Assessing the Net Zero Measures and the Achievement of Just Outcomes in Community Energy and Emissions Planning in Canada: A Study of Three Communities in New Brunswick

by

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Abstract

In response to the global mission of limiting warming to 1.5°C, numerous measures have been implemented throughout the world at different scales, specifically targeting the achievement of net-zero emissions by 2050. While these measures are designed to address issues related to climate change, they also create new adverse impacts and injustices in society. The concept of “just transition" emphasises the need to mitigate such impacts, paving the way towards creating more sustainable net zero communities. Community energy and emissions planning is one such measure that has gained widespread recognition internationally and in Canada which is aimed at taking climate actions in the local context to reduce emissions and overcome injustice that could emerge from the transition. New Brunswick (NB) communities are actively engaged in developing Community Energy and Emissions Plans (CEEPs) to both reduce emissions and enhance community resilience. Despite these efforts, challenges such as unclear guidance and vague conceptualizations of the concepts of net-zero emissions and just transitions still persist. These issues challenge the development of robust net-zero measures that also generate just outcomes and hinder the effectiveness of achieving their intended targets. Additionally, despite the widespread implementation of community energy and emissions planning in Canada, their academic application remains limited. To close these gaps, the current research focused on identifying the key indicators that would define what needs to be considered in the measures to reach net zero emissions and guarantee a just transition and reviewing the actions of developed CEEPs in NB from an emission reduction and a just transition-based perspective to understand the level of integration of the key considerations and to gain a better understanding of the actions that NB communities have planned to pursue in reaching their net zero targets. A literature review was conducted to identify key indicators for the concepts of net zero emissions and just transition. CEEPs of three communities in NB: the city of Fredericton, the city of Moncton, and the town of St. Andrews were analysed using qualitative data analysis

methods. The review of the literature generated 10 indicators that should be considered in the measures to achieve net-zero emissions and generate just outcomes. The case study analysis revealed that the integration of actions that would support the generation of just outcomes was significantly less than the measures for net zero emissions in the CEEPs of NB communities. And most of the actions that were identified for just transition indirectly support the indicators rather than directly addressing it.

Foreword

This research paper is essentially a specification of the area of concentration of my plan of study, for the MES program which is “Climate Solutions for Sustainable Development”. The primary focus of my plan of study is to understand how to navigate climate change adaptation and mitigation measures towards sustainable development. I categorised the area of concentration into the main components of climate change adaptation and mitigation, sustainable development, and local climate actions and community energy and emissions planning. The current research contributes to assisting most of the learning objectives under all the components of the plan of study to different degrees. As the research focuses on net zero emissions and community energy planning and the topics that revolve around them such as climate change, adaptation, and mitigation, it supported me in gaining a general, foundational understanding of climate change topics including its causes, impacts, and mitigation and adaptation measures. Another major component of the research is just transition. Just transition could be identified as one of the concepts that come under the umbrella of sustainable development. By researching the just transition concept and linking the concept with community energy planning, I was able to gain a clear understanding of specific sustainability measures and learn how sustainability pathways and considerations can be integrated into climate solutions. The research also makes a substantial contribution to the component, local climate actions, and community energy and emissions planning. The specification into identifying specific local level net zero measures significantly contributes to developing a deep understanding of energy system measures that can be taken towards climate change and getting a deep understanding of local climate actions and the practice of community energy and emissions planning.

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List of Acronyms

CCS	Carbon Capture and Storage
CCSU	Carbon Capture Storage and Utilisation
CEEP	Community Energy and Emissions Plan
ESI	Energy Systems Integration
EV	Electric Vehicle
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NB	New Brunswick
PACE	Property Assessed Clean Energy
PCP	Partners for Climate Protection
R-CNG	Renewable Compressed Natural Gas
RNG	Renewable Natural Gas
UNFCC	United Nations Framework Convention on Climate Change

USEPA	United States Environmental Protection Agency

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1. Introduction

Climate change has become a major topic of discussion today not only because of the severity of the impacts but also because of the measures that countries, communities, and many other different organisations are taking toward its mitigation and adaptation. According to scientific data, global warming will continue for many centuries even after atmospheric CO_2 levels are stabilized. Therefore, studies emphasize that the stabilization of global climate within the next several centuries requires a rapid decrease in emissions to reach net zero emissions rather than stabilizing greenhouse gas(GHG) levels (Bistline, 2021). Within a very short period, the concept of net zero emissions which was once just a scientific discussion has started to be put into action within the international, national, community and corporate efforts to address climate change(Hale et al., 2022). Following their commitment to the Paris Agreement, many countries are now moving towards achieving their climate targets, especially in alignment with net zero emissions. Canada has also joined over 130 countries in the mission to achieve net-zero emissions by 2050 (Government of Canada, 2023).

Measures to reach net zero emissions involve operationalization in varied social, political, and economic disciplines and in every sector including households, industries, transportation, buildings, agriculture, etc. Key solutions for achieving emission reductions include improved energy efficiency, carbon offsetting mechanisms, electrification, and switching to renewable energy resources (Moghaddasi et al., 2021). While such measures reduce emissions, the successful implementation of net zero measures also requires the management of numerous ethical and justice related considerations and unintended outcomes(Williams & Doyon, 2019). Since the utilization of fossil fuels for energy is the largest contributor to GHG in the world, the energy sector plays a critical role decarbonization (Johnsson et al., 2019). Hence, addressing the threat of anthropogenic climate change and reaching net-zero targets involves

fundamental transformations from fossil fuel energy systems to low-carbon systems (Bistline, 2021; Bistline & Young, 2022). Such system transitions not only change how energy is generated, distributed, and used but also change and influence the social, political, economic, and environmental structuring and functioning of society (Garcia-Casals et al., 2019). As Sovacool et al., (2017) point out, the current state of energy transitions may not only create new injustices and vulnerabilities but also may fail to address existing injustices and vulnerabilities in society. Just transition is a concept that is popular among policymakers, scholars, and activists as the grounding principle in mitigating the negative impacts of energy transition(Wang & Lo, 2021). Many studies emphasise the importance of just transition in ensuring both a fair and equitable transition for all individuals and communities(Chen et al., 2019; Upham et al., 2022; Williams & Doyon, 2019). In essence, the just transition concept highlights the development of principles, tools, and agreements to ensure the attainment of key elements such as equal distribution of benefits and burdens, inclusive decision-making, addressing vulnerabilities, and protecting the environment (McCauley & Heffron, 2018).

An important aspect highlighted in net zero research is the importance of having clear guidance to ensure that the net zero measures are robust and capable of delivering meaningful results. Fankhauser, (2021) highlights that there are occasions when plans and actions designed to reach net zero emission targets are not effectively prioritised and balanced to deliver the desired outcomes. For example, some entities can rely too heavily on carbon offset measures rather than cutting emissions. Tozer (2013) highlights that some targets set by the communities do not reflect the drastic reductions in GHG emissions recommended by scientific research, because they have not taken a holistic community-wide approach that includes major transformational changes in local energy systems. This emphasizes the need to identify the key attributes essential for successful net-zero measures, to make them understandable for the target

audience, and to develop clearer and more specific actions that would effectively reduce GHG emissions from key sources.

Furthermore, from the just transition perspective, research highlights that as just transition has different engagements within different sectors, the interpretation has become difficult resulting in diverse definitions, understandings, and viewpoints of the term (Henry et al., 2020). Such conceptualization issues have reduced the clarity of the content making it difficult to understand what should or should not be considered as just transition pathways making it difficult to deliver the content to the right audience (Wang & Lo, 2021). For example, St. Denis & Parker (2009) in their research of analysing CEEPs in Canada identified that the failure to make CEEPs a guidance document to the entire community has undermined its main objective of prioritizing the local context. Another key aspect in just transition research is the gap between theory and practice. Although research has been conducted theoretically to explain what just transition should be, they are primarily theoretical and not much research has been conducted to explore the practicality of applying the proposed frameworks in real-world scenarios (Banerjee & Schuitema, 2022; Wang & Lo, 2021).

Community Energy and Emissions Planning is a measure that has emerged with the need to drastically reduce emissions to reach net zero targets while also ensuring the development of a sustainable energy system within the principles of just transition (Hanke et al., 2021; Van Veelen, 2018). It is one of the measures that has gained widespread recognition internationally and in Canada for achieving net zero emissions by 2050(Wyse & Hoicka, 2019)). The main characteristic of community energy and emissions planning is that it is a socially inclusive process of developing strategic energy plans in the local context to attain net zero communities. The local context emphasizes the development of decentralized self-sufficient energy systems for the way energy is produced, distributed, and consumed to meet community priorities

(Bauwens et al., 2016; Winfield et al., 2021). One of the outcomes of the process of community energy and emissions planning is a document with communities' vision and prioritised actions to achieve energy and emission related goals within a specific timeline. This is generally called a Community Energy and Emissions Plan (CEEP). CEEPs created by different communities may be titled differently. Thus, in practice, CEEPs can be known by various names, such as, Community Energy Plan, Local Climate Action Plan, Local Climate Mitigation Plan, etc.

Traditionally energy and low-carbon projects are managed by large, centralized utility systems without community involvement. Such systems are known to be associated with issues of unstable energy prices, supply, and other social and economic concerns that are mainly discussed under the adverse impacts of energy transition (Bauwens et al., 2016; St. Denis & Parker, 2009). Studies emphasize that the incorporation of local participation in community energy planning develop systems that are aligned with local needs and values while deriving multiple benefits (Forman, 2017; Haggett & Aitken, 2015). Canada, in its effort to contribute to achieving net zero targets, has recognized the significance of community energy planning and has been implementing measures to put them into action. According to GTI (2016), in Canada, more than 200 communities representing more than 50% of Canada's population have a CEEP of one form or another. Several nonprofit organizations, utilities, and government organizations, including organizations such as Natural Resources Canada, The Arctic Energy Alliance, Quality Urban Energy Systems of Tomorrow, The Federation of Canadian Municipalities, and Partners for Climate Protection program play important roles in promoting and establishing the practice of community energy planning in Canada.

In theory, community energy and emissions planning meant to support emission reductions while also promoting just outcomes (Van Veelen, 2018). Studies highlight that despite the increasing motive to initiate community energy planning measures worldwide, there is still

doubt whether they are being properly operationalized to reduce emissions and to take into account just transition considerations. Tozer (2013) conducted a study in five Canadian communities and identified that, with the adaptation of CEEPs, although GHG emissions had been reduced in municipal operations, the community's overall greenhouse gas emissions had not been significantly reduced. Furthermore, St. Denis & Parker (2009) analyzed ten CEEPs in Canada and revealed that, although the target of community energy and emissions planning is the local context, they were not intended for communication with the target communities, and community participation is not fully realized. Hence, given that community energy planning is a widespread measure in reaching net zero, it is important to analyze the plans that are created to understand whether they are formed in a way to achieve their intended outcomes. Such evaluation of climate actions is important for learning, to assess progress, and to identify any challenges before the implementation (Uitto et al., 2017).

Moreover, analysing and identifying the actions communities are planning to take to achieve net-zero emissions targets and ensure just transitions provides numerous benefits. Such evaluations offer practical examples of how different communities address climate change mitigation, promoting the sharing of effective strategies and solutions. The actions of other communities can inspire new and innovative approaches tailored to local needs and contexts and help understand the challenges and how to overcome them (Gluch et al., 2013; Seto et al., n.d.).

Several studies have been conducted in the areas of net zero measures, just transition, and community energy planning globally and even within the Canadian context. Subsequent studies have been conducted in other countries to link the concepts and analyse CEEPs by considering both net zero aspects as well as just transition based aspects. For example, drawing on data collected from 71 European renewable energy communities Hanke et al., (2021) analysed how

renewable energy communities align the achievement of just outcomes described within a justice framework. However, in Canada, although studies have been conducted to analyse decarbonization measures and net-zero goals broadly, composite studies examining CEEPs in the context of both emission reduction and just transition are rarely discussed and researched. Moreover, in NB, despite the strong commitment for implementation, there is a noticeable lack of academic research on community energy and emissions planning.

Hence, the current research will help close these gaps by developing a framework for net-zero and just transition attributes and applying it in the Canadian context, focusing on three communities in New Brunswick: the city of Fredericton, the city of Moncton, and the town of St. Andrews.

The research targets to achieve the following four main objectives.

1. To identify the key indicators that define what needs to be considered in the measures to reach net zero emissions.

2. To identify the key indicators that define what is essential for guaranteeing a just transition within a framework of distributive, procedural, and restorative justice in the efforts towards reaching net zero emissions.

3. To thoroughly understand whether the CEEPs in NB encompass actions that are necessary to achieve net zero emissions and adhere to the principles that would generate just outcomes in a low carbon/net zero emissions transition.

4. To identify the types of actions communities in NB are planning to embrace in order to reach net zero emissions and generate just outcomes as mentioned in their CEEPs.

2. Methodology

The research methodology consists of two main components: the development of the criteria framework and the case study analysis.

2.1. Development of the Criteria Framework

The first part involved conducting a deep literature review to identify key indicators that would define what needs to be considered in measures to reach net zero emissions and guarantee a just transition. The research on both net zero emissions and just transition was carried out from a broader perspective to understand what attributes would make net zero measures a successful frame of reference and what attributes will ensure the achievement of just outcomes. The existing research was analysed qualitatively using a thematic analysis approach. For the concept of net zero emissions, existing literature was analysed in accordance with the scientific definition of net zero emissions. As research highlights, there are different theoretical approaches in the literature that describe what a just transition is (Banerjee & Schuitema, 2022; García-García et al., 2020).

For the current study, the justice-based framework described by McCauley & Heffron (2018) which comprises distributive, procedural, and restorative justice aspects was used to analyse just transition literature. Following the definition and the justice-based frameworks, existing literature was reviewed exploring frequently occurring themes related to net zero emissions and just transition. Based on the literature review, a set of key indicators that describe the concepts of net zero emissions and just transition was identified, described, and presented as a simple and general criteria framework.

2.2. Case Study Analysis

The second part of the study involved the application of the developed framework criteria with indicators to analyse community energy and emissions planning in Canada, particularly in NB. For the current study, community energy and emissions planning in NB was evaluated by analysing already developed CEEPs of three communities. The primary focus was on the planned actions sections of the developed CEEPs. The analysis was conducted qualitatively using a deductive content analysis approach. The objective was to analyse whether the communities have integrated actions that are necessary to achieve net zero emissions and that would help generate just outcomes in low carbon/ net zero emissions transition. Another objective was to analyse the actions sections to identify the measures the communities in NB have planned to embrace to reach net zero emissions targets and generate just outcomes.

The criteria framework developed in the first part of the research was intended to be a general guide for understanding net zero emissions and just transition. Hence, when applied in the community context, not all indicators from the general framework, especially the ones related to net zero emissions were expected to be fully visible or applicable. Community energy and emissions planning research highlights that when it comes to community level actions, the focus is mainly on actions over which communities have control. The current case study analysis was therefore, conducted with careful consideration of this focus on community capacity and control.

2.3. Selection of the Study Area

Prior to selecting the province and communities, a web search was conducted to get a general idea of community energy and emissions planning in Canada. A major finding of the web search was QUEST Canada's involvement in community energy and emission planning in the

Canadian context. QUEST Canada is a registered Canadian charity that supports communities in Canada on their pathway to net zero. Since 2016, QUEST Canada, has been involved with communities in NB in assisting them with developing CEEPs to support their targets to reach net zero emissions. One of their major projects is the New Brunswick Smart Energy Communities Accelerator Program (NB SECA) which involves working with communities in NB assisting them with the tools and knowledge to develop and implement CEEPs (QUEST Canada, n.d). It is an indication that communities in NB are actively engaged in developing CEEPs to reduce emissions and enhance community resilience. Taking into account QUEST Canada's involvement with NB, province's significant engagement in community energy and emissions planning as well as the data and information availability, the current research was focused on analysing community energy and emissions planning in NB, Canada, particularly through the developed CEEPs.

The term 'community' in the context of community energy planning is a vague concept rather than a well-defined one (Winfield et al., 2023). It generally refers to a group of people living in the same locality who share common resources, needs, and goals, especially related to energy usage, sustainability, and reducing emissions. This group typically includes various stakeholders such as residents, local businesses and municipal governments, who work together to create and execute energy and emissions plans that are aligned with their shared interests and priorities. They are typically carried out by agencies with specific responsibilities and defined areas of authority, aligned with administrative boundaries that encompass various municipalities, such as cities, towns, and villages. In NB, a similar approach is observed as in the rest of Canada, where CEEPs are developed by each municipality. Consequently, for this study, three municipalities in NB were selected.

The three communities selected for the case study analysis were the city of Fredericton, the city of Moncton, and the town of St. Andrews. The community selection was mainly based on the availability of completed CEEPs, accessibility to data, as well as the community's active involvement in community energy and emission planning.

The Partners for Climate Protection (PCP) program is a program that provides municipalities in Canada the access to tools, networking venues, and events for taking local climate actions. The PCP program provides a framework to understand where communities lie in community energy planning through a five-step Milestone Framework. Membership in the PCP program and the milestones stages is a great indication of community's commitment and evolution in taking local climate actions (PCP, n.d). The milestone stages range from one to five, five being the highest. Milestones 1, 2, 3, 4, and 5 correspond to: creating a baseline emissions inventory, setting emission reduction targets, developing a local climate action plan, implementing the local climate action plan, and monitoring and reporting on the local climate action plan, respectively. The completion of each milestone signifies the achievement of the above specific actions.

For the current study, the selection of the communities was also based on the PCP milestone achievement stage of the communities. Only communities that have achieved above milestone 3 were considered. According to PCP, the city of Fredericton has achieved mistletone:5 (implementing a local climate action plan). And the city of Moncton and the town of St. Andrews have both achieved milestone 3 which is the plan development stage. The completion of an action plan was also confirmed by conducting a web search to look for publicly available CEEPs.

Figure 1 – A map of the locations of selected communities of NB (City of Fredericton, City of Moncton, Town of St. Andrews). Image sourced from Google Earth Pro.

2.4. The Three Communities and their CEEPs

Since all three communities are members of the PCP and have successfully attained PCP Milestone 3 through the development of their respective plans, these plans adhere to certain requirements mandated by the PCP program. There are four key elements that the communities should demonstrate before Milestone 3 recognition can be issued. They are: a description of activities that will be taken to achieve target reductions, stakeholder engagement; a description of cost and/or funding sources; and a description of where the overarching responsibilities for the plan are contained (Partners for Climate Protection [PCP], n.d.). Following the first

requirement which is, “a description of activities that will be taken to achieve the targets reduction pattern”, the community plans of all three communities outline a range of activities that will be taken to reduce corporate or community GHG emissions and meet their community emissions goals.

2.4.1. City of Fredericton

The city of Fredericton is the capital city of NB and is the third-largest city in the province. The city is situated in the west-central portion of the province along the Saint John River which is a dominant natural feature of the area. Fredericton is one of the main urban cities in NB that holds a population of 63,116 residents (Statistics Canada, 2021). Based on forecasted population growth, without any actions from the city, the city’s GHG emissions are projected to increase to 680,000 tonnes by 2050 which is an 18 % increase over 2000 levels (City of Fredericton,2022). Recognizing the importance of reducing emissions based on the future projections of emissions, the city has planned to reduce emissions to 50% below 2004 levels by 2030 and attain net zero emissions by 2050. This effort is guided by their CEEP which was originally developed around 2020 and updated in 2022. The City of Fredericton has categorized the planned actions of the CEEPs into the categories: buildings, solid waste, transportation, land use, alternative energy, local economy, community, and municipal leadership sections. In their plan, the actions in each category encompass the expected timeline of initiation and completion, goals area and responsible departments (City of Fredericton,2022).

