that local governments are currently playing, as well as the barriers that they face in scaling-up their net-zero ambitions. Just as important, it will provide insight into the distinct challenges and opportunities that different communities face.

We also plan to develop a series of community archetypes that capture key community characteristics that will shape the path to net-zero. An archetype approach can more effectively capture the diversity of local conditions and inform the development of tailored transition policies that better reflect the diversity of local needs and capacities.

32. Indigenous Climate Action 2021

33. Rhodes et al. 2021

34. Net-Zero Advisory Body 2021

TABLE 1: THE BENEFITS OF COMMUNITY PERSPECTIVES ON NET-ZERO

CURRENT GAPS

BENEFITS OF A COMMUNITY PERSPECTIVE

Behaviour changes and social acceptability required to quickly scale up the net-zero solutions we have

Incorporation of community concerns into net-zero programs contributes to positive, locally-grounded net-zero narratives

Absence of the necessary conditions to accelerate the deployment of low-carbon transition

Building local support and conditions for the deployment of tailored policies and technological solutions

Tailored workforce transition programs needed

Granular understanding of sectoral and geographical training needs

Financing solutions aligned with the financing gaps

Building a bridge between large investors and local investment opportunities

Limited policy alignment across all levels of government

Guide actions taken by higher levels of governments to support and empower communities

Leverage the opportunity to promote equity and advance Reconciliation

Support equity and inclusion and help advance Reconciliation

Better stress on the positive health impacts

Improve health outcomes for all communities

6. APPENDIX

REPORT TITLE + LINK	YEAR	ORGANIZATION	GRAPHICAL SCOPE	TYPE OF STUDY/ REPORT
Empowering Cities for a Net Zero Future: Unlocking resilient, smart, sustainable urban energy systems	Jul-21	IEA	Worldwide	Qualitative
Capital Mobilization: Plan for a Canadian Low-Carbon Economy	2019	Institute for Sustainable Finance	Canada	Modelling
Rhodes, E., Craig, K., Hoyle, A., and McPherson, M. (2021). Improving Climate Policy Projections: A Pan-Canadian Review of Energy-Economy Models. University of Victoria.	2021	University of Victoria and Simon Fraser University	Canada	Qualitative
Net Zero America - Potential pathways, Infrastructure and Impacts	2020	Princeton University	USA	Modelling
Canada's Energy Future 2020	2020	CER	Canada	Modelling
Decolonizing Climate Policy in Canada Phase 1: Critique of the PCF and the HEHE	2021	Indigenous Climate action	Canada	Qualitative

REPORT TITLE + LINK	YEAR	ORGANIZATION	GRAPHICAL SCOPE	TYPE OF STUDY/ REPORT
Bistline, Blanford, McCollum, and Roney (2021), "Canadian National Electrification Assessment: Electrification Opportunities for Canada's Energy Future," EPRI Report 3002021160 (EPRI, Palo Alto, CA	Forth coming	EPRI	Canada	Modelling
The New Reality	2021	Clean Energy Canada	Canada	Modelling
Making the Case for Building to Zero Carbon	2019	Canada Green Building Council	Canada	Recomendations
Pathways to Net Zero: A Decision Support Tool	2021	Transition Accelerator	Canada	Tool
Canada's Net Zero Future: Finding our way in the global transition	2021	CICC	Canada	Modelling
Net-Zero Pathways Initial Observations	2021	Net Zero Advisory Body	Canada	Qualitative
10 Ways to Win the Global Race to Net-Zero	2021	IISD	Canada	Recommendations

REPORT TITLE + LINK	YEAR	ORGANIZATION	GRAPHICAL SCOPE	TYPE OF STUDY/ REPORT
Net Zero by 2050	2021	IEA	Worldwide	Modelling
The North American Renewable Integration Study: A Canadian Perspective	2021	NREL	Canada	Modelling
Stenghtening Canada's Building Code Process to Achieve Net-Zero Emissions	2021	Efficiency Canada	Canada	Recomendations
Dangerous Distractions - Canada's carbon emissions and the pathway to net zero	2021	Canadian Centre for Policy Alternative	Canada	Qualitative
Canada in a Changing Climate: National Issues report (Cities and Towns)	2021	NRCAN	Canada	Modelling
Zeroing in on Emissions: Canada's Clean Power Pathways	2019	David Suzuki Foundation	Canada	Qualitative
Creating Clean Prosperity	2020	Clean Prosperity	Canada	Modelling
All Hands on Deck - An assessment of provincial, territorial and federal readiness to deliver a safe climate	2021	Pembina	Canada	Assessment

BIBLIOGRAPHY

Bistline, Blanford, McCollum, and Roney. "Canadian National Electrification Assessment: Electrification Opportunities for Canada's Energy Future." EPRI, 2021.