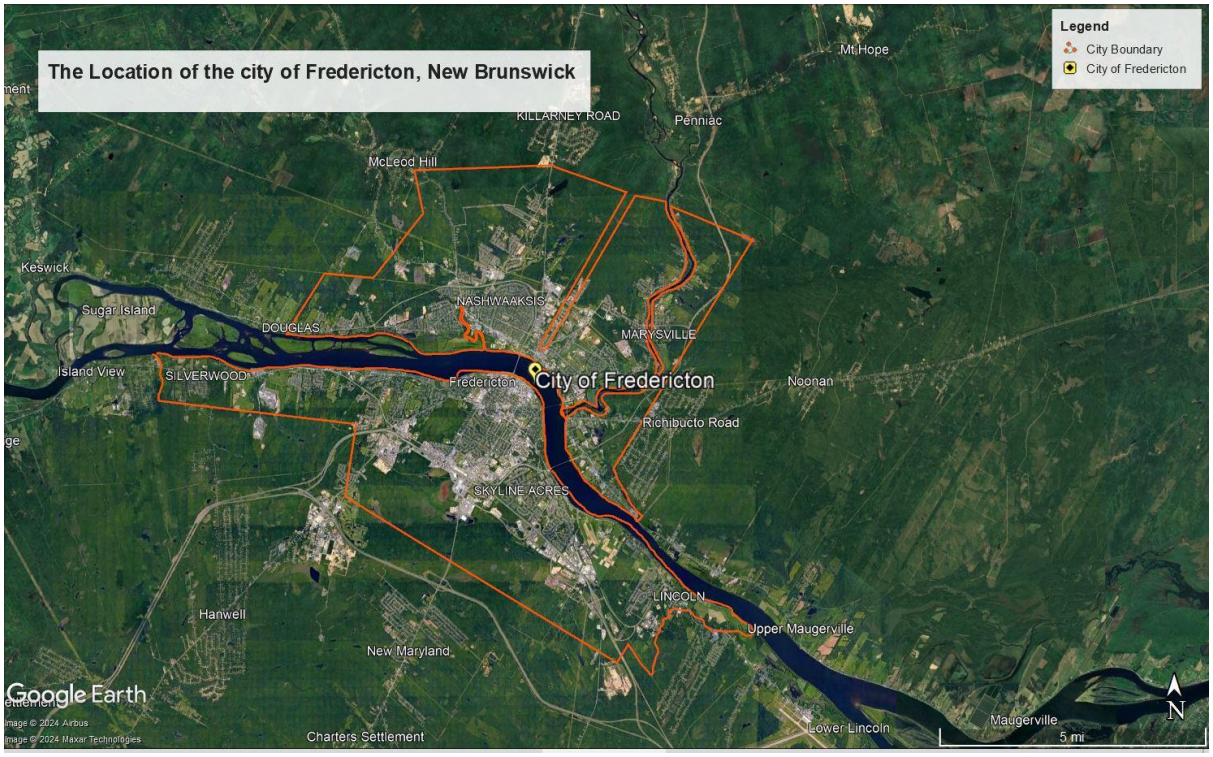

Figure 2: Map of the City of Fredericton. Image sourced from Google Earth Pro.

2.4.2. City of Moncton

The city of Moncton is situated along the famous Tidal Bore Petitcodiac River in Southeastern NB. It holds a population of 79,470 residents and is the largest city in NB (Statistics Canada, 2021). As the city is partially built on low land around a tidal river, it is vulnerable to the impacts of climate change, especially to high-intensity and more frequent storms, and of flooding. To tackle these issues, Moncton has been actively taking action to reduce GHG emissions in the city and improve resilience. Between 2002 and 2017, the community has achieved 18% reduction in GHG emissions. The city has already completed different climate adaptation and mitigation plans such as Integrated Community Sustainability, Plan (2011) and Climate Change Adaptation Measures for the Greater Moncton Area (2011). In July 2022, the city council approved Moncton's CEEP. The plan includes a target to get the community to net zero by 2050. In Moncton's CEEP, the actions have been categorized into seven categories: urban form, buildings and industry energy, transportation, waste and sequestration, and

resilience and capacity, governance, and equity. The actions under each category have specific quantitative targets and objectives as well the time sensitivity-related information (City of Moncton, 2022).

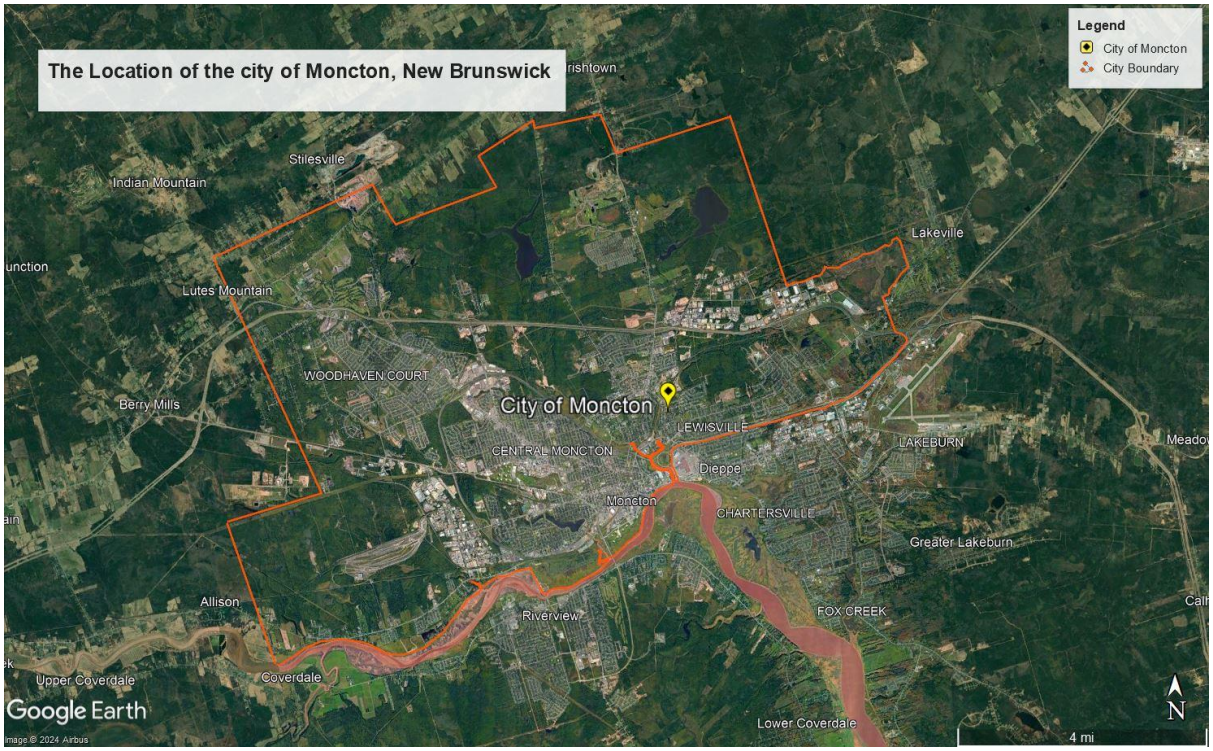

Figure 3: Map of the City of Moncton. Image sourced from Google Earth Pro.

2.4.3. Town of St. Andrews

The town of St. Andrews is located in Charlotte County, NB. The town is a national historic site in Canada and is a popular destination for tourism. According to 2021 census, the population of the town is 2,048 (Statistics Canada, 2021). Between 2016 to 2020, the population rose from 1,786 to 2,048, which had resulted in a 14% increase in the overall population of the municipality. On January 2023, Saint Andrew's geographical boundary changed, and the town annexed the local service district of Bayside and Chamcook under the NB Local Governance Reform legislation. St. Andrews is also considered vulnerable to climate change impacts mainly because of its location near to the coast. The area and community are exposed to rising sea levels, flooding, and severe storm surge events.

Recognizing these vulnerabilities and risks, the town has taken a series of actions to create comprehensive, informed climate adaptation actions. The CEEP which had been developed in 2022 is also a part of that commitment. The town's plan is not necessarily named CEEP but “Greenhouse Gas Emissions Mitigation Plan ". However, the context of the plan describes that this is also called their local climate action plan. The objective of the local action plan maps out specific reduction actions, in each of the five main corporate emission sectors, buildings, water, vehicle fleet, land use, greenspace, GHG sink actions, community actions, and all sector actions (Town of St. Andrews, 2022).

Figure 4: Map of the Town of St. Andrews. Image sourced from Google Earth Pro.

3. Results and Discussion

3.1. Section 1 - Development of the Criteria Framework

3.1.1. Defining Net Zero

Recently, climate ambitions have been increasingly shifting from the historically expressed targets to reduce the atmospheric concentrations of GHG emissions to specific targets for reaching net zero emissions (Fankhauser et al., 2022).The term “net zero” emerged as a solution

for climate change and has become an important topic of discussion today. The importance of reaching net zero emission by 2050 is stressed out by many international treaties. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 °C highlights the importance of reaching net zero emissions globally by mid-century or sooner to avoid the worst impacts of climate change. The Paris Agreement calls for a balance between sinks and sources of emissions in order to achieve global net zero (Allen et al., 2022; IPCC, 2022).

From the scientific perspective net zero is defined as a strategy by which GHGs released into the atmosphere are reduced as close to zero as possible while any additional emissions released are offset by removals into sinks, in order to keep the rise in global average temperatures within certain limits (United Nations [UN],2022). The above definition emphasizes two key areas crucial for achieving net-zero emissions:

1. Reducing GHG emissions
2. Offsetting additional emissions by removing them into sinks

3.1.1.1. Reducing GHG Emissions

Carbon dioxide (CO_2) is considered the most significant anthropogenic GHG as it is the largest contributor to global warming. While CO_2 is not the most potent GHG in terms of its warming potential, its significant abundance in the atmosphere creates a much more overall impact on the greenhouse effect than other gases. By 2020, CO_2 concentration in the atmosphere had risen to 48% above its pre-industrial level (Hyman et al., n.d.; Ritchie & Roser, 2017). Therefore, as the concept of net zero emissions explains, halting global warming in the long term requires, at a minimum, that no additional CO_2 emissions from human activities are added to the atmosphere.

The primary source of the increased atmospheric concentration of CO_2 since the pre-industrial period results from fossil fuel use, with land use change providing another significant but smaller contribution (Bridlington et al., 2022). The global energy system is the largest source of CO_2 in the world accounting for approximately two-thirds of global CO_2 emissions. Reducing energy sector emissions is therefore essential to limit warming and reach net zero emissions targets. Many studies emphasize that energy system changes such as reduced fossil fuel consumption, increased production from low and zero-carbon energy sources, and increased use of electricity and alternative energy carriers are essential to limit global warming for the next thirty years(Ang et al., 2022; Fawzy et al., 2020; Williams et al., 2012).

Land use management also plays a key role in achieving net-zero emissions. Land use management not only assists in mitigating GHG emissions but also contributes to enhancing and safeguarding GHG sinks (Dale, 1997). Demand-side mitigation measures which involve modifications of demand for goods and services, technology, consumption, behaviour, and lifestyles are also crucial in reaching net zero targets and goals (Mundaca et al., 2019).

Although CO_2 is the most prominent GHG, the reduction of non-CO_2 GHG emissions should not be ignored, as most of them can trap more heat within the atmosphere than CO_2. Methane (CH_4), which is the second most abundant anthropogenic GHG after CO_2, contributes to approximately 16 % of global emissions and is approximately 25 times more powerful at warming the atmosphere than CO_2 over 100 years (United States Environmental Protection Agency [USEPA], n.d.). These gases are emitted from a broad range of sectors and sources. Methane (CH_4) is mostly emitted from extraction, distribution, and combustion of fossil fuel, industrial processes, agricultural sources such as enteric fermentation, manure management, etc., and the waste and wastewater sector. Hence, measures to manage CH_4 emissions can be

implemented across various sectors, including waste management, agriculture, and energy (Montzka et al., 2011).

3.1.1.2. Offsetting Additional Emissions by Removing Them into Sinks

The importance of GHG sinks has been widely recognized by many countries at both national and global levels. GHG sinks are identified as "any processes, activities or mechanisms which removes a GHG, an aerosol or a precursor of a GHG from the atmosphere" (United Nations Framework Convention on Climate Change [UNFCC], n.d.). Both natural and artificial sinks can remove GHGs from the atmosphere. As far as the sinks of GHGs are concerned, many of them are absorbed naturally by land and ocean-based sinks and most of them can remain in the atmosphere for several hundred years. To overcome this and regulate the atmospheric concentration of GHGs, methods are developed to create artificial sinks to sequester them and enhance the removal potential of already existing natural sinks. Furthermore, after the removal from the atmosphere by various natural and artificially created sinks, subsequent methods are also being developed to store carbon in deep reservoirs for an extended period and utilize them (Post et al., 2012; Sonwani & Saxena, 2022).

3.1.1.3. Key Indicators that Define What Needs to be Considered in the Measures to Reach Net zero Emissions

The indicators described below are identified based on a comprehensive understanding of studies focusing on efforts to reduce the release of GHGs, particularly through changes in the energy sector and land use practices, waste management and methods to create and enhance GHG sinks. They centre on the two primary components outlined previously under the

definition of net zero emissions: reduction of GHG emissions and offsetting additional emissions by removing them into sinks.

I. Energy Systems Decarbonization

The energy system encompasses all the processes and systems from energy extraction and generation to different uses of energy including in industrial processes, the transport sector, etc. Decarbonization can be defined as a decrease in the specific amount of carbon emitted per unit of primary energy consumed(Grübler & Nakicenovic, n.d.). This indicator therefore describes attempts to reduce and eliminate the use of fossil fuel and overall energy usage in the energy system.

Energy systems decarbonization involves two main aspects of energy systems. First, is the decarbonization of the energy supply side sector including energy production through low-carbon generation systems. The second is the decarbonization in demand-side sectors such as buildings, transportation, industry, etc(Winfield et al., 2021). Recent research has also given a huge focus on the combined and integrated approach for energy systems decarbonization as described in the framework of Energy Systems Integration (ESI).

ESI is a new approach that proposes a holistic view of the energy systems decarbonization. The International Institute for Energy Systems Integration (IESI) defines ESI as "the process of coordinating the operation and planning of energy systems across multiple pathways and/ or geographical scales to deliver reliable, cost-effective energy services with minimal impact on the environment"(O'Malley et al.,2016,p.1). The objective is to reduce total energy system costs while also achieving a clean, affordable, and reliable energy system(Cambini et al., 2020) .The ESI approach focuses on the interaction of different energy vectors such as electricity, natural gas, hydrogen, heating and cooling, and their integration with fuel, water,

and transport infrastructures. ESI options typically involve smart operation and aggregation of energy systems, cross-vector integration, and power-to-X technologies. Smart operation and aggregation of energy systems involve communication and storage technologies, and automation systems that are tailored to optimize the use of energy resources. Examples include smart devices such as meters and monitoring systems and distributed system resources such as power generators, electric vehicles, and batteries. Cross-vector integration focuses on combining two or more energy vectors for the production or delivery of energy services. An example is Combined heat and power (CHP) technologies. Power-to-X technologies utilize energy carriers, primary hydrogen as an interface among different energy vectors. The use of electrolytic hydrogen as an energy storage option in transportation, industries, and gas grid is an example of this(Hanna et al., n.d.; IPCC 2023).

Renewable energy plays a crucial role in decarbonizing the energy supply sector. According to the UN (n.d.), renewable energy is the energy derived from natural processes that are replenished at a faster rate than they are consumed. A broad spectrum of resources, such as sunlight, wind, flowing water, the earth's internal heat, and biomass such as energy crops, agricultural and industrial waste, and municipal waste can be utilized for renewable energy production (Bull, 2001). Various types of renewable energy can supply electricity, thermal energy, and mechanical energy, as well as produce fuels that can satisfy multiple energy service needs (Owusu & Asumadu-Sarkodie, 2016).

However, several sectors that are hard to decarbonize and are not completely amenable to renewable energy need other alternative fuels (IPCC ,2023). Alternative fuels are any alternative to gasoline that can be produced without restrictions on the type of feedstock resource, meaning that they can either be derived from renewable or fossil fuel resources(Sangeeta et al., 2014). Stančin et al. (2020) outlines that alternative fuels can be

produced from either direct utilization of electricity surplus or from the thermochemical conversion of raw feedstock. These processes are widely investigated nowadays since they can convert different waste materials or raw feedstock into valuable alternative fuels or chemicals.

Alternative fuels are often considered cleaner than conventional fossil fuels because they typically produce fewer GHG emissions and pollutants when burnt(Wang et al., 2022). However, the level of cleanliness can vary depending on the production process, the energy source used, and how the fuel is utilized. For example, hydrogen produced from renewable sources through electrolysis is considered clean, while hydrogen derived from fossil fuels with Carbon Capture and Storage (CCS) may still result in GHG emissions. Hydrogen is an alternative that has been extensively investigated (Fernández-Dacosta et al., 2019). Despite the significant attention on hydrogen, they are also subject to some significant limitations. Developing hydrogen infrastructure to support global expansion requires considerable investment, and there are many significant technical challenges associated with hydrogen storage.Hence, it is unlikely to be a cost-effective and technically feasible decarbonization solution, except in specific transportation sectors and industrial applications like steel production (Qazi, 2022).

All energy users engage in the operation of energy systems by demanding energy at particular times and in particular forms. By adjusting their behaviour and energy demands, usage can be reduced, leading to lower emissions(IPCC, 2023).

End use electrification is an important element in net zero energy systems, particularly for managing the energy demand side. It entails replacing technologies or processes that use fossil fuels, like internal combustion engines and gas boilers, with electrically powered equivalents,

such as electric vehicles or heat pumps (International Energy Agency [IEA], n.d.). The central theory is to rely more heavily on the increased use of electricity in end uses such as transport, buildings, industries, etc. Scholars highlight that there would probably not be an alternative to widespread switching of direct fuel uses to electricity to achieve the expected reduction targets by 2025 (Williams et al., 2012).

Electricity can be produced carbon-free by renewable resources such as solar, hydro and wind energy. Electric technologies can efficiently meet various forms of energy service demands. For example, low-carbon vehicles, powered by electricity, namely electric vehicles(EVs) offer an alternative to conventional fossil-fuel technologies and are considered as a significant way to reduce direct CO_2 emissions (Sugiyama, 2012). Heat pumps that primarily use electricity for space and water heating in residential and commercial buildings offer clean, highly efficient, versatile solutions that reduce energy costs and environmental impact (J. H. Williams et al., 2012).

Another measure for energy demand management is taking measures to improve energy efficiency. Simply put, energy efficiency improvement means reducing the amount of energy needed per unit of output. It involves the reduction of energy usage by investing in optimizing systems, technologies, and practices to reduce energy consumption while maintaining or improving performance (Zhang et al., 2017). Energy efficiency plays a significant role in achieving net-zero targets as it directly reduces energy demand and is also one of the most cost-effective means of reducing emissions, sometimes even resulting in net cost savings (Ürge-Vorsatz & Metz, 2009).

Efficiency improvement measures can be applied in many different end-user sectors including buildings, transportation, and industry. For example, building sector energy efficiency improvements include improved building envelope, building technical systems for heating,

ventilation, air conditioning, cooking and electrical uses, use of efficient and SMART appliances, etc.(Cagno et al., 2013; Meng et al., 2017). The International Energy Association (IEA) identifies energy efficiency as the "first fuel" supporting net zero energy goals at lower costs and delivering a wide array of benefits to society.

Behavioural change is an important element in addressing the climate crisis. Research highlights that the shift away from fossil fuels entails not only technological changes but also strategies in consumption, behaviour, and lifestyles. Similar to energy efficiency, behavioural changes also directly reduce energy demand and are one of the most cost-effective ways emissions can be reduced (Khan, 2019; Niamir, 2019). Moreover, behavioural changes play a critical role in reducing emissions from areas where decarbonization is difficult. In particular, aviation where reducing business travel and long-haul holidays could reduce energy demand(Baumeister, 2020).

Behavioural changes can take different forms. One way is changing the behaviour of consumers by promoting energy conservation practices. Society can conserve energy through their daily routine and habits. For example, increased use of active transportation including walking and cycling, increased use of ridesharing, turning off lights in unoccupied rooms, etc. can reduce energy usage and demand. Behavioural changes also include getting adapted to efficiency improvements, renewable technologies, and other climate initiatives. Since behaviour change is mostly voluntary, it requires the support of physical infrastructures, policy, governance, and financial incentives, and information access to convince people to adopt low-carbon choices. Mandatory standards such as for appliances, buildings or vehicles are also important. Financial incentives and price signals, such as subsidising climate-conscious lifestyles and making emissions-intensive activities more costly, can help promote cleaner options. The adoption of these choices in communities also requires appropriate education and

awareness in delivering the message of how climate actions can help save energy, cost and the environment (Jorgensen et al., 2021; Schreyer et al., 2020; Whitmarsh et al., 2021)**.**

II. Land Use Management

This indicator describes the importance of land use management in reaching net zero emission targets. Human use directly affects more than 70% of the global, ice-free land surface. Land use change is among one of the two primary sources of the increased atmospheric concentration of GHG Emissions since the pre-industrial period alongside fossil fuel use. As Chang et al. (2022) highlights, land use and land cover change accounts for approximately one-third of the carbon emissions caused by human activities since the industrial revolution. Hence, in addition to major cuts in GHG emissions from fossil fuels, actions in the land use sector are essential to reduce emissions and reach net zero targets. Land use and land cover change encompass not only human-induced alterations to land but also various land management practices that impact it.

The primary human activities responsible for the changes in land include deforestation, urbanization, industrial development, agricultural expansion, and unsustainable farming practices (IPCC, 2022). The conversion of tropical forests to agricultural land is a massive source of carbon emissions and contributes substantially to global warming. Forest soil and vegetation contain almost 90% of the carbon stored in global vegetation. When forests are cleared or burnt, they release the carbon they have stored. In addition to emissions from burning, GHG gases are also released by the decay of biomass and from soils (Fearnside, n.d.).Land degradation due to pollution, and unsustainable land management practices is another key element. Land degradation decreases soil's ability to store carbon and contribute to climate change. Infrastructure development and urbanization lead to landscape

fragmentation and urban sprawl that affect forest resources and land use. Extractive industries such as mining cause significant changes to the environment and land use (Sonter et al., 2017). Livestock populations and management in agriculture especially, fermentation is a significant source of CH_4 emissions. In addition to that both CH_4 and Nitrous Oxide (N_2O) are emitted from manure storage and application.

At the same time, land-based ecosystems act as sinks of GHGs. Land-based ecosystems could provide 20 to 30 percent of the mitigation requir ed to ensure that global warming stays below 1.5^{o}C towards 2050. Hence, land is both a source and a sink of GHGs and plays a key role in the exchange of energy, water, and aerosols between the land surface and atmosphere(IPCC, 2022). Land use effects on climate change therefore include both implications of land use change on atmospheric flux of CO_2 and also land management practices that remove CO_2 from the atmosphere. IPCC (2022) emphasizes that land-based climate change mitigation includes a variety of land management practices that reduce GHG emissions and/or enhance carbon sequestration within the land system including in forests, wetlands, grasslands, croplands, etc. Land use management practices that enhance carbon sinks include activities including afforestation, and reforestation and may include the improved management of agricultural soil. Reducing deforestation and forest degradation conserves existing carbon pools in forest vegetation and soil by avoiding tree cover loss and disturbances.

Land use management not only helps mitigate climate change but also provides other non-climate benefits such as food security, enhanced biodiversity, clean air and water and other ecosystem services and social benefits (Eekhout & De Vente, 2019; Popp et al., 2014; Stone, 2009)**.** Moreover, IPCC (2022) emphasises that if implemented with benefits to human well-being and biodiversity, land-based mitigation measures are often referred to as nature-based solutions and/or natural climate solutions.

III. Waste Management

The waste sector is a widely recognized source of GHG emissions, particularly non-CO_2 GHGs such as CH_4 and N_2O. Karakurt et al. (2012) emphasize that waste sector emissions account for about 20.61% of the anthropogenic CH_4 methane emissions. Although, on a global scale, the waste sector's contribution to GHG emissions is relatively low (3-5%), it has the potential to shift from a minor emitter to a significant reducer of GHG emissions (Bian et al., 2022). The emissions from landfilling of solid waste and wastewater are the two largest sources of emissions in the waste sector.

Emissions of CH_4 result from the decomposition of biodegradable components in the solid waste stream which can be generated from municipal solid waste (MSW), industrial waste, and commercial waste. Methane is also emitted during the handling and treatment of municipal and industrial wastewater when the organic material in the wastewater anaerobic decomposition (Bian et al., 2022; Ilmas et al., 2018).

A wide range of actions including technical and behavioural changes can be taken to mitigate GHG emissions from the waste sector. Common mitigation measures include landfill gas capture and utilization, reducing the amount of waste entering landfills, improved landfill practices, and engineered wastewater management (Bogner et al., 2008). Captured gas from landfills can be sold to the natural gas pipeline system and be used for electricity generation and industrial processes. The amount of waste entering landfills can be reduced through recycling, reuse, and waste diversion to alternative treatment and disposal methods, such as composting and incineration. CH_4 emissions from wastewater can be eliminated if wastewater and sludge are stored and treated under aerobic conditions(Hoa & Matsuoka, 2017; Karakurt et al., 2012; Karimipour et al., 2019).

Waste management practices are also known to provide other co-benefits to the society such as air quality improvements, job creation, resource conservation, and reduced environmental pollution, beyond just GHG emission reduction(Bogner et al., 2008; Islam, 2018; Zaman, 2016).

IV. Application of Nature-based Solutions for Mitigation

In 2016, during its World Conservation Congress, the International Union for Conservation of Nature (IUCN) adopted a definition for nature-based solutions. According to that definition, nature-based solutions are , "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al.,2016,p.2).

Various global initiatives such as the Convention on Biological Diversity (CBD), the Paris Agreement under the UNFCC, and the UN Sustainable Development Goals (SDGs) emphasise the importance of addressing global challenges through integrated measures. Nature-based solutions for climate change is one of such measures that has the potential to address many global challenges such as climate change, biodiversity loss, poverty and economic instability and social injustice (Donatti et al., 2022). Nature-based solutions can reduce GHG emissions arising from the loss, degradation and mismanagement of ecosystems, and increase natural CO_2 sequestration.

Many key functions and services provided by natural ecosystems, especially the regulating and supporting services help mitigate and adapt to climate change. Several components of terrestrial ecosystems like vegetation cover, productivity, soil and plant respiration influence

the C-cycle. Oceans are the largest natural sink for CO_2 with about 30% of the carbon uptake since the industrial revolution. Various factors in an ocean ecosystem including temperature, salinity, circulation, biodiversity and ice cover affect its functioning as a potent sink for GHGs. Coral reefs, vegetation and wetlands along a coastline have the ability to reduce the impact of wave intensity by attenuating wave velocity and reducing the vulnerability of people and assets to storm surge (Kabisch et al., 2016; Post et al., 2012; Seddon, 2022; Seddon et al., 2020).

A major attraction of nature-based solutions as a strategy for climate change mitigation is that they can deliver multiple benefits. These benefits include retained and restored ecosystem services that support human health and well-being, biodiversity conservation and sustainable livelihood development (Donatti et al., 2022). .

V. Carbon Capture, Storage and Utilisation (CCSU)

CCSU emerged as a means to create artificial sinks for GHGs, and it has been recognized that its broader use has significant potential to mitigate anthropogenic climate change(Baena-Moreno et al., 2019). CCSU focuses on the selective removal of CO_2 from gas streams, its compression into a supercritical condition, and the use of geological formations to store captured CO_2 for hundreds or even thousands of years. CO_2 capture technologies can be either systems that directly remove CO_2 from flue gas streams or the development of advanced low carbon-intensive combustion systems that reduce the carbon intensity of conventional power generation(Psarras et al., 2017). IEA (2023) emphasises that carbon capture will greatly contribute to emissions reduction from all applicable processes in power generation and industrial applications. Most importantly CCSU would be a solution to reduce emissions in heavy industrial sectors that are difficult to decarbonize such as cement, iron and steel and oil refining industries. CCSU may also enable low-cost, low-carbon hydrogen production, which

can support the decarbonization of other parts of the energy systems such as transportation, buildings, etc.

Captured carbon has various direct and indirect applications. Currently, CO_2 is utilized in the fertilizer industry and for enhanced oil recovery. However, emerging applications such as the production of CO_2-based synthetic fuels, chemicals, and building aggregates are still in development (Al-Mamoori et al,.2017). Despite its various benefits and significant progress within the past few years, most CO_2-capture technologies still have a long way to go to become commercially available because of its potential high costs, geographical limitations as well as scalability related issues that hinder widespread adoption(Baena-Moreno et al., 2019; Psarras et al., 2017)

3.1.2. Just Transition

3.1.2.1. Defining Just Transitions from a Justice-based Perspective

The concept of just transition has increasingly been recognized as an important component in low carbon transition. Different disciplines and literature offer varying definitions of what just transition is (Jenkins et al., 2016). However, it can be generally defined as a fair and equitable process of moving towards a post-carbon society. The concept tries to address the equity and justice related issues associated with efforts to address energy and climate problems. This means that achieving a just transition requires a holistic, comprehensive vision that goes beyond emissions reduction, to addressing other issues of society such as health and well-being, affordable housing, transportation, and job creation to ensure communities can thrive in a low-carbon future(Ash & Boyce, 2018).

The term just transition was originally proposed by global trade unions in the 1980s with the closure of several fossil fuel-based industries due to the rise of environmental, sustainability, and climate related concerns (X. Wang & Lo, 2021). With its different definitions and perspectives that have emerged over time, Heffron and McCauley (2018) recommends bringing together different framings of justice from three justice frameworks; climate justice, environmental justice, and energy justice to create a common framework for just transition(McCauley & Heffron, 2018; S. Williams & Doyon, 2019).

Climate change and justice are interrelated topics. McCauley & Heffron (2018) emphasise that climate change is considered a topic that causes issues of injustice all around the world. It is well understood that the impacts of climate change will fall disproportionately upon individuals and communities and thereby creating and further exacerbating existing social issues such as access to adequate food, clean water, and other resources as well as poverty (Carley & Konisky, 2020). On the other hand, research highlights that while climate change creates injustice in society, the actions taken for mitigation and adaptation could also create new injustice, especially during the transition to a low carbon energy system. As Sovacool et al. (2019) rightly point out, the current wave of low carbon transitions may create new injustices and vulnerabilities, while also failing to address pre-existing structural drivers of injustice in energy markets and the wider socio-economy. Hence, studies highlight that climate issues cannot be meaningfully addressed without taking the promotion of justice as a central aim.

3.1.2.2. Just Transition as an Integrated Framework for Justice- Heffron and McCauley (2018)

For the current study, we consider the framework proposed by McCauley & Heffron (2018) that views just transition as an integrated framework for justice, to identify key indicators that

will ensure a just transition in achieving net zero emission targets. Heffron and McCauley (2018) recognize the linkage between the transition to a low carbon society with more established concepts in the justice-related literature, including environmental, climate, and energy justice to connect justice with climate solutions. It provides a more comprehensive framework for analysing and ultimately promoting fairness and equity throughout the transition away from fossil fuels. Their framework highlights two dominant frames of analysis used by all three justice scholarships: distributional justice and procedural justice. They also present a third dimension namely restorative justice which is fairly a new topic of discussion in literature. In essence, McCauley & Heffron's framework describes how each of the three justice frameworks (environmental, climate, and energy) is incorporated into the theories of distributive, procedural, and restorative justice.

3.1.2.2.1. Distributive Justice

In essence, distributive justice entails the equal distribution of benefits and burdens. Research highlights that the different principles of distributive justice vary based on what is considered relevant to distributive justice, the nature of the recipients of the distribution as well as on what basis the distribution should be made. When it comes to low carbon or net zero emission transitions, distributive justice entails the perceived justice of the distribution of costs and benefits inherent in any transition to prevent inequitable distributions across groups in society(Banerjee & Schuitema, 2022; Hanke et al., 2021).

Distributive environmental justice describes the scale and drivers of the distribution of environmental burdens and benefits across society. Farrell (2012) indicate that although environmental justice seeks to distribute environmental benefits equally throughout society, when it comes to environmental burdens, it seeks to reduce harm for everyone as opposed to the equal distribution of harm. In essence, environmental distributive justice accounts for the

fair and equal distribution of environmental goods, costs, and benefits among all the members of society, especially of the least advantaged groups(Banerjee & Schuitema, 2022).

Environmental justice literature places a special emphasis on stressing that vulnerable groups such as low-income, marginalized, and minority communities are more likely to face higher levels of burdens from environmental pollution and pay more for amenities such as clean water and air, and have less access to benefits such as green space than others in the society(Hughes & Hoffmann, 2020). The impact of fossil fuel-based energy systems on low-income communities and other vulnerable groups who are disproportionately impacted by pollution is a major emphasis in environmental and energy and environmental justice literature. For example, facilities like power plants, and refineries create justice concerns by polluting the area, forming environmental and health hazards to nearby communities. Ottinger (2013) highlights that such polluting sites are more likely to be located near the most vulnerable populations, usually low-income communities and communities of colour. Low-carbon energy systems are being developed to make such energy systems cleaner to reduce emissions and contribute to overall sustainability. However, transition studies emphasize that, although the transition to low carbon sources of energy is a way of removing such polluting facilities and promoting justice, replacing the most harmful energy facilities with greener sources of power will not completely eliminate all the problems related to pollution and injustice. Infrastructure such as renewable energy facilities, can create injustice similar to fossil fuels-based infrastructure. One example could be taken from the research conducted by Ottinger (2013), where they highlight that wind energy technology is developing in a direction that tends to undermine progress toward environmental justice.

Apart from the environmental risks, distributive aspects of environmental justice also try to address the distribution of benefits of low-carbon transition. Ash & Boyce (2018) highlights

this by conducting an assessment to get a visual map of the locations of renewable energy facilities in California to determine if these facilities are situated in areas previously impacted by fossil fuel operations. They emphasise the importance of ensuring that the benefits of clean energy are equitably distributed across members of the society during the transition, especially among those who are already burdened.

Proximity is a central concept of discussion in environmental justice as well as distributive justice. It reflects the considerations of the geographical distribution of benefits and burdens of low-carbon transition. Heffron and McCauley (2018), emphasize that, with the increased need to build new energy infrastructure, proximity will remain an important component to be assessed when considering a just transition. However, researchers argue that there is a need to explore distributive justice beyond the concept of proximity to consider injustices that take place outside proximity as potential impacts cannot be just captured through simple proximity measures. Heffron and McCauley (2018), identify how other dimensions of vulnerability also play out across space and time in describing what inequality is. These include aspects of capabilities and well-being, risk and responsibility, vulnerability and recognition which are mostly discussed in the concepts of climate and energy justice.

The need to integrate climate justice in a just transition is an attempt to think beyond the consideration of geographical proximity to include the distributions of other aspects of vulnerabilities especially, risks and responsibilities(Sultana, 2022). Is it a well-known fact that the unequal distribution of risks and responsibilities related to climate change creates injustice. Shaw (2016) emphasizes that with regard to the equal distribution of risks and responsibilities, the relevant justice questions focus on identifying who bears the risks and responsibilities, how, and why. The most common example highlighted by many scholars to describe the unequal distribution of risk and responsibility is that, although the Global North bears significant

responsibility for contributing to climate change, the Global South, despite being far less responsible for its causes, is enduring the major adverse impacts.

Climate change is a matter of injustice, including its causes, impacts, and the actions taken for mitigation and adaptation(Harlan et al., 2015). Human-induced climate change is putting human rights at risk. From this perspective, climate change is creating injustice by undermining fundamental rights, such as that of everyone's right to the enjoyment of the highest attainable standard of life(Robinson & Shine, 2018). While climate change has a profound effect on human rights, so do climate actions. Climate actions that do not respect human rights can have direct and indirect negative impacts on people and their rights. For instance, climate action including reforestation, afforestation, renewable energy installations, and other land use changes can pose threats to housing and livelihood, the right to water and to food systems. Similar to environmental justice literature, climate justice literature also stresses the fact that climate change, impacts, and climate actions affect individuals, communities, and countries in varying degrees. As Sultana (2022) highlights, meaningful climate justice also addresses complex issues across space, place, and time in terms of vulnerabilities, losses, and damages. Therefore, understanding climate disruption and how to address the potentially devastating problems of climate change requires knowledge of inequalities in human wealth, power, and privilege.

Energy justice principles are very complimentary and consistent with society's aim to achieve its environmental and climate change goals. Similar to climate justice, energy justice places a significant focus on vulnerabilities. Heffron and McCauley (2018) emphasize that as opposed to focusing on environmental, and climate change-related impacts, distributive energy justice focuses on the distribution of community vulnerabilities in terms of availability, access, or affordability. The energy justice framework emphasizes that injustices of vulnerability can also

exist outside the context of climate change impacts. The distributive justice aspects of energy justice therefore consider aspects related to concepts such as energy poverty, energy security, and energy vulnerabilities. This is quite similar to the injustice discussed in environmental justice. Jenkins et al. (2016) provides an example: in the US, discussions on energy justice have typically centred around the locations of polluting energy production facilities, which are often found in socially disadvantaged areas.

Distributional justice concerns can go beyond infrastructure injustice of where technologies are located, to understand who can access their output. Energy justice scholars therefore repeatedly specify the importance of the components of energy availability and affordability for just transition on several occasions. In their research on energy justice, Sovacool & Dworkin (2015) proposes nine principles as fundamental elements in energy decisions to facilitate a socially and environmentally equitable transition to low-carbon energy. These principles include the key elements of availability, affordability, intergenerational equity, and intragenerational equity.

3.1.2.2.2. Procedural Justice

Procedural justice is a key component in environmental, climate, and energy justice frameworks and just transition. It is the arm of justice that accounts for the injustice surrounding processes rather than just the outcomes. This includes the shift away from purely outcome based assessments to examine the means by which decisions were made, whose voices were heard, and what opportunities were available to influence the outcomes. It is inevitable that the low carbon transition will generate new injustice around the processes of community engagement and involvement. Procedural justice seeks to ensure the fairness of such processes that are used to design certain pathways and the process taken to implement such plans, to

ensure that decisions are made in pursuit of societal goals(Banerjee & Schuitema, 2022; Marques et al., 2015).

Procedural and distributive justice are often interlinked and tend to provide collective effects on the outcomes. Considerations of procedural justice such as democratic and participatory decision-making procedures deliver solutions to address inequitable distribution of outcomes and ensure meaningful participation for affected vulnerable groups(Mundaca et al., 2018; Wang & Lo, 2021).Research also emphasizes the significance of procedural justice, during the initial stages of projects to collect specific information when there is only limited information available (Marques et al., 2015).

Environmental justice research specifically highlights the shortcomings of exclusive and closed decision-making processes, particularly how they can lead to conflicts during the evaluation of perceived environmental threats. Research also emphasizes that environmental justice movements focus on identifying the relationship between social, cultural, and ecological issues and the lack of democratic participation in the development and ongoing processes. Such considerations are important because it is unfair and unethical to impose a risk on individuals without their participation in the siting process, especially for communities who are affected by adverse environmental impacts of proposed low carbon projects.

Procedural justice within the framework of environmental justice therefore prioritises building engagement and participation in the environmental decision-making process, with a major focus on the affected communities or vulnerable groups. Ottinger (2013) highlights that gaps in knowledge representation are correlated with low-income, high-minority populations or areas that bear the most burden from industrial pollution. This conceptual development suggests that integrating environmental justice and just transition concerns in low carbon

transition measures could help obtain support from vulnerable and marginalized groups and derive more collective efforts(Walker, 2012)

Procedural justice within climate justice mainly focuses on ensuring that the engagement processes are designed to generate positive responses in communities to major shocks imposed by climate change. Climate justice is not just about determining what a fair distribution of risk and responsibility is, but also about understanding what fair procedures can be implemented to address the impacts. In their research on procedural justice in local climate adaptation, Holland (2017) highlights the importance of communities, especially marginalized or vulnerable people having control over how their community adapts to climate change. Holland (2017) emphasises that engaging local communities in discussions about their vulnerability, mapping their vulnerabilities, and designing adaptation policies to protect them are some of the measures that can be used in addressing procedural justice in climate adaptation. Moreover, Brandstedt & Brülde (2019) emphasize that, in climate justice frameworks, self-determination, transparency, equal participation, and voice are key elements of procedural justice that should be considered.

Energy justice frameworks also target to deliver greater energy justice within the transition through equitable processes (McCauley et al., 2019). Procedural justice aspects within the energy justice framework therefore inform that stakeholders should be able to take part equitably in decision-making about energy. Measures to achieve procedural energy justice include prior informed consent for energy projects, representation in energy decision making, and access to high-quality information about energy and potential changes. Sovacool & Dworkin (2015) in their research highlights “due process” as one of the key components required to facilitate a socially and environmentally equitable transition to low carbon energy. The energy justice framework also reminds us of the importance of full recognition of those affected by different energy related actions and decisions. More specifically, the decision-

making principle suggests that communities must be involved in deciding about projects that will affect them(Sovacool et al., 2019).