Bouckaert, Stephanie, Araceli Fernandez Pales, Christophe McGlade, Uwe Remme, and Wanner. "Net Zero by 2050: A Roadmap for the Global Energy Sector." International Energy Agency, July 2021.
https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroBy2050-ARoadmapfortheGlobalEnergySector_CORR.pdf.

Brinkman, Gregory, Dominique Bain, Grant Buster, Caroline Draxl, Paritosh Das, Jonathan Ho, Eduardo Ibanez, et al. "The North American Renewable Integration Study: A Canadian Perspective." NREL, June 2021.
<https://www.nrel.gov/docs/fy21osti/79225.pdf>.

Canada Energy Regulator. "Canada's Energy Future 2020." Government of Canada, 2020. <https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/canada-energy-futures-2020.pdf>.

Canada Green Building Council. "Making the Case for Building to Zero Carbon," February 2019.
https://www.cagbc.org/cagbcdocs/advocacy/Making_the_Case_for_Building_to_Zero_Carbon_2019_EN.pdf.

Carlson, Richard, Mariana Eret, Michael Lee, and Aida Nciri. "Getting to Deployment: Bridging Gaps in Energy Innovation in Canada." Quest Canada and Pollution Probe, 2020. <https://questcanada.org/wp-content/uploads/2020/11/Innovation-Sandboxes-Report-2-EN-1.pdf>.

Clean Energy Canada. "The New Reality." Clean Energy Canada, June 2021. https://cleanenergycanada.org/wp-content/uploads/2021/06/Report_CEC_CleanJobs2021.pdf.

Corvidae, Jacob, Chiara dalla Chiesa, Robert Denda, Jason Hartke, Ulrika Jardfelt, Rob Lichtman, Grania Long, et al. "Net Zero Carbon Cities: An Integrated Approach." World Economic Forum, January 2021.
http://www3.weforum.org/docs/WEF_Net_Zero_Carbon_Cities_An_Integrated_Approach_2021.pdf.

Dion, J, J Kanduth, J Moorhouse, and D Beugin. "Canada's Net Zero Future: Finding Our Way in the Global Transition." Canadian Institute for Climate Choices, 2021. https://climatechoices.ca/wp-content/uploads/2021/02/Canadas-Net-Zero-Future_FINAL-2.pdf.

Friedmann, Julio S., Mahak Agrawal, and Amar Bhardwaj. "Evaluating Net-Zero Industrial Hubs in the United States: A Case Study of Houston." Columbia Center on Global Energy Policy, June 2021.
<https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/Houston,%20final%20design,%206.29.21.pdf>.

Gattinger, Monica. "What the IEA's Net Zero by 2050 Report Means for Canada." Daily Oil Bulletin, May 25, 2021.
<https://www.dailyoilbulletin.com/article/2021/5/25/what-the-ieas-net-zero-by-2050-report-means-for-ca/>.

BIBLIOGRAPHY

Goodwin, Brett, Jesse Steinberg, and Junyi Feng. "A Microgrid Playbook: Conditions and Opportunities for Investment." Conference Board of Canada, 2021.

Health Canada. "Health Impacts of Air Pollution in Canada: Estimates of Premature Deaths and Nonfatal Outcomes," 2021. <https://www.canada.ca/content/dam/hc-sc/documents/services/publications/healthy-living/2021-health-effects-indoor-air-pollution/hia-report-eng.pdf>.

Hoicka, Christina E., Runa R. Das, Maria-Louise McMaster, Yuxu Zhao, Susan Wyse, and Jenny Lieu. "Diffusion of Multiple Demand-Side Low-Carbon Innovations in a 1.5°C Energy Transition." Smart Prosperity Institute, February 2021. <https://institute.smartprosperity.ca/sites/default/files/Hoicka-SPI-report-WP.pdf>.

ICLEI Local Governments for Sustainability and Federation of Canadian Municipalities. "National Measures Report 2019," 2020. <https://data.fcm.ca/documents/reports/PCP/2020/pcp-national-measures-report-2019.pdf>.

Indigenous Climate Action. "Decolonizing Climate Policy in Canada: Report from Phase One." Indigenous Climate Action, March 2021. https://static1.squarespace.com/static/5e8e4b5ae8628564ab4bc44c/t/6061cb5926611066ba64a953/1617021791071/pcf_critique_FINAL.pdf.