3.1.2.2.3. Restorative Justice

Restorative justice is a justice framework that is becoming more popular within justice research because of its ability to facilitate and ensure meaningful change. McCauley & Heffron (2018) emphasises that restoration justice is a concept that has not been explored sufficiently by the three justice frameworks (environmental, energy, and climate justice). The idea of restorative justice emerged as a concept within criminal justice studies in the second half of the twentieth century as a way to respond to criminal acts by repairing the damage and restoring the dignity and well-being of all those involved (Hazrati & Heffron, 2021). Hence, restorative justice is considered as a problem solving approach focused on taking preventive and strategic actions for stakeholders who are at risk of being victims of low carbon transition. Restorative justice is key to a just transition because it addresses key aspects of the rehabilitation of a region, in terms of environmental, social, and economic context. A just transition builds on restorative justice, therefore takes a holistic view to understand that restoration in the context of transition is not just about replacing lost jobs but also includes many other considerations such as the impacts on livelihoods and overall well-being of those who are affected(Banerjee & Schuitema, 2022).

Restorative environmental justice in the context of low carbon transition discussed the need to repair the damages incurred on the environment during and after the shift towards a low carbon economy. The damage repair not only includes present and future damages but also entails addressing past damages, to ensure a more equitable transition. On the other hand, climate justice takes a more global perspective and considers the historical development of restorative justice for a much deeper understanding of the interconnectedness between environmental

degradation and social injustices on a global scale over time. Consequently, energy justice brings an understanding of restorative justice based on the polluter pays principle to hold energy providers accountable for the impacts. This involves rectifying the injustice caused by the energy decision makers by incorporating restorative justice principles in existing and new programs or projects(Ibrahim, 2024; McCauley & Heffron, 2018).

Although not discussed widely, restorative justice is connected to distributive justice and procedural justice. Studies highlight that restoring those harms is an attempt to restore distributive injustice. Recognition justice which in turn connects with procedural justice also connects with restorative justice in terms of calling for a fair representation. This involves advocating for the recognition of diverse perspectives in vulnerabilities, including those related to income, ethnicity, race, etc. Ibrahim (2024) identifies three fundamental concepts within restorative justice: respect, responsibility, and remediation and sub-components, including consultation, inclusion, accountability, participation, compensation, and mitigation which are key components associated with distributive and procedural justice frameworks.

3.1.2.3. Key Indicators that Define What is Essential for Guaranteeing a Just Transition within a Framework of Distributive, Procedural, and Restorative Justice

The following indicators were derived by identifying common themes within the written literature on distributive, procedural, and restorative justice in the context of environmental, climate, and energy justice frameworks.

I. Assessment of Risks and Benefits of Measures for Achieving Net Zero Emissions and Ensuring the Management of Risks and Equitable Distribution of the Benefits

This indicator describes both the benefits and risks of measures taken to reach net zero emissions. From the risk perspective, the indicator highlights the need for the identification of risks and taking actions to prevent, mitigate and rectify the damages caused by measures taken towards reaching net zero emission targets. From the benefits perspective, it highlights the need for the identification of benefits and the equitable distribution of them.

The risks of measures taken to reach net zero emissions can be mainly categorised as environmental, social and economic risks (Lieu et al., 2020). Environmental risks refer to negative impacts on natural environment systems, processes, and flows. For example, studies have identified that expansions in renewable energy infrastructure compromise land and lead to intensification of actions such as deforestation and pollution. Social risks involve impacts on health, quality of life, and livelihoods for different social individuals and groups in the society. For example, the operation of industrial-scale wind turbines can cause adverse health effects to people living closest to wind farm facilities (Ottinger, 2013). Economic risks involve a negative influence on the distribution of resources and adverse financial impacts on the economy. As the demand shifts toward renewables, there could be losses in jobs in communities that are tied to the fossil fuel industry, impacting local economies(X. Wang & Lo, 2021). Hence, it is important to assess what risks are present and where they occur to ensure that the low-carbon transition does not create new injustices. These risks could arise either from the impacts of climate change or from the inherent vulnerabilities present because of the existing fossil fuel-based energy systems. Recognizing existing and potential environmental, social, and economic issues and challenges supports their integration into plans, policies,

strategies, and technologies to address current and future issues, and pave the path towards sustainability(Lieu et al., 2020).

Although the primary benefit of low carbon transition or measures to reach net zero is to significantly reduce GHG emissions and mitigate the impacts of climate change, the benefits of low carbon transition are not only limited to climate-related benefits alone (Stern & Valero, 2021). They are also known to provide other economic, social, and environmental benefits which are known as co-benefits. For example, reduced use of fossil fuels reduces harmful emissions, air pollution, water pollution, and subsequent impacts on the people and natural environment. Reforestation activities support the growth of natural ecosystems. Initiatives such as green roofs support urban biodiversity. Active transportation reduces air pollution and improves air quality(Iacobuţă et al., 2021). Equal distribution of benefits informs us to recognize that everyone should have access to the advantages of a low-carbon system, along with the additional benefits it provides. This concept is centred on ensuring that these benefits aren't restricted to just a few locations but are spread out fairly so that nobody is left out. Different communities are affected differently by the impacts of climate change and negative fossil fuel-based energy systems. A truly just transition must ensure that the opportunities of a low-carbon future are made available to these communities, who have largely been excluded from the gains of the fossil fuel economies(Cheshmehzangi, 2016; Gouldson et al., n.d.; Sovacool et al., 2020)

Ensuring the fair distribution of such benefits helps reduce social disparities and promotes inclusive growth. Economic opportunities will be distributed across diverse regions and communities, creating jobs and promoting local economies in a way that doesn't concentrate wealth in just a few places. Equal distribution of benefits can also lead to greater public support for low-carbon practices(Iacobuţă et al., 2021; Sovacool et al., 2020).

II. Assessment of Vulnerabilities

The main question that this indicator tries to answer is, who bears the risk of low carbon transition or measures to reach net zero emissions targets? This indicator therefore more generally describes distributive justice and supports procedural and restorative justice, highlighting the need for conducting proper assessments to identify vulnerabilities in communities.

Vulnerability is a central component of all three justice frameworks (environmental, climate, and energy justice). The vulnerability of exposed humans and natural systems is also a component of risk assessments. Hence, this indicator ties up with the first indicator of risk assessment and mitigation but rather specifically focuses on identifying communities that are vulnerable to such risks, ensuring their inclusion in plans and strategies to reach net zero targets(Carley & Konisky, 2020; Ottinger, 2013).

IPCC (2023) defines vulnerability as "the propensity or predisposition to be adversely affected, which encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt"(p.133). Polcarová & Pupíková, (2022) highlight that vulnerable groups should include individuals who do not have the same opportunities and abilities as the rest of the society. In general, influencing factors for vulnerability encompass various aspects such as age, socioeconomic class, level of education, income, ethnic background, race and religion, sexual orientation, gender identity, subcultures, immigration status, etc. For climate change, vulnerable groups include people who bear the main burden of climate disruption. Vulnerability is also higher in climate-sensitive livelihoods, locations with poverty, governance challenges, limited access to basic services and resources, and places with violence and conflict(Brooks, n.d.).

The identification of vulnerabilities is twofold. First, it's important to identify existing vulnerable communities in areas where low-carbon transitions are taking place, especially those already affected by climate change. Secondly, it is important to identify any other groups that might become vulnerable due to climate related risks and actions toward the transition to a low-carbon economy (Brown et al., 2017; Carley et al., 2018). Recognizing and understanding vulnerabilities is key to successfully identifying, prioritising, and adapting to current and emerging risks of climate change and low-carbon transition.

III. Ensure Energy Availability, Access and Affordability

This indicator reflects distributive justice highlighting the need for equitable distribution of low-carbon energy services. It specifically outlines the aspects of energy justice frameworks where vulnerability is discussed in terms of energy access, availability, and affordability. Ensuring access to energy, as well as its availability and affordability, are significant considerations in the transition to a low-carbon economy due to the pivotal role the energy sector plays in both climate change and its mitigation (McCauley & Heffron, 2018).

The term ‘access’ is often used interchangeably with energy ‘availability’. Availability is the physical availability of energy carriers, while energy ‘access’ is more closely related to whether people can use the available energy. Energy availability is related to key components of security of supply, sufficiency, reliability, and the physical resource endowment of a particular country or region, as well as the technological solutions that the region utilizes to produce, transport, conserve, store, and distribute energy. The dimension of availability thus encompasses independence and diversification. Ensuring energy access involves overcoming obstacles such as infrastructure limitations, socio-economic barriers, or service interruptions to ensure that energy reaches the people who need it. It includes the amount of investment needed

to keep the system functioning ensuring a robust and diversified energy value chain(Cherp & Jewell, 2014; Sankhyayan & Dasgupta, 2019). Another core element is the basic affordability of energy services. Affordability does not just necessarily mean lower prices so that people can afford energy, but also energy bills that do not impose a burden on consumers. Affordability thus encompasses stable prices as well as equitable prices that do not require lower-income households to expend larger shares of their income on essential services(Rabbi et al., 2022; Sankhyayan & Dasgupta, 2019).

Availability, access, and affordability are fundamental components that promote meaningful change in low carbon transition. Such consideration reduces energy poverty, barriers to economic well-being, and improves energy security for more engaging actions. The importance of energy availability, access, and affordability has been recognized by several international organizations, including the United Nations, the World Bank, Non-Governmental Organisations (NGO)s, and many charitable foundations. The United Nations Sustainable Development Goal 7, "affordable, reliable, sustainable and modern energy for all" by 2030 specifically emphasizes the need for universal access to affordable, reliable and modern energy services. It is also comprehensively documented in the Global Energy Assessment(Nathwani & Kammen, 2019; Olujobi et al., 2023; Sovacool & Rafey, 2011).

IV. Mobilisation of Local Knowledge

This indicator reflects procedural justice highlighting that a fair and equitable low-carbon transition requires engaging and incorporating local expertise and insights.

The integration of local knowledge is important in engaging and including affected communities in decision-making processes. This concept is most often associated with

vulnerable communities, especially indigenous peoples, whose environmental insights are frequently overlooked in the transition. The neglect of local knowledge and insights can be detrimental to local communities and to achieving sustainable outcomes. Studies highlight that procedural justice is therefore not restricted to physical involvement in decision-making but also involves the inclusion of local knowledge into action and plans(Hägele et al., 2022). Jenkins et al.(2016) provides a great example from Finnmark Kraft where the developers had sought inputs from the Sami council, an indigenous tribe in the northern parts of Norway, Sweden, Finland, and Russia in the development of a wind farm that had threatened the reindeer populations in the area. Studies emphasize that early integration or involvement of local knowledge is crucial for meaningful consultation, and it improves the ability to ensure their perspectives are valued before key decisions are made(Bell, 2021; Suboticki et al., 2023).

Mobilization of local knowledge also provides recognition and respect for the cultural traditions and practices of local communities and avoids any disruptions to local customs and ways of life. The development of low-carbon strategies in partnership with local communities fosters collaboration and ensures that the resulting solutions align with local knowledge, practices, and needs(Jenkins et al., 2016).

V. Information Disclosure and Stakeholder Engagement

This indicator reflects procedural justice highlighting that a fair low-carbon transition requires impartiality and full information disclosure by relevant parties as well as inclusivity and fair participation in decision-making. Information disclosure and stakeholder engagement also supports the mobilization of local knowledge by providing a more complete and comprehensive understanding to design more effective and practical solutions.

Information disclosure discusses not only the transparency in specific low-carbon project-related information but also access to such information. The data and information that are usually disclosed on climate or energy-related topics generally include GHG emissions data, net zero targets, action plans, progress towards meeting the targets, etc. Clear and accessible data are known to provide many benefits. Threats and barriers to low-carbon initiatives will be easily identified, creating a shared understanding of what solutions are needed. Publicly available clear data and information will also enable effective tracking and progress toward net zero goals, ensure meaningful stakeholder participation and improve public support for low-carbon initiatives (Jetoo, 2019; Setyowati, 2021).

Stakeholder engagement emphasizes that procedural injustice also occurs because of the limited space provided for the public to participate in relevant decision-making processes. Climate change is a global issue with local impacts that affect all sectors of society at different levels. Its complexity and scale make it a requirement to address both macroscopic and microscopic level considerations in decision-making processes. Hence, climate actions require changes in human systems that comprise a wide range of choices to be made by different stakeholders, at different jurisdictional scales and for different times(Van Vliet et al., 2020). Stakeholder engagement involves identifying all relevant stakeholders, understanding their interests, influence, and potential contributions, and including them in the decision-making process of the low-carbon transition whenever possible. Approaches to stakeholder engagement vary from simply only providing information to stakeholders to a level where the stakeholders themselves initiate and design the process, make decisions and initiate actions. Academic literatures emphasize the importance of stakeholder involvement in both the development and implementation of low-carbon policies and initiatives. As climate impacts are severe and sometimes irreversible in nature, studies outline that preventative and proactive approaches require diverse knowledge and experiments. The incorporation of various

perspectives and value judgments in decision-making processes enables a more comprehensive understanding and consideration of diverse viewpoints to enhance the legitimacy of the decision-making process(André et al., 2023).

3.1.3. A General Criteria Framework to Analyse Community Energy and Emissions Plans from a Net zero and Just Transition-Based Perspective

Overall, 10 indicators were identified through the literature review for measures to achieve net zero emissions and ensure a just transition within a framework of distributive, procedural, and restorative justice.

Table 1- Key indicators identified for net zero emissions and just transition

Concept	Key Indicators
Net Zero Emissions	● Energy Systems Decarbonization ● Land Use Management ● Waste Management ● Application of Nature-Based Solutions for Mitigation ● Carbon Capture, Storage and Utilisation (CCSU)
Just Transition	● Assessment of Risks and the Benefits of Measures for Achieving Net Zero Emissions or Low carbon Transition, and Ensuring the Management of Risks and Equitable Distribution of the Benefits ● Assessment of Vulnerabilities ● Ensure Energy Availability, Access and Affordability ● Mobilisation of Local Knowledge ● Information Disclosure and Stakeholder Engagement

3.2. Section 2- Case Study Analysis

Table 2 in Appendix 1 summarises the analysis results, listing the actions identified in the CEEPs and categorising them under the relevant indicators. The following subsections discusses the findings regarding the actions identified in the CEEPs based on the framework of indicators identified for net zero emissions and just transition.

- **Energy Systems Decarbonization**

The overall integration of efforts to decarbonize energy systems are clearly reflected in the community's CEEPs. Fredericton has identified more actions than the other communities. Demand side management measures, especially energy efficiency measures and support for behavioural changes are the most prominently integrated ones. Other measures include renewable energy integration, utilization of alternative fuel, and electrification.

Communities have incorporated a wide range of energy efficiency measures including efficiency improvements in buildings, waste heat recovery, industrial efficiency, and water efficiency in the plans. A common priority among the communities is to improve building sector energy efficiency through initiatives related to building retrofitting and net zero and green building standards. These actions have been developed to aim for both existing and new buildings and developments.

Fredericton, for example, has planned various efforts to provide financial support for building retrofitting. At the top of the list is seeking out funding to support the development of a separate deep energy retrofit strategy for buildings in a wide range of sectors including residential, high-density residential, institutional, and commercial sectors. The city has also developed targets to encourage building owners to access retrofit funding through the utility and to explore the

feasibility of tools and incentives to help undertake deep energy retrofits in existing buildings. Fredericton has also planned to conduct a cost and benefits analysis of setting up community funds for energy efficiency retrofits and new building features. The city has also planned to offer incentives to encourage the use of white roofs on large buildings and to explore the creation of a fast-track rebate program for building permit applications that involve energy efficient constructions.

Moncton's plan targets both residential and non-residential sectors for deep energy retrofitting. The city has identified the need to develop programs to ensure that 80% of all buildings of the city have deep retrofits completed by 2040, and 100% completed by 2050. On the other hand, St. Andrews primarily targets to only retrofit municipal buildings. Key highlights include plans to install energy-saving plumbing fixtures in municipal buildings, occupancy sensors in public bathrooms, and lighting timers in other building areas. The town has also planned to continue with the city-wide LED lighting transition. As specific actions, the town has identified several efficiency improvements for the W.C. O'Neill Arena building. These actions include insulating the theatre roof and dormitory area, replacing the roof/ceiling with a low-emission ceiling, and adapting the REALice technology to enable ice resurfacing using cold water instead of warm water.

The community's targets on net zero building standards and green building standards focus on planning, designing, and developing more energy-efficient buildings and neighbourhoods. Fredericton has planned to advocate for the province to adopt the National Energy Code of Canada for buildings. The city also aims to advance and support the development of a green buildings program and explore the feasibility of developing green development standards. Moncton has planned to develop and implement a strategy to ensure all new buildings in the community are built to net-zero energy standards and also to update the city's internal

municipal green building policy to ensure all new buildings starting in 2025 are built to be net zero ready. St Andrews has identified the need to develop town-specific green building standards for new developments.

To increase energy efficiency through waste heat recovery, Fredericton has planned to study the potential opportunities for waste heat recovery systems, evaluate waste heat recovery from large refrigeration systems in new large developments, identify potential zones and buildings, and assess partnerships, financing, and governance models to advance waste heat recovery systems.

Water efficiency and energy efficiency are related topics. Increased water efficiency reduces the intensity of water use, thereby decreasing water consumption and saving energy, as less water needs to be treated and pumped to end users (Kenway et al., 2016). Fredericton aims to advocate for the province to modify the Community Planning Act and Municipalities Act to allow water conservation and efficiency via by-laws and development guidelines. St Andrew's has planned to install energy-saving plumbing fixtures, improve stormwater management, and separate stormwater from sanitary systems. These efforts aim to reduce water usage, lower energy consumption, and enhance environmental sustainability in the town.

Only Moncton has identified measures that directly target industrial energy efficiency. The city has planned to develop an industrial leadership program to improve industrial energy efficiency with a specific goal of ensuring that industrial energy use is reduced by 20% by 2050.

In addition to the sector-specific energy efficiency improvement targets, the plans have also included some general actions that support energy efficiency in their communities. One action that Fredericton has proposed is to advocate for the province for municipalities to establish and

manage Property Assessed Clean Energy Programs (PACE) or similar initiatives. The PACE program which provides property owners with a means to finance energy efficiency and renewable energy upgrades is a measure that supports the adoption of energy efficacy measures in a community (USEPA, n.d). The city also targets to review and adjust current zoning and development cost charge bylaws to identify energy conservation and efficiency strategies.

In the reviewed CEEPs, the measures to support behavioural changes and reduce energy demand primarily focus on the transportation sector. The shift in behaviour requires a comprehensive approach that encompasses different actions related to physical infrastructure, policies, financial incentives, as well as access to information (Whitmarsh et al., 2021). Together, these elements collectively encourage individuals to adopt low-carbon choices, influencing consumer behaviour to reduce energy demand either directly or indirectly. While the plans have identified only a few actions directly focused on behavioural change, they have identified several indirect actions that support and encourage behavioural shifts in communities.

The direct actions identified in the plans include actions to change driver behaviour and promote water conservation behaviour. Fredericton has planned to advocate for the province to provide city-specific vehicle registration data to improve GHG estimates and inform the development of related policies to encourage driver behaviour. St. Andrews has planned to promote fuel-efficient driving among town staff as well as wider community members and to develop and adapt a town-wide anti-idling policy. Apart from the direct behavioural measures in the transportation sector, St. Andrews also aims to promote water conservation behaviour and efficient use of water in the community through public awareness campaigns.

Indirect measures that support behaviour changes generally include physical infrastructure support for active transportation and public transportation, encouragement of ridesharing and car-sharing programs within the community and promotional efforts. One commonly discussed measure among the three communities is the support for active transportation. Active transportation reduces energy demand by decreasing reliance on motor vehicles, thereby lowering fossil fuel consumption(Frank et al., 2010). Actions supporting active transportation include awareness-raising campaigns and other promotional efforts, as well as developing infrastructure to facilitate active transportation modes.

Fredericton, for example, has planned to invest in sidewalk, pedestrian, roadway, and bikeway projects, promote bicycle safety education programs, increase the number of secure bike parking and maintenance facilities, and to enhance off-street bicycle parking standards and requirements for new developments. Moncton has planned to establish a car-free zone to encourage alternative forms of transportation, expand and improve active transportation networks and end-of-ride facilities. The city has also planned to increase bike security to increase trips taken using active modes of transportation. On the other hand, St. Andrews has planned on promoting active transportation mainly by expanding the local trail system in the town.

Actions related to the use of public transit systems and shared rides and cars to reduce the use of single-occupancy vehicles are also common topics among the three communities. Public transit and car-share programs reduce energy demand by encouraging shared use of vehicles, thereby decreasing overall fuel consumption and emissions. Fredericton and Moncton both focus on expanding and improving the transit network to increase transit service and transit utilization. Fredericton has planned to explore the piloting of a car share program. The city has also planned to develop and adopt a commuting technology platform that would allow users to

plan trips that use multiple modes and promote commute trip reduction programs. The city has also planned to explore the development of by-laws to support the adoption of micro-mobility initiatives. Moncton has planned to support the establishment of e-bike and EV car-share programs in the city. And St Andrews targets public transportation promotion through the existing programs.

In addition to that, any awareness-raising and promotional activity that encourages low-carbon transition could influence community members to change their behaviour and adapt to it. For example, outreach and promotional efforts for renewable energy, alternative energy sources, and energy efficiency practices can encourage and influence the community to lean toward them. Specific actions are further discussed under the indicator, "Assessment of risks and benefits of measures for achieving net-zero emissions/low-carbon transition and ensuring the management of risks and equitable distribution of the benefits".

The integration of renewable energy to achieve net-zero emissions is somewhat prominent in the actions of the community's CEEPs. All three communities have included actions to adopt renewable energy. Overall, the communities have expressed interest in harnessing solar and wind energy and the production of renewable natural gas to shift away from fossil fuels. The adoption of solar energy is common among the communities. Fredericton has planned to conduct solar mapping studies and St. Andrews has planned to conduct feasibility studies for the utilisation of solar. Moncton's plan targets to develop programs to encourage rooftop solar photovoltaic (PV) systems and ground-mount solar PV installations.

In addition to the utilization of solar energy, the communities have also identified actions to support the utilization of wind energy. Moncton has developed a specific target to offset 100% of its corporate electricity use with wind-generated electricity by 2040. St. Andrews has

vaguely identified the possibility of using wind energy when converting the energy source of the town arena to a renewable source. To integrate RNG, both Moncton and St. Andrews have planned to produce RNG from organic waste using an anaerobic digester.

Besides the focus on solar, wind, and RNG, the communities have also identified measures that generally embed renewable energy aspects into their plans. They are reflected in their plans through the term "Net Zero Buildings". While the general actions do not specifically address the adaptation of renewable energy, they indirectly support the integration and promotion of renewable energy solutions. Both Fredericton and Moncton have expressed interest in eliminating the use of fossil fuel in the building sector and ensuring buildings are net zero. Moncton, in particular, has set specific targets with clear timelines and scopes, targeting buildings in various sectors such as residential, non-residential, and industrial. Although neither of these actions directly mentions the use of renewable energy resources in buildings, it is important to note that one of the main intentions of developing net zero buildings is to design buildings that generate as much energy as they use, through building integrated renewable energy systems(Robert & Kummert, 2012, Efficiency Canada, n.d.)

The integration of electrification related measures in the CEEPs is also somewhat prominent in the plans. All three communities have included actions related to electrification in their plans, with the majority of the actions planned for the transportation sector and, to a lesser extent, the building sector. The action plans of all three communities have prioritised various efforts to promote EVs. Fredericton focuses on the promotion of EVs and the installation and expansion of EV infrastructure in the city. Moncton targets to integrate EVs across a broad range of sectors including municipal and commercial sectors. The city's strategy extends beyond the adoption to include demand management strategies through initiatives like e-bike and EV car share programs as well as imposing surcharges on internal combustion engine vehicles.

Moncton has also planned to develop and implement a “Zero Emissions Fleet and Equipment Policy” to transition the city’s fleet and equipment to EVs. St. Andrews has planned to analyze the feasibility of converting the vehicle fleet to a lower-emitting energy source and develop a plan to upgrade vehicles to choose electricity.

Electrification in the building sector typically includes measures such as the installation of heat pumps, electric appliances, and other technologies (Wei et al., 2019). While St. Andrews briefly mentions a target in their plan to convert heating from fuel to electric heaters, other communities have only mentioned making buildings net-zero and installing deep energy retrofits without specifying further actions. Moncton has also mentioned briefly about transitioning buildings away from fossil fuel-based space and domestic water heating.

All three communities have included actions aimed at utilising alternative fuels in their plans and the integration is somewhat prominent. These actions are mostly at the exploratory stage. The primary focus in these plans is on the utilization of natural gas and hydrogen. Attempts to use natural gas as an alternative fuel is common to all the three communities. Fredericton has planned on conducting studies to understand the feasibility of installing renewable compressed natural gas (R-CNG) infrastructure in the city. Moncton has focused on developing an anaerobic digester facility that will convert organic waste of the city to renewable natural gas. Similarly, St. Andrews’ has planned to conduct studies to understand the feasibility of producing natural gas from municipal organic waste in the town. The town has also planned to use the produced natural gas as transportation fuel. St. Andrews has also planned to convert the heating energy source of the town from fuel to natural gas.

Hydrogen, which is becoming a huge topic of discussion today, is only discussed in Fredericton and Moncton’s plans. While Fredericton is primarily focused on conducting feasibility studies for hydrogen infrastructure, Moncton's plans for the production of hydrogen using ground-

mounted solar panels. One of the notable highlights of Moncton's actions is the inclusion of measures to support hard to decarbonize sectors like freight rail and aviation in the plan. The city has incorporated targets to ensure that the Canadian National Railway uses hydrogen-powered engines for all freight loads transported to or through Moncton, and that the Greater Moncton International Airport Authority meets the net zero commitment of the International Commercial Aviation Organization.

Additionally, the communities have also identified several general actions that focus on the use of alternative fuel and energy, as well as efforts towards achieving a "net zero emissions fleet." While these actions do not prescribe any particular source of alternative fuel, they generally signify a commitment to explore the use of alternative fuel. Fredericton focuses on adjusting bylaws to promote alternative fuel vehicles. Moncton has planned to decarbonize the transit fleet by implementing a “Zero Emissions Fleet and Equipment Policy”. St. Andrews has planned to explore the conversion of vehicle fleets from gas and diesel to lower emitting energy sources.

While all the above actions support the Energy Systems Integration (ESI), a few notable specific integrated actions were also revealed through the plans. These include communities' commitment to EVs and Fredericton’s commitment to conduct feasibility studies for hydrogen infrastructure which were discussed previously. Another notable measure is the commitment to District Energy (DE) systems. Actions related to DEs have been identified by all the communities. DE systems are energy systems that consist of a shared facility that produces and distributes the heating and cooling required for a certain set of buildings. Heat and/or cold are distributed via circulating hot or cold water through a series of piping networks. One important feature of DE systems is their flexibility in using a wide variety of energy sources as their feedstock, including conventional fossil fuels as well as renewables(Akhtari et al., 2014). As

actions, Fredericton plans to complete an alternative energy assessment to identify neighbourhoods or hotspots where DE systems could be used. St. Andrews has planned to conduct a technical study on options for district heating. Finally, Moncton's plans to develop and support the implementation of a plan for three emission free DE systems.

- **Land use management**

Specific land use management activities aimed at achieving net-zero emissions are quite prominent in the plans. Fredericton has identified more actions than the other communities. However, all three communities have incorporated some land use management practices. The actions include measures related to densification and mixed-use development, active transportation infrastructure, green spaces, sustainable food systems, and stormwater management infrastructure.

Densification and mixed-use development are a common theme in Fredericton and Moncton's plans. Fredericton has planned for infill development, densification of downtown, and the review and adjustment of bylaws to overcome barriers to densification. Moncton's actions extend beyond increasing density in key nodes and corridors to focus on integrating mixed-use and multi-unit residential buildings into future urban developments.

Infrastructure support for active transportation is highlighted in Fredericton's plan. Specific activities include implementing sidewalk, pedestrian, transit, roadway, and bikeway investment projects in the city, reviewing development permit plans to ensure that neighbourhoods establish cycling and pedestrian networks to complement the active transportation master plan, and embedding the city's Street Design Guidelines in transportation

and infrastructure planning. The city has also identified the need for strong connectivity, including an appropriate variety of route types, separated bike paths, and end-of-trip facilities.

St. Andrews and Moncton have planned to encourage green spaces in the communities. Moncton has planned to develop policy measures to protect, monitor, and actively manage the remaining forested and wetland areas in the city while St. Andrews has targeted supporting urban forestry planning, the protection of town-owned green spaces, and conversion of town-owned vacant lots and brownfields to green spaces.

A key highlight in Fredericton's plan is the target to locate suitable land for urban farms and community gardens and to adjust zoning to support local, sustainable food systems. Furthermore, St. Andrews aims to implement stormwater management infrastructure measures, including evaluating municipally owned land to identify potential locations for retention ponds, bioswales, and rain gardens.

- **Waste Management**

Overall, waste management actions are not prominently integrated into the plans. However, all three communities have incorporated some waste management measures that support net zero emissions. Fredericton has identified more specific actions than the other communities. Many of the actions and goals are general rather than specific. The main actions planned for waste management include measures related to composting, waste-to-energy conversion, waste reduction and reuse, and management of demolition, land clearing, and construction waste.

Actions to promote composting in the community are discussed in Fredericton and St. Andrew’s plans. Fredericton has proposed to promote home composting while St. Andrews has planned to focus on providing a composter to town-owned facilities to initiate composting and

providing composting services to community gardens, youth gardens, and the wider community.

Moncton and St. Andrews have both aimed at converting organic waste into RNG using an anaerobic digester. Moncton has specifically planned to produce 70,000 GJ of RNG from organic waste by 2030. St. Andrew's actions are more in the exploratory phase and involve conducting feasibility studies to analyse the feasibility of developing an anaerobic digester for municipal organic waste. Fredericton's plan for waste reduction and reuse includes measures such as promotional campaigns, social marketing campaigns, and the implementation of a green event guide aimed at reducing waste during major community events. A highlight of Moncton's plan is its collaborative approaches to waste management in the community to develop and implement a "Zero Waste by 2050" plan to divert 100% of Moncton's waste from the landfill. Additionally, Fredericton has identified the need to incorporate the management of waste generated from demolition, land clearing, and construction activities in the plan.

- **Carbon Capture, Storage and Utilisation (CCSU)**

None of the communities' plans have incorporated measures related to carbon capturing and storage and utilization. Although there is a growing interest in the technologies for CCSU in the world today, research emphasizes that there are still doubts about the practicality, feasibility of cost and large-scale deployments of such technologies(Orr, 2018). The International Institute for Sustainable Development [IISD] highlights that, despite years of development, there are only 30 commercial carbon capture projects globally and that only captures less than 0.2% of the necessary emissions reduction needed to close the emissions gap by 2030. Geographical factors also obstruct the development of such technologies. Keighley & Maher (2015) conducted a study to assess carbon storage suitability in deep underground geological

formations of NB and found that although NB would be a suitable location for CO_2 storage, the province contains several upland and highland regions where the basic geological criteria for storage in the subsurface are not met. Hence, at the current level of development, the adaptation of CCSU is not necessarily applicable in the community context, especially in NB.

3.2.1. Just Transition

- **Assessment of Risks and Benefits of Measures for Achieving Net Zero Emissions/Low Carbon Transition and Ensuring the Management of Risks and Equitable Distribution of the Benefits.**

Overall, the integration of measures that directly assess risks and benefits, as well as their management and equitable distribution, is minimal in the plans. Most of the related actions are expected to be pursued by Fredericton. While some actions directly support this indicator, there are also a few actions such as conducting feasibility studies and pilot programs, providing incentives, and promoting benefits that would indirectly contribute to risks and benefits assessment, management, and equal distribution.

The CEEPs have integrated a few actions to ensure that the risks and benefits of low carbon transition/net zero emissions are identified, managed, and equally distributed. For example, Fredericton has planned to conduct an analysis to identify the cost and benefit of setting up a community fund/ not-for-profit for energy efficiency improvements in the city. The city has also planned to develop an engagement plan to collect information from city staff to identify and assess barriers that they face in their efforts to implement sustainable transport programs and policies. As a direct mitigation measure of risks, Fredericton has planned actions to ensure that investments are made to develop compliance processes, tools, and training for staff and applicants before the applications of the National Energy Code of Canada for buildings and

National Building Code requirements with an aim to prepare for the upcoming changes. Although not listed as specific actions, Moncton has already conducted an evaluation of expected cost savings and job creation from the planned actions for the city, including detailed quantitative results.

Feasibility studies and pilot studies are common measures to identify both benefits and risks. Generally, for a plan, process, or program to be considered feasible, it must be practical and achievable in practice. Feasibility studies typically encompass technical, financial, regulatory, and operational aspects that help decide whether an action is possible or not(Cheshmehzangi, 2016). While risks and benefits assessments are not always the primary focus, feasibility studies often include an evaluation of potential benefits and risks associated with any proposed action. With this regard, actions to conduct feasibility studies could be an interpretation of a commitment to ensure the potential risks and benefits of proposed actions are considered in the plans.

Fredericton has planned on conducting feasibility studies on developing green development standards/guidelines for near-net zero buildings, alternative energy potential, developing bylaws to regulate illuminated signs or following the principals of “Dark Sky”, adopting a revitalization tax exemption bylaw and other tools and incentives that help deep energy and GHG emissions retrofits, waste heat recovery from large refrigeration systems and installing hydrogen R-CNG infrastructure systems within the City. St. Andrews focuses on conducting studies on exploring the conversion of vehicle fleets from gas and diesel to a lower-emitting energy source, acquiring an industrial composter for town-owned facilities, and identifying options for district heating.

The term “pilot studies” refers to mini versions of a full-scale study. And it could generally be the next step when a feasibility study generates positive results. Carefully planned and executed pilot studies can provide valuable insights into optimal research methodologies and sometimes even predict potential outcomes before scaling up the initiative (Van et al.,2002). Similar to feasibility studies, the outcomes of a pilot study can also provide information on risks and benefits associated with proposed actions. Fredericton has planned to conduct three pilot studies: one to assess the suitability of new technologies in city-owned assets for broader community application, another to implement a residential energy labelling program, and the final one to initiate a car-sharing program.

Incentives play a crucial role in ensuring the equitable distribution of benefits from the transition to low-carbon/net-zero emissions. By offering targeted incentives, governments and organizations can encourage diverse communities to adopt sustainable practices and technologies. This helps bridge the gap between different socioeconomic groups, ensuring that everyone has access to the advantages of a low-carbon economy(Bogner et al., 2008; Seto et al., n.d.). The city of Fredericton has planned to provide incentives to encourage the use of green roofs and white roofs on large buildings and to promote EV and alternative fuel vehicles in the community. Other planned actions include exploring the feasibility of incentives that can support building retrofitting and examining the opportunity around developing financial incentives that can support DE, microgrids, waste heat recovery, and solar PV systems. The city of Moncton tries to leverage incentives to accelerate the transition of buildings from fossil fuel-based space and domestic water heating and expand financial mechanisms to gradually retire all gas and diesel fuelling stations in the city.

Outreach and promotional actions ensure that the benefits of climate initiatives are clearly communicated and fairly distributed among society. One of the highlights of the city of

Fredericton’s plan is its specific goal to develop a communication and engagement strategy that outlines the economic and community resilience benefits of implementing CEEPs. Fredericton's promotional activities also include promoting home composting programs, commute trip reduction programs, bicycle safety education programs, product exchange/resale networks, information on existing programs that support energy efficiency improvements in commercial buildings, and initiatives that promote sustainable and efficient commuting habits. Fredericton also plans to implement a community-based social marketing campaign focused on waste reduction and an educational program to encourage growing food locally. The city has also planned to advocate to the province to allow municipalities to develop a PACE or similar program.

Additionally, the city aims to develop commuting technology platforms, such as apps, to help users plan trips using public transit, car sharing, etc. and promote other existing programs to reduce the use of single-occupancy vehicles. Moncton plans to continue to collaborate with partners to promote EVs and alternative fuel vehicles. St. Andrews focuses on promoting water conservation and the efficient use of water, fuel-efficient driving, active transportation, and public transportation systems in the community. The town has also identified the need to ensure that the business community of the town has all of the information available to make their buildings run as efficiently as possible.

- **Assessment of Vulnerabilities**

Actions to assess vulnerabilities as a part of community energy planning have not been included in the CEEPs of the three communities. Recent research highlights the importance of assessing vulnerabilities, particularly for groups that lack the same opportunities and abilities as the rest of society, in relation to climate risks and the risks associated with measures taken for climate

change. Despite its importance, the community plans have not recognized the inclusion of such action that would specifically target vulnerabilities in the society.

- **Ensure Energy Availability, Access and Affordability**

Measures that directly target to ensure energy availability, affordability, and access are somewhat prominent in the plans. All three communities have incorporated a few measures to ensure that energy is available, accessible, and affordable despite the expected changes. Therefore, the level of integration between the communities is quite similar. Actions that support this indicator involve the adoption of renewable energy, other alternative energy sources, adoption of DE systems, infrastructure support, education and promotional activities, and financial incentives.

Communities' planned actions to utilize renewable and alternative energy sources, implement DE systems, and support infrastructure for various energy initiatives can ensure energy availability. Research highlights that the exploration and utilization of various renewable and other alternative energy sources increases the diversity in energy supply markets and contributes to securing long-term, sustainable energy supplies (Asif & Muneer, 2007). Community-specific action for the adoption of renewable energy and other alternative energy sources were previously discussed under the indicator, “Energy Systems Decarbonisation”. In essence, the communities have shown interest in harnessing solar and wind energy, the production of renewable natural gas, and the use of natural gas and hydrogen as alternative fuels to shift away from fossil fuel, reduce emissions, and probably diversify the energy supply. One of the highlights in the plans that significantly support energy availability is the commitment to DE systems. An important feature of DE systems is their flexibility in using a wide variety of energy sources including fossil fuels and renewables. They are also known to

improve the potential to introduce more renewable energy sources in a larger scale of a region(Rismanchi, 2017). DE systems have the ability to provide a reliable and resilient energy supply and improve energy security even without integrating renewable energy sources(Rezaie & Rosen, 2012). More specific actions on the three communities' commitment to DE systems are fully discussed under the section, “Energy Systems Decarbonization”.

Having adequate infrastructure to support energy production, storage, and distribution ensures that the energy is available as well as accessible. The city of Fredericton has planned to install EV infrastructure on city-owned property and expand EV infrastructure and infrastructure that supports alternative fuel vehicles. The city has also planned to continue to explore the feasibility of installing hydrogen and/or R-CNG infrastructure systems within the city. Moncton has planned to support the development of a “Green Hydrogen Freight Fueling Facility” as a pilot project to convert ground-mount solar electricity to hydrogen and then use it to fuel hydrogen fuel cells, and long-haul trucks.

Outreach, educational and promotional activities enhance accessibility by informing community members about the opportunities available to them. Financial incentives also play a crucial role in making energy both accessible and affordable. Incentives ensure that clean and efficient energy solutions are within reach for a broader segment of the population, contributing to overall energy affordability and sustainability. Specific actions on promotional activities and financial incentives are further discussed under the indicator, “Assessment of risks and benefits of measures for achieving net-zero emissions/low-carbon transition and ensuring the management of risks and equitable distribution of the benefits”.

- **Mobilisation of Local Knowledge**

Overall, the actions to mobilize local knowledge are minimally integrated in the plans. Direct actions are expected to be pursued by Fredericton. Specific actions that directly target and support local knowledge mobilization are less prominent. Some efforts to gather local knowledge and insights have been identified by Fredericton. The city has planned to continue to use the “Engage Fredericton Platform" and the city’s Environmental Dashboard to provide up-to-date information on the CEEP’s progress and continue to engage residents and allow them to provide inputs.

Fredericton also aims to work with the local business community to develop and adopt intermodal or mixed-modal commuting technology platforms (e.g., apps) that allow users to plan trips that use multiple modes, and work with local businesses to promote or implement commute trip reduction programs. The city has also planned to connect with local businesses, and farmers/ producers to identify land for urban farms and community gardens and to implement a “buy local” campaign in the region.

In addition to that, it is mentioned in the three plans that the CEEPs were developed by consulting local communities to gather their input. Although the list of proposed actions in the CEEPs does not specifically include efforts to mobilize local knowledge, the CEEPs were developed after consulting local communities. Therefore, the existing actions in the plans reflect the integration of local knowledge. The city of Fredericton’s plan had been created with inputs from staff, stakeholders, and the public on what actions the city could take to reduce GHG emissions. Moncton’s plan had been created by gathering views of diverse groups of the city such as business owners, activists, grandparents and parents, educators, and utility

operators. St Andrew's plan had been created by engaging the Chief Administrative Officer (CAO), Treasurer-Clerk, and the Environmental Advisory Committee (EAC).