International Energy Agency. "Empowering Cities for a Net Zero Future: Unlocking Resilient, Smart, Sustainable Urban Energy Systems," 2021. <https://iea.blob.core.windows.net/assets/4d5c939d-9c37-490b-bb53-2c0d23f2cf3d/G20EmpoweringCitiesforaNetZeroFuture.pdf>.

Jaccard, Mark, Rose Murphy, Brett Zuehlke, and Morgan Braglewicz. "Cities and Greenhouse Gas Reduction: Policy Makers or Policy Takers?" *Energy Policy* 134 (2019).

Lamberink, Liny. "Here's an inside Look at Canada's First Rare Earth Mining Project in the N.W.T." *CBC News*, April 20, 2021. <https://www.cbc.ca/news/canada/north/rare-earth-mine-northwest-territories-1.5993809>.

Larson, Eric, Chris Greig, Jesse Jenkins, Erin Mayfield, Andrew Pascale, Chuan Zhang, Joshua Drossman, et al. "Net-Zero America: Potential Pathways, Infrastructure, and Impacts." Princeton University, December 15, 2020. https://environmenthalfcentury.princeton.edu/sites/g/files/toruqf331/files/2020-12/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf.

Lee, Marc. "Dangerous Distractions: Canada's Carbon Emissions and the Pathway to Net Zero." Canadian Centre for Policy Alternatives, June 2021. https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2021/06/CCPA%20report_Dangerous%20Distractions%20Net%20Zero.pdf.

BIBLIOGRAPHY

Lockhart, Kevin, and Brendan Haley. "Strengthening Canada's Building Code Process to Achieve Net-Zero Emissions." Efficiency Canada, October 2020. <https://www.encycanada.org/wp-content/uploads/2020/10/Strengthening-Canadas-Building-Code-Process-to-Achieve-Net-Zero-Emissions.pdf>.

Martin, Simon, and Ryan Riordan. "Capital Mobilization Plan for a Canadian Low-Carbon Economy." Institute for Sustainable Finance, September 2020. <https://smith.queensu.ca/centres/isf/pdfs/ISF-CapitalMobilizationPlan.pdf>.

McCarthy, Shawn. "Net-Zero Report Card: How Future-Friendly Are Canadian Provinces." Corporate Knights, 2021. <https://www.corporateknights.com/channels/climate-and-carbon/net-zero-report-card-how-future-friendly-are-canadian-provinces-16188303/>.

Meadowcroft, James, Katherine Monahan, Hossein Hosseini, Shabnam Khalaj, Colleen Kaiser, Nathan Lemphers, Sonia Patel, Derek Eaton, and Cameron Roberts. "Pathways to Net Zero: A Decision Support Tool." The Transition Accelerator, January 2021. <https://transitionaccelerator.ca/wp-content/uploads/2021/01/2021-01-24-Pathways-to-Net-Zero-v9-4.pdf>.

Net-Zero Advisory Body. "Net-Zero Pathways: Initial Observations," June 2021. https://ehq-production-canada.s3.ca-central-1.amazonaws.com/9e3bb1476e46e10b839309c4eb5c6dae3a674e48/original/1624044169/9fce922e91ab369313cf4caff773e79_NZAB_-_Summary_-_Pathways_to_Net-Zero_-_EN.pdf.

Rhodes, Ekaterina, Kira Craig, Aaron Hoyle, and Madeleine McPherson. "Improving Climate Policy Projections: A Pan-Canadian Review of Energy-Economy Models." University of Victoria, March 2021. https://www.uvic.ca/hsd/publicadmin/assets/docs/sshrc-report_ee-models.pdf.

Turcotte, Isabelle, and Nichole Dusyk. "How to Get Net-Zero Right." Pembina Institute, March 2021. <https://www.pembina.org/reports/how-to-get-net-zero-right.pdf>.

Waldron, Ingrid. "Environmental Racism and Climate Change: Determinants of Health in Mi'kmaw and African Nova Scotian Communities." Canadian Institute for Climate Choices, July 22, 2021. <https://climatechoices.ca/publications/environmental-racism-and-climate-change/>.

Woynillowicz, Dan, Estan Beedell, and Peter Wooders. "10 Ways to Win the Global Race to Net-Zero." International Institute for Sustainable Development, May 2021. <https://www.iisd.org/system/files/2021-05/10-ways-net-zero-canada-climate.pdf>.