Additionally, stakeholder engagement can also provide a platform for local input, thereby offering an opportunity to mobilize local knowledge into actions aimed at achieving net zero emissions. Actions for stakeholder engagement are discussed in the next section.

- **Information Disclosure and Stakeholder Engagement**

Overall, information disclosure and stakeholder engagement are somewhat prominently integrated into the plans. All three communities have incorporated measures to ensure transparency in information and to ensure actions are implemented in collaboration with stakeholders. These actions include making relevant information publicly available, fostering collaborations, and engaging in outreach and promotional efforts. Fredericton has integrated more actions than the other communities.

The city of Fredericton has identified specific measures to ensure the public availability of information in their actions. An example is the city's plan to make the results of a solar mapping study publicly available. Additionally, the CEEPs of all three communities are already publicly available and accessible. This action, which has already been implemented, promotes the availability of public information and thereby fosters transparency and accountability in community energy and emissions planning process.

Collaboration and engagement for specific actions are common to all of the three communities. While some communities target to collaborate with specific partners others have not identified who to be involved. Overall, Fredericton plans to collaborate with organizations such as the Canadian Home Builders Association, NB Power and NRCan, Chamber of Commerce, Green

Economy New Brunswick, and Google. In addition to that. The actions also emphasize the plan to collaborate and partner with local developers, businesses, and local youth. Such collaborations have been planned for several actions including the promotion of electric and alternative fuel vehicles, waste management, building energy efficiency, transportation demand management, building community engagement and education programs, and developing sustainable food systems. In addition to that Fredericton has also planned to develop an engagement plan to collect information from city staff to identify and assess the barriers the employees face in efforts to implement sustainable transport programs and policies.

The City of Moncton has planned to collaborate with organizations such as Codiac Transpo, the town of Riverview, the city of Dieppe, and Eco360. The city has also mentioned about partnering with other communities that are served by Eco360. Moncton's collaborations focus on decarbonizing the transit fleet and producing RNG from organic waste. The town of St. Andrews plans to collaborate with the Faculty of Forestry and Environmental Management of the University of New Brunswick and NB Power. St Andrew's collaborations focus on actions such as urban forestry planning and building efficiency. Additionally, the town has also planned to designate a responsible party to research and plan an effective public engagement campaign on climate change mitigation with stakeholder round tables, and workshops on GHG reduction.

Promotional activities improve access to information, raising awareness, informing people, and promoting stakeholder engagement. Specific actions on outreach and promotional activities are further discussed under the indicator, "Assessment of risks and benefits of measures for achieving net-zero emissions/low-carbon transition and ensuring the management of risks and equitable distribution of the benefits".

Conclusion

The review of the literature generated 10 indicators that define what should be considered in the measures to achieve net zero emissions and generate just outcomes. Indicators that were identified for net zero emissions are: energy systems decarbonization, land use management, waste management, application of nature-based solutions for mitigation, and CCSU. Indicators that were identified for just transition are: assessment of risks and the benefits of measures for achieving net zero emissions or low-carbon transition and ensuring the management of risks and equitable distribution of the benefits, assessment of vulnerabilities, ensuring energy availability and access and affordability, mobilization of local knowledge and information disclosure and stakeholder engagement.

After reviewing the CEEPs it was found that apart from the indicators, CCSU, and assessment of vulnerabilities, actions for all other indicators were included in the community's CEEPs to varying degrees, at least to some extent. Nature-based solutions and waste management were incorporated to a very limited extent. Actions for energy systems decarbonization specifically demand side management such as energy efficiency improvements and promotion of behavioural changes were prominently featured.

Energy efficiency improvements primarily focused on efficiency improvements in buildings, waste heat recovery, industrial efficiency, and water efficiency. Behavioural shifts emphasized promotional efforts such as promoting fuel-efficient driving, water conservation, waste reduction, supporting active and public transportation infrastructure, and encouraging ridesharing and car-sharing within the community. Other energy systems decarbonization methods that were identified include efforts for electrification, renewable energy integration and the utilizations of alternative fuel. Electrification efforts primarily focused on promoting

EVs, while renewable energy integration focused on utilizing solar, wind, and RNG resources. Efforts towards the utilization of alternative fuel focused on conducting feasibility studies for hydrogen infrastructure, production of hydrogen and the promotion of alternative fuel vehicles.

Land use management focused on densification and mixed-use development, active transportation infrastructure, green spaces, sustainable food systems, and stormwater management infrastructure. Waste management strategies involved composting, waste-to-energy conversion, waste reduction, reuse, and managing demolition, land clearing, and construction waste. Nature-based solutions were centred on the preservation, conservation, and management of natural resources and urban greening initiatives.

Most of the actions that were identified for just transition, however, indirectly supported the indicators rather than directly addressing them. Actions supporting the indicators of ensuring energy availability, access, affordability information disclosure, and stakeholder engagement were somewhat prominently integrated with some direct actions. Measures to ensure energy availability, access, and affordability focused on actions related to the adoption of renewable energy, other alternative energy sources, DE, infrastructure support, education and promotional activities, and financial incentives. Measures that supported information disclosure and stakeholder engagement focused on making relevant information publicly available, fostering collaborations, and engaging in outreach and promotional efforts. Although actions to mobilize local knowledge were minimal, it was supported by the consultation processes they conducted with local communities to gather their input during the development of the plans. Among the identified actions, Fredericton distinguishes itself through initiatives aimed at energy systems decarbonizations, conducting benefit and risk assessments, mobilizing local knowledge, and promoting information disclosure and stakeholder engagement.

Overall, the case study analysis revealed that the integration of actions that would support the generation of just outcomes were significantly less prominent than the measures for net zero emissions in the CEEPs of NB communities. Most of the actions that were identified for just transition indirectly support the indicators rather than directly addressing them. When examining the rationale for developing these plans, it is evident that their primary intention is to reduce local GHG emissions. Therefore, it is clear that actions in the CEEPs are intended to reduce GHG emissions in the community rather than focusing on generating just outcomes. This could be due to a lack of awareness, knowledge, or understanding, of the importance of integrating just transition aspects in such measures and the benefits it could generate to the overall well-being of the community. Moreover, the gap in integration emphasizes that although the development of CEEPs aims to ensure a just transition, this goal is not effectively applied in practice.

In addition to that, the analysis of the CEEPs revealed that certain actions, such as CCSU, were not included in the plans. This omission does not necessarily indicate a lack of focus but rather reflects their limited applicability in the community context. This emphasizes the understanding that not all technological measures aimed at achieving net zero emissions are feasible and applicable at the community level. Some technologies such as nuclear energy, hydrogen fuel, renewable natural gas, and biofuels are also typically beyond the scope of local initiatives and require careful consideration due to technological complexities.

These observations highlight that taking community level actions has its limitations that are often influenced by the geographical context and community capacity in terms of resources including finances, technology, expertise, etc. Communities typically rely on actions that they have control. Such limitations highlight the need and opportunity for participatory and coordinated actions and planning that leverage and share capacity among stakeholders to

address cross-sectoral challenges and opportunities, rather than isolating themselves and trying to proceed with implementation on their own.

The research concludes that the integration of emission reduction measures along with just transition-related aspects is important to ensure that the communities are reaching net-zero targets while reducing burdens and increasing the benefits the transition can derive. The current study also highlights the importance of developing specific frameworks for community energy and emissions planning that reflect the unique capacities of local areas that would lead to the creation of the most appropriate actions and generate the best outcomes.

Limitations of the Study

The scope of the current study was limited to evaluating CEEPs to understand the broader topic of community energy and emission planning. However, gaining a comprehensive understanding of the topic might require more analysis methods that cover the whole community energy and emissions planning process. Moreover, CEEPs and the actions mentioned in these plans represent what communities intend to do from the date of the plan's final development. Many communities, as leaders in climate action, may have already pursued numerous actions that are not included in the plans. This is not because they were overlooked, but because they were no longer a priority, having already been completed. Therefore, it is important to note that the actions in the plans might not necessarily reflect all the actions the communities are pursuing or have already pursued.

Future Studies

Future studies can be conducted to understand the reasoning behind the integration or lack of integration of net zero and just transition related indicators in the actions communities have

planned in their CEEPs of NB. Understanding these gaps and reasoning would help identify and overcome barriers, leading to more comprehensive community energy and emissions planning that takes a holistic approach towards reaching sustainability goals.

More comprehensive comparative analysis between the three communities can also be conducted to understand the differences between community energy and emissions planning and to understand the reasoning behind the differences. Each community varies in terms of geography, climate vulnerability, size, economic structure, and available resources, etc. These variations can significantly impact how communities approach energy and emissions planning. Therefore, future studies can explore the relationship between geography and other factors with community energy planning to get a better understanding of what influences each community.

Bibliography

Al-Mamoori, A., Krishnamurthy, A., Rownaghi, A. A., & Rezaei, F. (2017). Carbon capture and utilization update. *Energy Technology, 5(6)*, 834-849. https://doi.org/10.1002/ente.201600747

André, K., Gerger Swartling, Å., Englund, M., Petutschnig, L., Attoh, E. M. N. A. N., Milde, K., Lückerath, D., Cauchy, A., Botnen Holm, T., Hanssen Korsbrekke, M., Bour, M., & Rome, E. (2023). Improving stakeholder engagement in climate change risk assessments: Insights from six co-production initiatives in Europe. *Frontiers in Climate*, *5*, 1120421. https://doi.org/10.3389/fclim.2023.1120421

Asif, M., & Muneer, T. (2007). Energy supply, its demand and security issues for developed and emerging economies. *Renewable and Sustainable Energy Reviews*, *11*(7), 1388–1413. https://doi.org/10.1016/j.rser.2005.12.004

Baena-Moreno, F. M., Rodríguez-Galán, M., Vega, F., Alonso-Fariñas, B., Vilches Arenas, L. F., & Navarrete, B. (2019). Carbon capture and utilization technologies: A literature review and recent advances. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, *41*(12), 1403–1433. https://doi.org/10.1080/15567036.2018.1548518

Banerjee, A., & Schuitema, G. (2022). How just are just transition plans? Perceptions of

decarbonisation and low-carbon energy transitions among peat workers in Ireland. *Energy Research & Social Science*, *88*, 102616. https://doi.org/10.1016/j.erss.2022.102616

Bauwens, T., Gotchev, B., & Holstenkamp, L. (2016). What drives the development of community energy in Europe? The case of wind power cooperatives. *Energy Research & Social Science*, *13*, 136–147. https://doi.org/10.1016/j.erss.2015.12.016

Bell, M. Z. (2021). Spatialising procedural justice: Fairness and local knowledge mobilisation in nuclear waste siting. *Local Environment*, *26*(1), 165–180. https://doi.org/10.1080/13549839.2020.1867841

Bistline, J. E. T. (2021). Roadmaps to net-zero emissions systems: Emerging insights and modeling challenges. *Joule*, *5*(10), 2551–2563. https://doi.org/10.1016/j.joule.2021.09.012

Bistline, J. E. T., & Young, D. T. (2022). The role of natural gas in reaching net-zero emissions in the electric sector. *Nature Communications*, *13*(1), 4743. https://doi.org/10.1038/s41467-022-32468-w

Bogner, J., Pipatti, R., Hashimoto, S., Diaz, C., Mareckova, K., Diaz, L., Kjeldsen, P., Monni, S., Faaij, A., Qingxian Gao, Tianzhu Zhang, Mohammed Abdelrafie Ahmed, Sutamihardja, R. T. M., & Gregory, R. (2008). Mitigation of global greenhouse gas emissions from waste: Conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Working Group III (Mitigation). *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *26*(1), 11–32. https://doi.org/10.1177/0734242X07088433

Brandstedt, E., & Brülde, B. (2019). Towards a Theory of Pure Procedural Climate Justice. *Journal of Applied Philosophy*, *36*(5), 785–799. https://doi.org/10.1111/japp.12357

Brooks, N. (n.d.). *Vulnerability, risk and adaptation: A conceptual framework*.

Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. *Nature Energy*, *5*(8), 569–577. https://doi.org/10.1038/s41560-020-0641-6

Chen, B., Xiong, R., Li, H., Sun, Q., & Yang, J. (2019). Pathways for sustainable energy transition. *Journal of Cleaner Production*, *228*, 1564–1571. https://doi.org/10.1016/j.jclepro.2019.04.372

Cherp, A., & Jewell, J. (2014). The concept of energy security: Beyond the four As. *Energy Policy*, *75*, 415–421. https://doi.org/10.1016/j.enpol.2014.09.005

Cheshmehzangi, A. (2016). Feasibility Study of Songao's Low Carbon Town Planning, China. *Energy Procedia*, *88*, 313–320. https://doi.org/10.1016/j.egypro.2016.06.143

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

City of Moncton, (2022). Community Energy and Emissions Plan. https://www5.moncton.ca/docs/plans/Community_Energy_Emissions_Plan.pdf

Efficiency Canada. (n.d). *Net-Zero Energy Ready Buildings in Canada*.https://www.efficiencycanada.org/building-codes/net-zero-energy-ready-buildings-in-canada/

Fankhauser, S. (2021). What next on net zero? *One Earth*, *4*(11), 1520–1522. https://doi.org/10.1016/j.oneear.2021.10.017

Farrell, C., 2012. A just transition: Lessons learned from the environmental justice movement. Duke FL & Soc. Change, 4, p.45.

Forman, A. (2017). Energy justice at the end of the wire: Enacting community energy and equity in Wales. *Energy Policy*, *107*, 649–657. https://doi.org/10.1016/j.enpol.2017.05.006

Fredericton. (2022). Community Energy and Emissions Plan. https://www.fredericton.ca/sites/default/files/202305/cof_ceep_synposis_2022_20220614_0_1.pdf

Garcia-Casals, X., Ferroukhi, R., & Parajuli, B. (2019). Measuring the socio-economic footprint of the energy transition. *Energy Transitions*, *3*(1–2), 105–118. https://doi.org/10.1007/s41825-019-00018-6

Getting to Implementation. (2016). Community Energy Implementation Framework. QUEST Canada.https://questcanada.org/getting-to-implementation-in-canada/

Gluch, P., Johansson, K., & Räisänen, C. (2013). Knowledge sharing and learning across community boundaries in an arena for energy efficient buildings. *Journal of Cleaner Production*, *48*, 232–240. https://doi.org/10.1016/j.jclepro.2012.10.020

Gouldson, A., Sudmant, A., Khreis, H., & Papargyropoulou, E. (n.d.). *The Economic and Social Benefits of Low-Carbon Cities: A Systematic Review of the Evidence*.

Government of Canada. (2023, October 27). Net-zero emissions by 2050. Canada.ca. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

Hägele, R., Iacobuţă, G. I., & Tops, J. (2022). Addressing climate goals and the SDGs through a just energy transition? Empirical evidence from Germany and South Africa. *Journal of Integrative Environmental Sciences*, *19*(1), 85–120. https://doi.org/10.1080/1943815X.2022.2108459

Haggett, C., & Aitken, M. (2015). Grassroots Energy Innovations: The Role of Community Ownership and Investment. *Current Sustainable/Renewable Energy Reports*, *2*(3), 98–104. https://doi.org/10.1007/s40518-015-0035-8

Hale, T., Smith, S. M., Black, R., Cullen, K., Fay, B., Lang, J., & Mahmood, S. (2022). Assessing the rapidly-emerging landscape of net zero targets. *Climate Policy*, *22*(1), 18–29. https://doi.org/10.1080/14693062.2021.2013155

Hanke, F., Guyet, R., & Feenstra, M. (2021). Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases. *Energy Research & Social Science*, *80*, 102244. https://doi.org/10.1016/j.erss.2021.102244

Hazrati, M., & Heffron, R. J. (2021). Conceptualising restorative justice in the energy Transition: Changing the perspectives of fossil fuels. *Energy Research & Social Science*, *78*, 102115. https://doi.org/10.1016/j.erss.2021.102115

Henry, M. S., Bazilian, M. D., & Markuson, C. (2020). Just transitions: Histories and futures in a post-COVID world. *Energy Research & Social Science*, *68*, 101668. https://doi.org/10.1016/j.erss.2020.101668

Hughes, S., & Hoffmann, M. (2020). Just urban transitions: Toward a research agenda. *WIREs Climate Change*, *11*(3), e640. https://doi.org/10.1002/wcc.640

Iacobuţă, G. I., Höhne, N., Van Soest, H. L., & Leemans, R. (2021). Transitioning to Low-Carbon Economies under the 2030 Agenda: Minimizing Trade-Offs and Enhancing Co-Benefits of Climate-Change Action for the SDGs. *Sustainability*, *13*(19), 10774. https://doi.org/10.3390/su131910774

International Energy Agency [IEA]. (n.d.). *Electrification.* https://www.iea.org/energy-system/electricity/electrification

Intergovernmental Panel On Climate Change (Ipcc). (2023). *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009325844

International Institute for Sustainable Development [IISD]. (2023). *Unpacking Carbon Capture and Storage: The technology behind the promise.* https://www.iisd.org/articles/insight/unpacking-carbon-capture-storage-technology

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science*, *11*, 174–182. https://doi.org/10.1016/j.erss.2015.10.004

Jetoo, S. (2019). Stakeholder Engagement for Inclusive Climate Governance: The Case of the City of Turku. *Sustainability*, *11*(21), 6080. https://doi.org/10.3390/su11216080

Johnsson, F., Kjärstad, J., & Rootzén, J. (2019). The threat to climate change mitigation posed by the abundance of fossil fuels. *Climate Policy*, *19*(2), 258–274. https://doi.org/10.1080/14693062.2018.1483885

Keighley, D., & Maher, C. (2015). A preliminary assessment of carbon storage suitability in deep underground geological formations of New Brunswick, Canada. *Atlantic Geology*, *51*(1), 269. https://doi.org/10.4138/atlgeol.2015.011

Kenway, S. J., Binks, A., Scheidegger, R., Bader, H.-P., Pamminger, F., Lant, P., & Taimre, T. (2016). Household analysis identifies water-related energy efficiency opportunities. *Energy and Buildings*, *131*, 21–34. https://doi.org/10.1016/j.enbuild.2016.09.008

Lieu, J., Hanger-Kopp, S., Van Vliet, O., & Sorman, A. H. (2020). Assessing risks of low-carbon transition pathways. *Environmental Innovation and Societal Transitions*, *35*, 261–270. https://doi.org/10.1016/j.eist.2020.04.009

Marques, S., Lima, M. L., Moreira, S., & Reis, J. (2015). Local identity as an amplifier: Procedural justice, local identity and attitudes towards new dam projects. *Journal of Environmental Psychology*, *44*, 63–73. https://doi.org/10.1016/j.jenvp.2015.09.007

McCauley, D., & Heffron, R. (2018). Just transition: Integrating climate, energy and environmental justice. *Energy Policy*, *119*, 1–7. https://doi.org/10.1016/j.enpol.2018.04.014

McCauley, D., Ramasar, V., Heffron, R. J., Sovacool, B. K., Mebratu, D., & Mundaca, L. (2019). Energy justice in the transition to low carbon energy systems: Exploring key themes in interdisciplinary research. *Applied Energy*, *233–234*, 916–921. https://doi.org/10.1016/j.apenergy.2018.10.005

Moghaddasi, H., Culp, C., & Vanegas, J. (2021). Net Zero Energy Communities: Integrated Power System, Building and Transport Sectors. *Energies*, *14*(21), 7065. https://doi.org/10.3390/en14217065

Mundaca, L., Busch, H., & Schwer, S. (2018). 'Successful' low-carbon energy transitions at the community level? An energy justice perspective. *Applied Energy*, *218*, 292–303. https://doi.org/10.1016/j.apenergy.2018.02.146

Orr, F. M. (2018). Carbon Capture, Utilization, and Storage: An Update. *SPE Journal*, *23*(06), 2444–2455. https://doi.org/10.2118/194190-PA

Ottinger, G. (2013). The Winds of Change: Environmental Justice in Energy Transitions. *Science as Culture*, *22*(2), 222–229. https://doi.org/10.1080/09505431.2013.786996

Partners for Climate Protection (PCP). (n.d). *The PCP Milestone Framework*. https://www.pcp-ppc.ca/program

Polcarová, E., & Pupíková, J. (2022). Analysis of Socially Vulnerable Communities and Factors Affecting Their Safety and Resilience in Disaster Risk Reduction. *Sustainability*, *14*(18), 11380. https://doi.org/10.3390/su141811380

Psarras, P. C., Comello, S., Bains, P., Charoensawadpong, P., Reichelstein, S., & Wilcox, J. (2017). Carbon Capture and Utilization in the Industrial Sector. *Environmental Science & Technology*, *51*(19), 11440–11449. https://doi.org/10.1021/acs.est.7b01723

Qazi, U. Y. (2022). Future of Hydrogen as an Alternative Fuel for Next-Generation Industrial Applications; Challenges and Expected Opportunities. *Energies*, *15*(13), 4741. https://doi.org/10.3390/en15134741

QUEST Canada. (n.d). *New Brunswick Smart Energy Communities Accelerator Pilot Program.* https://questcanada.org/new-brunswick-smart-energy-community-accelerator-pilot-program/

Rezaie, B., & Rosen, M. A. (2012). District heating and cooling: Review of technology and potential enhancements. *Applied Energy*, *93*, 2–10. https://doi.org/10.1016/j.apenergy.2011.04.020

Rismanchi, B. (2017). District energy network (DEN), current global status and future development. *Renewable and Sustainable Energy Reviews*, *75*, 571–579. https://doi.org/10.1016/j.rser.2016.11.025

Robert, A., & Kummert, M. (2012). Designing net-zero energy buildings for the future climate, not for the past. *Building and Environment*, *55*, 150–158. https://doi.org/10.1016/j.buildenv.2011.12.014

Robinson, M., & Shine, T. (2018). Achieving a climate justice pathway to 1.5 °C. *Nature Climate Change*, *8*(7), 564–569. https://doi.org/10.1038/s41558-018-0189-7

Sankhyayan, P., & Dasgupta, S. (2019). 'Availability' and/or 'Affordability':What matters in household energy access in India? *Energy Policy*, *131*, 131–143. https://doi.org/10.1016/j.enpol.2019.04.019

Seto, B., Gl, D., Leahy, J., Gl, D., Herrschaft, B., Gl, D., Butterworth, B., Gl, D., Punjabi, S., & Gl, D. (n.d.). *Zero Net Energy Communities: Three Cities Leading the Way*.

Setyowati, A. B. (2021). Mitigating inequality with emissions? Exploring energy justice and financing transitions to low carbon energy in Indonesia. *Energy Research & Social Science*, *71*, 101817. https://doi.org/10.1016/j.erss.2020.101817

Shaw, C. (2016). The role of rights, risks and responsibilities in the climate justice debate.

International Journal of Climate Change Strategies and Management, *8*(4), 505–519. https://doi.org/10.1108/IJCCSM-10-2014-0127

Sovacool, B. K., Burke, M., Baker, L., Kotikalapudi, C. K., & Wlokas, H. (2017). New frontiers and conceptual frameworks for energy justice. *Energy Policy*, *105*, 677–691. https://doi.org/10.1016/j.enpol.2017.03.005

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435–444. https://doi.org/10.1016/j.apenergy.2015.01.002

Sovacool, B. K., Martiskainen, M., Hook, A., & Baker, L. (2019). Decarbonization and its discontents: A critical energy justice perspective on four low-carbon transitions. *Climatic Change*, *155*(4), 581–619. https://doi.org/10.1007/s10584-019-02521-7

Sovacool, B. K., Martiskainen, M., Hook, A., & Baker, L. (2020). Beyond cost and carbon: The multidimensional co-benefits of low carbon transitions in Europe. *Ecological Economics*, *169*, 106529. https://doi.org/10.1016/j.ecolecon.2019.106529

St. Denis, G., & Parker, P. (2009). Community energy planning in Canada: The role of renewable energy. *Renewable and Sustainable Energy Reviews*, *13*(8), 2088–2095. https://doi.org/10.1016/j.rser.2008.09.030

Stern, N., & Valero, A. (2021). Innovation, growth and the transition to net-zero emissions. *Research Policy*, *50*(9), 104293. https://doi.org/10.1016/j.respol.2021.104293

Statistics Canada. 2023. (Census Profile, 2021 Census of Population). Census Profile. 2021 Census of Population. Statistics Canada Catalogue no. 98-316-X2021001. Ottawa. Released November 15, 2023.

Suboticki, I., Heidenreich, S., Ryghaug, M., & Skjølsvold, T. M. (2023). Fostering justice through engagement: A literature review of public engagement in energy transitions. *Energy Research & Social Science*, *99*, 103053. https://doi.org/10.1016/j.erss.2023.103053

Sultana, F. (2022). Critical climate justice. *The Geographical Journal*, *188*(1), 118–124. https://doi.org/10.1111/geoj.12417

Town of St. Andrews. (2022). Local Climate Action Plan. https://www.townofsaintandrews.ca/wp-

content/uploads/2022/04/SA_GHGMitigation_LocalActionPlan_Final.pdf.

Tozer, L. (2013). Community energy plans in Canadian cities: Success and barriers in implementation. *Local Environment, 18*(1), 20–35. https://doi.org/10.1080/13549839.2012.716406

Uitto, J. I., Puri, J., & Van Den Berg, R. D. (Eds.). (2017). *Evaluating Climate Change Action for Sustainable Development*. Springer International Publishing. https://doi.org/10.1007/978-3-319-43702-6

United States Environmental Protection Agency (USEPA). (n.d). *Importance of Methane.* https://www.epa.gov/gmi/importance-methane#:~:text=Methane%20is%20the%20second%20most,trapping%20heat%20in%20the%20atmosphere.

United States Environmental Protection Agency (USEPA). (n.d). *Commercial Property Assessed Clean Energy.* https://www.epa.gov/statelocalenergy/commercial-property-assessed-clean-energy

United Nations Framework Convention on Climate Change (UNFCC). (n.d). https://unfccc.int/resource/ccsites/zimbab/conven/text/art01.htm#:~:text=%22Sink%22%20means%20any%20process%2C,greenhouse%20gas%20into%20the%20atmosphere.

Upham, D. P., Sovacool, P. B., & Ghosh, D. B. (2022). Just transitions for industrial decarbonisation: A framework for innovation, participation, and justice. *Renewable and Sustainable Energy Reviews, 167,* 112699. https://doi.org/10.1016/j.rser.2022.112699

Van Veelen, B. (2018). Negotiating energy democracy in practice: Governance processes in community energy projects. *Environmental Politics, 27*(4), 644–665. https://doi.org/10.1080/09644016.2018.1427824

Van Vliet, O., Hanger-Kopp, S., Nikas, A., Spijker, E., Carlsen, H., Doukas, H., & Lieu, J. (2020). The importance of stakeholders in scoping risk assessments—Lessons from low-carbon transitions. *Environmental Innovation and Societal Transitions,* 35, 400-413. https://doi.org/10.1016/j.eist.2020.04.001

Wang, X., & Lo, K. (2021). Just transition: A conceptual review. *Energy Research & Social Science, 82,* 102291. https://doi.org/10.1016/j.erss.2021.102291

Whitmarsh, L., Poortinga, W., & Capstick, S. (2021). Behaviour change to address climate change. *Current Opinion in Psychology*, *42*, 76–81. https://doi.org/10.1016/j.copsyc.2021.04.002

Williams, S., & Doyon, A. (2019). Justice in energy transitions. *Environmental Innovation and Societal Transitions*, *31*, 144–153. https://doi.org/10.1016/j.eist.2018.12.001

Winfield, M., Harbinson, S., Morrissey Wyse, S., & Kaiser, C. (2021). Enabling community energy planning? Polycentricity, governance frameworks, and community energy planning in Canada. *Canadian Planning and Policy / Aménagement et Politique Au Canada*, *2021*, 35–54. https://doi.org/10.24908/cpp-apc.v2021i2.14405

Winfield, M., Hill, S. D., & Gaede, J. R. (Eds.). (2023). Sustainable energy transitions in Canada. UBC Press.

Wyse, S. M., & Hoicka, C. E. (2019). "By and for local people": Assessing the connection between local energy plans and community energy. *Local Environment*, *24*(9), 883–900. https://doi.org/10.1080/13549839.2019.1652802

Appendices

Appendix 1 -Table 2- Analysis of the Actions found in each community's CEEP

Area	Indicator	Actions found in each community's CEEP Guiding question: What actions relevant to the indicators have the communities incorporated into their plans?"			Comment
		City of Fredericton	City of Moncton	Town of St. Andrews	
Net Zero	**Energy Systems Decarbonization**	• Continuing with the city-wide rooftop solar mapping study and making the results publicly available. • Exploring the feasibility of developing Green Development Standards/Guidelines that encourage the planning, design, and development of near-net zero buildings and neighbourhoods. • Installing EV infrastructure on city-owned property and developing a strategy to expand the EV infrastructure within the city, while also collaborating with partners to promote them. • Exploring the feasibility of a revitalization tax exemption bylaw and other tools and incentives to help property owners and managers undertake deep energy and	• Developing and implementing a strategy to ensure all new buildings in the community are built to "net-zero energy" standards by 2030. A specific target is to ensure that 100% of all new construction is net zero by 2030. • Updating the city's internal Municipal Green Building Policy to ensure all new buildings starting in 2025 are built to be "net-zero ready" and are built to "net-zero energy" standards by 2030. A specific target is to ensure that 100% of all new municipal buildings are net zero by 2030. • Developing and launching a program to encourage rooftop solar PV systems on	• Converting the greatest energy consumer of the town, which is the W.C. O'Neill Arena to a renewable source (solar/wind/geothermal). Specific actions include contracting an expert to do a feasibility study to determine the effectiveness of solar and creating an implementation plan for most beneficial renewable energy source. • Employing an anaerobic digester for municipal organic waste and probably creating biogas that can be combusted to generate renewable natural gas. Specific actions include	The integration of actions for energy systems decarbonization is highly prominent. The focus is on renewable energy, alternative fuel, energy efficiency, behavioural changes, and electrification measures. Energy efficiency measures and support for behavioural changes are the most prominently integrated. Overall, Fredericton has identified more actions than the other communities for energy systems decarbonization.

		GHG emissions retrofits of existing buildings. • Exploring the feasibility of installing hydrogen and/or renewable compressed natural gas (R-CNG) infrastructure systems within the city. • Collaborating with partners to promote alternative fuel vehicles. • Reviewing current zoning and development cost charge bylaws to identify energy conservation and efficiency strategies, low carbon fuel switching strategies and adjust the development cost charges and bylaws accordingly. • Advocating for the province to adopt the National Energy Code of Canada for buildings. • Seeking out funding to support the development of separate residential, high-density residential buildings, and institutional / commercial building deep building energy retrofit strategies.	residential and commercial buildings. • Developing ground-mount solar PV installation initiatives. A specific target is to ensure that, by 2030, 2.8 MW of ground-mounted solar PV systems are operating at locations such as city-owned parking lots, at city facilities, etc. • Supporting the development of a "Green Hydrogen Freight Fuelling Facility" as a pilot project to convert ground mount solar electricity to hydrogen, then using the fuel hydrogen fuel cell, long-haul trucks. The goal for this initiative is to ensure that, by 2035, the industrial trucking park in East Moncton will have 184 MW of ground-mounted solar panels. • Developing and supporting the implementation of a plan for three emission free	conducting feasibility studies. • Initiating town wide renewable energy or waste energy integration/ district heating. Specific action includes having a technical study done on options for district heating and determining implementation phases for district heating if deemed feasible. • Converting the heating energy source from fossil fuel to electric heaters. • Exploring the conversion of vehicle fleet from gas and diesel to a lower emitting energy source by conducting a study to explore feasibility of the conversion and coming up with an implementation plan to upgrade vehicles to chosen lower emitting energy sources.	For energy efficiency, the focus is primarily on building efficiency improvements, waste heat recovery, industrial efficiency, and water efficiency. Behavioural changes focus on fuel-efficient driving and water conservation behaviours. Indirect measures include promotional efforts, physical infrastructure support for active and public transportation, and encouragement of ridesharing and car-sharing within the community. Renewable energy integration efforts focus on utilizing solar, wind, and renewable natural gas resources and alternative energy use

		• Collaborating with the Canadian Home Builders Association and other partners to advance and support the development of a green buildings program. Packaging and promoting information through city channels around retrofitting and developing more sustainable and energy efficient buildings. • Exploring the opportunity to establish a fast-track/rebate program for building permit applications that undertake energy-efficient builds/deep retrofits. • Working with NB Power and NRCan to encourage commercial building owners to adopt the use of a Portfolio Manager to track energy consumption and demand charges and encouraging building owners to access benchmarking, auditing and retrofit funding through NB Power.	district energy systems. The target includes operating three district energy systems with a total capacity of 8.36 MW by 2035. • Offsetting 100% of the city's corporate electricity use with net new 10, wind-generated electricity by 2040. • Partnering with Eco360 and other communities served by Eco360 to develop an anaerobic digester facility that will convert organic waste to renewable natural gas. The target is to produce at least 70,000 GJ of renewable natural energy from organic waste by 2030. • Developing a program to stimulate deep energy retrofits in residential and non- residential buildings. A specific target is to ensure that 80% of all buildings have deep retrofits completed by 2040, and 100% completed by 2050.	• Energy conversion for heating from fuel to natural gas. • Applying the REALice technology to the W.C. O'Neill arena. • Developing town's own Green Building Standards. • Continuing with the town wide LED light transition. • Insulating the theatre roof and dormitory area of the W.C. O'Neill Arena. • Redoing the Roof/Ceiling of Arena and replace with low emission ceiling • Adding occupancy sensors to public bathrooms and lighting timers to other building areas.	focuses on natural gas and hydrogen, particularly within the transportation sector. For electrification, the focus is on transportation, particularly electric vehicles, and to a lesser extent, the building sector.

		• Packaging and promoting information on existing programs that support energy efficiency improvements in commercial buildings. • Advocating for the province to modify the community planning act and municipalities act to allow NB cities to address energy and water conservation, efficiency and GHG reduction requirements via by-laws and development guidelines. • Offering incentives to encourage the use of green roofs and white roofs on large buildings. • Studying the costs and benefits of setting up a community fund or not-for-profit entity that could fund energy efficiency retrofits and new building features in the community. • Examining the opportunity around developing financial incentives that can support waste heat recovery such as	• Leveraging the city's legal authorities and incentives to expedite the transition of buildings off fossil fuelled space and domestic water heating. Specific targets include tracking the number of fossil fuel building heating systems installed annually, having all existing residential, non-residential and industrial users of fossil fuels transitioned to zero emissions alternatives by 2030 and having 75% of all users of fuel oil systems have transitioned to zero emissions alternatives by 2035. • Ensuring that, all non-municipal, commercial, medium and heavy-duty trucks are made electric or hydrogen fuel cell vehicles between 2026-2035. • Establishing a city-wide parking surcharge on internal combustion engine vehicles	• Installing energy saving plumbing fixtures in municipal buildings • Installing stormwater management infrastructure. • Taking actions to separate stormwater and sanitary water. • Promoting water conservation and the efficient use of water in the community through public awareness campaigns and retrofitting programs that conserve water by installing energy saving plumbing fixtures such as: toilet dams, low-flow showerheads, faucet aerators or washers, and rain barrels. • Promoting fuel-efficient driving among town staff.	

		financing to assist in undertaking feasibility studies or low interest loans to help support upfront capital costs. • Continuing to advocate to the province to allow municipalities to develop/run a Property Assessed Clean Energy Programs (PACE) or similar programs. • Working with stakeholders to undertake an alternative energy pre-feasibility study to understand where potential opportunities exist and identify specific zones / buildings and, investigate partnerships, financing, and governance models to advance waste heat recovery systems. • Evaluating waste heat recovery from large refrigeration systems (such as arenas, grocery stores) in new large developments. • Continuing to implement sidewalk, pedestrian, transit, roadway, and bikeway	to expedite the shift to electric vehicles. A specific target is to start a surcharge program in 2025 that charges an annual $160 / tonne surcharge on all internal combustion engine vehicles to park in any non- private parking area across the city. • Supporting the establishment of e-bike and electric vehicle car share programs. A specific target includes ensuring that there are at least 95 shared e-bikes in Moncton by 2023 and at least 10% of trips up to 10 km long are taken on a shared e-bike or a shared EV car by 2050. • Developing and implementing a “Zero Emissions Fleet and Equipment Policy” to expedite the transition of the city’s fleet and equipment to zero emission alternatives. A specific target is to ensure	• Promoting active transportation/expanding local trail system. • Promoting public transportation. • Promoting fuel efficient driving. • Implementing a town wide anti-idling policy.	

		investment projects that encourage the shift to active transportation modes. • Implementing network improvements and undertaking planning to increase transit service, transit utilization (e.g., new routes, transit priority measures, on-demand technology, etc.) and traffic flow. • Advocating to the province to provide city-specific vehicle registration data to improve GHG estimates and inform the development of related policies to encourage fuel switching and driver behaviour. • Exploring the feasibility of developing a bylaw to regulate illuminated signs or keeping buildings lit at night following the principals of "Dark Sky". • Working with the local business community to develop and adopt commuting technology platforms such as apps that allow users to plan	that at least 45 municipal fleet vehicles are electric by 2030 and 100% of the municipal fleet vehicles and equipment are electric or zero emissions by 2035. • Working with Codiac Transpo, Riverview and Dieppe to decarbonize the transit fleet vehicles. A specific target is to convert all buses and associated flee at Codiac Transpo are zero emissions vehicles by 2035." • Preparing for and catalysing zero emission vehicle uptake by developing a community wide Zero Emission Vehicle Strategy. A specific target is to ensure that, at least 3900 electric vehicles are registered in Moncton in 2025. • Supporting freight rail and aviation in the city in reaching their emission reduction targets. A specific target is to ensure that CN		

		trips that use multiple modes (public transit, car sharing, bike sharing, car- and vanpooling, on-demand ride services, and shuttle services) and promote existing programs (e.g., Trail towns)." • Exploring and developing by-laws to support the adoption of micro mobility initiatives (e.g., bike share). • Supporting partners by promoting bicycle safety education programs that teach drivers and riders the laws, riding protocols, routes, safety tips and emergency manoeuvres. • Supporting partners by promoting workplace-and school-based initiatives that encourage more sustainable and efficient commuting patterns. • Working with car share providers to explore the piloting of a car share program.	(Canadian National Railway) uses hydrogen-powered engines for all freight loads transported to or through Moncton by 2040.And also ensuring that the Greater Moncton International Airport Authority meets the net zero commitment of the International Commercial Aviation Organization by 2050." • Developing an industrial leadership program to improve industrial energy efficiency. A specific target includes ensuring that industrial energy use is reduced by 20% by 2050. • Establishing a car free zone in a popular area of the city to encourage alternative forms of transportation. A specific is to ensure that, at the beginning of 2025, creating a designated car free area in the city.		

		• Working with local businesses / organizations to promote or implement commute trip reduction programs such as parking cash out, transit allowances, rideshare, end-of-trips, facilities, compressed or flexible work weeks, telecommuting, etc. • Increasing the number of secure and protected bike parking and maintenance facilities available to the public across the city. And also depending on the applicability, enhancing off-street bicycle parking standards and requirements for new developments. • Working with partners, including the Chamber of Commerce and Green Economy New Brunswick, to develop communications presenting the City's strengths as a location to grow the green economy (e.g., investment-ready land, willingness to find	• Working with Codiac Transpo, Riverview and Dieppe to expand and improve transit service to increase proportion of trips taken by transit. A specific target is to ensure that at least 10% of all trips taken within and into/out of Moncton are taken on transit by 2030. • Expanding and improving active transportation network, 'end-of-ride' facilities, and bike security to increase trips taken using active modes of transportation. Specific targets include ensuring that, 75% of trips shorter than 2 km will be walked, 75% of trips shorter than 5 km will be biked, and the total active mode share for all distances will exceed 30% by 2030.		

		supporting infrastructure district heating or smart grid space), along with the incentives and programs.			
	Land Use Management	• Continuing to implement sidewalk, pedestrian, transit, roadway, and bikeway investment projects that encourage the shift to active transportation modes. • Continuing to embed the city's street design guidelines in transportation planning, infrastructure planning, and urban design plans and processes. • Continuing to focus on infill development & densification of the downtown, according to the municipal plan. • Reviewing development permit plans and update them to ensure that neighbourhoods establish cycling and pedestrian networks to complement the active transportation master plan, and include strong	• Ensuring that Moncton's future urban development includes more density in key nodes and corridors, and a greater proportion of mixed-use and multi-unit residential buildings. A specific target is to develop, adopt and implement an urban growth strategy that increases density, develops local community life, and prioritizes shared and active transportation. • Developing a policy to protect, monitor and actively manage the remaining forested and wetland areas in Moncton. A specific target is to ensure that the area's forested and wetland areas are protected, expanded, and health maintained to sequester greenhouse gases	• Implementing stormwater management infrastructure initiatives. • Implementing urban forestry planning • Protecting town-owned greenspaces • Converting town owned vacant lots and brownfields to greenspace.	The integration of actions is somewhat prominent. Integrated actions focus on densification and mixed-use development, active transportation infrastructure, green spaces, sustainable food systems, and stormwater management infrastructure. Observed the same level of integration between the communities.

		connectivity, an appropriate variety of route types, separated bike paths, and end-of-trip facilities. • Reviewing current zoning and DCC bylaws to identify low carbon fuel switching, energy conservation and efficiency strategies, and other barriers to densification and adjust the DCCs and bylaws accordingly. • Establishing a local food policy and supporting programs that supports a local, sustainable food system. This is likely to include: collaborating with various partners to locate suitable land for urban farms and community gardens, adjusting zoning as needed. Additionally, exploring avenues for residents to grow edible plants along boulevards and bike paths. Developing an educational program to advocate for local food production and its benefits and initiating a ""buy local""	and to adapt and protect the community from sea level rise.		

		campaign with neighbouring municipalities and businesses to promote regional economic growth and sustainability.			
	Waste Management	• Continuing to implement community-based social marketing (CBSM) campaigns focused on waste reduction. • Continuing to promote home composting programs. • Continuing to implement the green events guide to reduce waste at the Garrison market & other city-run events. • Working with community partners to promote product exchange / resale networks. • Incorporating criteria related to the management of wastes from demolition, land clearing and construction activities into its sustainable development checklist.	• Partnering with Eco360 and other communities served by Eco360 to develop an anaerobic digester facility that will convert organic waste to renewable natural gas. A specific target is to ensure that at least 70,000 GJ of renewable natural energy is produced from organic waste by 2030. • Partnering with Eco360 to develop and implement a "Zero Waste by 2050" plan to divert 100% of Moncton's waste from the landfill. A specific target is to ensure that the total quantity of waste sent annually to the landfill (which will exclude organic waste) will not exceed 44,000 tonnes by 2025 and ensuring that no	• Installing composters for town-owned facilities • Conducting a feasibility study to install an anaerobic digester for municipal organic waste. • Implementing community wide composting service. • Facilitating composting within community gardens and youth gardens	The integration of actions is relatively limited. Integrated actions focus on composting, waste-to-energy conversion, waste reduction and reuse, and management of demolition, land clearing, and construction waste. Observed the same level of integration between the communities.

			waste is sent to the landfill by 2050.		
	Application of Nature Based Solutions for Mitigation	• Offering incentives to encourage the use of green roofs on large buildings.	• Supporting the development and implementation of tree-planting programs. A specific target is to ensure that 10,000 new trees have been planted, are still alive, and are being maintained between 2030 and 2050. • Developing a policy to protect, monitor and actively manage the remaining forested and wetland areas in Moncton. A specific target includes ensuring that the area's forested and wetland areas are protected, expanded, and health maintained to sequester greenhouse gases and to adapt and protect the community from sea level rise.	• Urban forestry planning. • Protection of town-owned greenspaces • Converting town owned vacant lots and brownfields to greenspace.	The integration of actions is relatively limited. Integrated actions focused on natural resource preservation, conservation and management, and urban greening. And observed the same level of integration between the communities.

	Carbon Capture, Storage and Utilisation (CCSU)	-	-	-	No actions have been integrated in the plans.
	Assessment of Risks and Benefits of Measures for Achieving Net Zero Emissions and Ensuring the Management of Risks and Equitable Distribution of the Benefits.	• Studying the costs and benefits of setting up a community fund or not-for-profit entity that could fund energy efficiency retrofits and new building features in the community—e.g., grants for community groups to implement education and outreach campaigns and also secure funds to retrofit and upgrade buildings and facilities. • Ensuring that new building policy and code requirements are supported with investment in the development of compliance processes, tools, and training for both staff and applicants prior to the National	• Using incentives to gradually retire all gas and diesel fuelling stations in Moncton. • Continuing to collaborate with partners to promote electric vehicles and alternative fuel vehicles.	• Conducting a study to explore the conversion of vehicle fleet from gas and diesel to a lower emitting energy source. Consider multiple options: EVs, Propane, etc." • Installing composters for town-owned facilities and conducting a feasibility study on acquiring an industrial composter. • Conducting a technical study on options for district heating and determining the implementation phases	The direct integration of actions is minimal. Indirect measures focus on conducting feasibility studies and pilot programs, providing incentives, and promoting benefits. Fredericton has integrated more actions than the other communities.

		Energy Code of Canada for Buildings and National Building Code requirements taking effect. • Exploring the feasibility of developing Green Development Standards/Guidelines that encourage the planning, design, and development of near-net zero buildings and neighbourhoods (e.g., establishment of Integrated Energy / Net Zero Master Plans). • Working with stakeholders to undertake an alternative energy pre-feasibility study to understand where potential opportunities exist and identify specific zones /buildings and, investigate partnerships, financing, and governance models to advance potential DE, microgrids, waste heat recovery and solar PV system(s).		for district heating if deemed feasible. • Initiating town wide renewable energy or waste energy integration/ district heating. Specific action includes having a technical study done on options for district heating and determining implementation phases for district heating if deemed feasible. • Promoting water conservation and the efficient use of water in the community. Implementing a public awareness campaign to promote water conservation through water conserving behaviours and/or conducting a retrofit program to conserve water by installing energy saving plumbing fixtures such as toilet	

		• Exploring the feasibility of developing a bylaw to regulate illuminated signs or keeping buildings lit at night following the principals of “Dark Sky”." • Exploring the feasibility of a Revitalization Tax Exemption Bylaw and other tools and incentives to help property owners and managers undertake deep energy and GHG emissions retrofits of existing buildings. • Continuing to explore the feasibility of installing hydrogen and/or renewable compressed natural gas (R-CNG) infrastructure systems within the city. • Working with NB Power, Realtors Association and Canadian Home Builders Association, and other partners to explore a pilot residential energy labelling program for residential homes.		dams, low-flow showerheads, faucet aerators or washers, and rain barrels. • Promoting fuel efficient driving among town staff. • Promoting active transportation/expanding the local trail system. • Promoting public transportation. • Implementing community-wide composting services. • Promoting fuel efficient driving. • Implementing a public engagement campaign on climate change mitigation. • Converting town owned vacant lots and brownfields to greenspace. • Taking steps to ensure that businesses have access to all the	

		• Working with car share providers to explore the piloting of a car share program. • Piloting new technologies in city-owned assets to assess suitability for broad community applications. • Developing an engagement plan to collect information from city staff to identify and assess the barriers that city employees face (or perceive they face) in their efforts to implement sustainable transport programs and policies. • Developing a comprehensive communication & engagement strategy that highlights the benefits of implementing the CEEP, like economic and community resilience benefits & leverages work being done by other community partners. • Packaging and promoting information on existing programs that support energy efficiency improvements in commercial buildings.		information needed to make their buildings operate as efficiently as possible.	

		• Packaging and promoting information through city channels around retrofitting and developing more sustainable and energy efficient buildings. • Developing an educational / communication program to encourage growing food locally and the benefits that accrue (e.g., reduced emissions, increased food security, etc.); Work with neighbouring municipalities, local business, farmers/ producers, chamber of commerce, etc. to implement a "buy local" campaign in the region. Promote the benefits of buying local via websites, in local stores, etc • Working with the local business community to develop/adopt intermodal or mixed-modal commuting technology platforms (e.g., apps) that allow users to plan trips that use multiple modes			

		(public transit, car sharing, bike sharing, car- and vanpooling, on-demand ride services, and shuttle services) and promote existing programs (e.g.,Trail towns). • Working with community partners to promote product exchange / resale networks. • Working with local businesses/organizations to promote or implement commute trip reduction programs (parking cash out, transit allowances, rideshare, end-of-trip facilities, compressed or flexible work weeks, telecommuting, etc.)." • Continuing to promote home composting programs. • Supporting partners by promoting bicycle safety education programs that teach drivers and riders the laws, riding protocols, routes, safety tips and emergency manoeuvres.			

		• Supporting partners by promoting workplace-and school-based initiatives that encourage more sustainable and efficient commuting patterns. • Continuing to implement community-based social marketing (CBSM) campaigns focused on waste reduction (e.g., no junk mail, smart purchasing, Metro Vancouver's Love Food Hate Waste campaign, reducing contamination in recycling). Continue promoting home composting programs.			
	Assessment of Vulnerabilities	-	-	-	No actions related to this indicator have been integrated into the plans.
	Ensure Energy Availability, Access and Affordability	• Continuing with the city-wide rooftop solar mapping study and making the results publicly available.	• Developing and implementing a strategy to ensure all new buildings in the community are built to "net-zero energy" standards by 2030. A specific	• Converting the greatest energy consumer of the town. which is the W.C. O'Neill Arena to a renewable source (solar/wind/geothermal).	The direct integration of actions is somewhat prominent. Measures focus on the adaptation of

		• Exploring the feasibility of developing Green Development Standards/Guidelines that encourage the planning, design, and development of near-net zero buildings and neighbourhoods. • Exploring the feasibility of installing hydrogen and/or renewable compressed natural gas (R-CNG) infrastructure systems within the city. • Collaborating with partners to promote alternative fuel vehicles. • Reviewing current zoning and development cost charge bylaws to identify low carbon fuel switching strategies and adjust the development cost charges and bylaws accordingly. • Installing EV infrastructure on city-owned property and developing a strategy to expand the EV infrastructure within the city. Continuing to collaborate with partners to promote electric vehicles and alternative fuel vehicles • Developing an engagement plan to collect information from city staff to	target is to ensure that 100% of all new construction is net zero by 2030. • Updating the city's internal Municipal Green Building Policy to ensure all new buildings starting in 2025 are built to be "net-zero ready" and are built to "net-zero energy" standards by 2030. A specific target is to ensure that 100% of all new municipal buildings are net zero by 2030. • Developing and launching a program to encourage rooftop solar PV systems on residential and commercial buildings. • Developing ground-mount solar PV installation initiatives. A specific target is to ensure that, by 2030, 2.8 MW of ground-mounted solar PV systems are operating at locations such as over City-owned parking lots, at City facilities, etc. • Supporting the development of a "Green Hydrogen Freight Fuelling Facility" as a pilot	Specific actions include contracting an expert to do a feasibility study to determine the effectiveness of solar and creating an implementation plan for most beneficial renewable energy source. • Employing an anaerobic digester for municipal organic waste and probably creating biogas that can be combusted to generate renewable natural gas. Specific actions include conducting feasibility studies. • Initiating town wide renewable energy or waste energy integration/ district heating. Specific action includes having a technical study done on options for district heating and determining implementation phases for district heating if deemed feasible. • Exploring the conversion of vehicle fleet from gas and diesel to a lower emitting energy sources by conducting	renewable energy, other alternative energy sources, DE, infrastructure support, education and promotional activities, and financial incentives. Observed the same level of integration between the communities.

		identify and assess the barriers that city employees face (or perceive they face) in their efforts to implement sustainable transport programs and policies. • Developing a comprehensive communication & engagement strategy that highlights the benefits of implementing the CEEP, like economic and community resilience benefits & leverages work being done by other community partners. • Packaging and promoting information on existing programs that support energy efficiency improvements in commercial buildings. • Packaging and promoting information through city channels around retrofitting and developing more sustainable and energy efficient buildings. • Developing an educational / communication program to encourage growing food locally and the benefits that accrue (e.g., reduced emissions, increased food security, etc.); Work with	project to convert ground mount solar electricity to hydrogen, then using the fuel hydrogen fuel cell, long-haul trucks. The goal for this initiative is to ensure that, by 2035, the industrial trucking park in East Moncton will have 184 MW of ground-mounted solar panels. • Developing and supporting the implementation of a plan for three emission free district energy systems. The target includes operating three district energy systems with a total capacity of 8.36 MW by 2035. • Offsetting 100% of the city's corporate electricity use with net new 10, wind-generated electricity by 2040. • Working with Codiac Transpo, Riverview and Dieppe to decarbonize the transit fleet vehicles. Specific target involves ensuring that all buses and associated flee at Codiac Transpo are zero emissions vehicles by 2025. "	a study to explore feasibility of the conversion and coming up with an implementation plan to upgrade vehicles to chosen lower emitting energy sources. • Energy conversion for heating from fuel to natural gas. • Promoting water conservation and the efficient use of water in the community • Promoting fuel efficient driving among town staff. • Implementing a public engagement campaign on climate change mitigation. • Promoting active transportation/expanding the local trail system. • Public Transportation Promotion. • Promoting Fuel Efficient Driving • Taking steps to ensure that businesses have access to all the information needed to make their buildings operate as efficiently as possible.	

		neighbouring municipalities, local business, farmers/ producers, chamber of commerce, etc. to implement a “buy local” campaign in the region. Promote the benefits of buying local via websites, in local stores, etc • Working with the local business community to develop/adopt intermodal or mixed-modal commuting technology platforms (e.g., apps) that allow users to plan trips that use multiple modes (public transit, car sharing, bike sharing, car- and vanpooling,on-demand ride services, and shuttle services) and promote existing programs (e.g., Trail towns)." • Working with community partners to promote product exchange / resale networks. • Working with local businesses/organizations to promote or implement commute trip reduction programs (parking cash out, transit allowances, rideshare, end-of-trip facilities, compressed or	• Developing and implementing a “Zero Emissions Fleet and Equipment Policy” to expedite the transition of the City’s fleet and equipment to zero emission alternatives. A specific target is to ensure that 100% of the municipal fleet vehicles and equipment are electric or zero emissions by 2035. • Supporting freight rail and aviation in the city in reaching their emission reduction targets. A specific target is to ensure that CN (Canadian National Railway) uses hydrogen-powered engines for all freight loads transported to or through Moncton by 2040.And also ensuring that the Greater Moncton International Airport Authority meets the net zero commitment of the International Commercial Aviation Organization by 2050." • Partnering with Eco360 and other communities served by Eco360 to develop an anaerobic digester facility that will convert organic		

		flexible work weeks, telecommuting, etc.)." • Continuing to promote home composting programs. • Supporting partners by promoting bicycle safety education programs that teach drivers and riders the laws, riding protocols, routes, safety tips and emergency manoeuvres. • Supporting partners by promoting workplace-and school-based initiatives that encourage more sustainable and efficient commuting patterns. • Continuing to implement community-based social marketing (CBSM) campaigns focused • on waste reduction (e.g., no junk mail, smart purchasing, Metro Vancouver's Love Food • Hate Waste campaign, reducing contamination in recycling). Continue promoting home composting programs." • Continuing to collaborate with partners to promote electric vehicles and alternative fuel vehicles.	waste to renewable natural gas. The target is to produce at least 70,000 GJ of renewable natural energy from organic waste by 2030. • Leveraging the city's legal authorities and incentives to expedite the transition of buildings off fossil fuelled space and domestic water heating. Specific targets include tracking the number of fossil fuel building heating systems installed annually, having all existing residential, non-residential and industrial users of fossil fuels transitioned to zero emissions alternatives by 2030 and having 75% of all users of fuel oil systems have transitioned to zero emissions alternatives by 2035. • Using incentives to gradually retire all gas and diesel fuelling stations in Moncton.		

		• Investigating to offer incentives to encourage the use of green roofs and white roofs on large buildings • Continuing to advocate to the province to allow municipalities to develop/run a • Property Assessed Clean Energy Programs (PACE) or similar program" • Seeking out funding to support the development of separate residential, high-density residential buildings, and institutional / commercial building deep building energy retrofit strategies. • Encouraging building owners to access retrofit funding through NB Power. • Studying the costs and benefits of setting up a community fund or not-for-profit entity that could fund energy efficiency retrofits and new building features in the community—e.g., grants for community groups to implement education and outreach campaigns and also secure funds to retrofit and upgrade buildings and facilities."			

		• Examining the opportunity around developing financial incentives that can support DE, microgrids, waste heat recovery and solar PV, such as financing to assist in undertaking feasibility studies or low interest loans to help support upfront capital costs. For example, removing property taxes for renewable technology or infrastructure"			
	Mobilisation of Local knowledge	• Continuing to use the Engage Fredericton Platform and the City's Environmental Dashboard to provide up to date information on the plan's progress and continue to engage residents and allow them to provide input." • Working with the local business community to develop / adopt intermodal or mixed-modal commuting technology platforms (e.g., apps) that allow users to plan trips that use multiple modes (public transit, car sharing, bike sharing, car- and vanpooling, on-demand	-	-	Integration is minimal. Fredericton has integrated clearer specific and clear actions.

		ride services, and shuttle services) and promote existing programs (e.g.,Trailtowns)."			
	Information Disclosure and Stakeholder Engagement	• Continuing with the city-wide rooftop solar mapping study and making the results publicly available." • Working with NB Power and NRCan to encourage commercial building owners to adopt • the use of a Portfolio Manager to track energy consumption and demand charges. • Encouraging building owners to access benchmarking, auditing and retrofit funding through NB Power." • Working with the Chamber of Commerce and Green Economy New Brunswick to identify, catalogue and profile local green businesses and businesses undertaking greening activities in the city and develop a recognition program." • Working with the local developer community, and organizations like	• Working with Codiac Transpo, Riverview and Dieppe to decarbonize the transit fleet and to expand and improve transit service to increase proportion of trips taken by transit. • Partnering with Eco360 and other communities served by Eco360 to develop an anaerobic digester facility that will convert organic waste to renewable natural gas. • Partnering with Eco360 to develop and implement a “Zero Waste by 2050” plan to divert 100% of Moncton’s waste from the landfill. • Partnering and collaborating to catalyse faster, broader and more integrated implementation. A specific target includes ensuring that partnerships, working groups, and collaborations are considered	• Partnering with the UNB, Faculty of Forestry and Environmental Management to develop a plan and standards to urban forest planning. • Promoting water conservation and the efficient use of water in the community • Promoting of fuel-efficient driving among town staff. • Implementing a public engagement campaign on climate change mitigation. • Active Transportation Promotion/ Expand Local Trail System. • Promoting public transportation. • Taking steps to ensure that businesses have access to all the information needed to	Integration is somewhat prominent. The primary focus is on include making relevant information publicly available, fostering collaborations, and engaging in outreach and promotional efforts. Fredericton has integrated more actions than the other communities.

		Google, to improve in-City and transboundary trip distance estimates and to inform the development of personal vehicle average trip length and active transportation targets." • Working with the local business community to develop / adopt intermodal or mixed-modal commuting technology platforms (e.g., apps) that allow users to plan trips that use multiple modes (public transit, car sharing, bike sharing, car- and vanpooling, on-demand ride services, and shuttle services) and promote existing programs (e.g., Trailtowns)." • Working with partners, including the Chamber of Commerce and Green Economy New Brunswick, to develop communications presenting the City's strengths as a location to grow the green economy (e.g., investment-ready land, willingness to find supporting infrastructure district heating or smart grid space), along with the incentives and programs.	as part of the planning for every action. • Developing and launching programs to encourage rooftop solar PV systems on residential and commercial buildings.	make their buildings operate as efficiently as possible.	

		• Working with NB Power, Realtors Association and Canadian Home Builders Association other partners to explore a pilot residential energy labelling program (at the time of sale) for residential homes and explore options for multifamily buildings." • Working with community partners to promote product exchange / resale networks. • Working with local businesses / organizations to promote or implement commute trip reduction programs (parking cash out, transit allowances, rideshare, end-of-trip facilities, compressed or flexible work weeks, telecommuting, etc.). • Working with stakeholders to undertake an alternative energy pre-feasibility study in an effort to understand where potential opportunities exist and identify specific zones /buildings and, investigate partnerships, financing, and governance models to advance potential DE, microgrids, waste heat recovery and solar PV system(s).			

		• Providing sponsorship to local youth to participate in programs that develop leadership in sustainability. • Collaborating with partners to promote electric vehicles and alternative fuel vehicles. • Developing an engagement plan to collect information from city staff to identify and assess the barriers that city employees face (or perceive they face) in their efforts to implement sustainable transport programs and policies. • Developing a comprehensive communication & engagement strategy that highlights the benefits of implementing the CEEP, like economic and community resilience benefits & leverages work being done by other community partners. • Packaging and promoting information on existing programs that support energy efficiency improvements in commercial buildings. • Packaging and promoting information through city channels around retrofitting and developing		

		more sustainable and energy efficient buildings. • Developing an educational / communication program to encourage growing food locally and the benefits that accrue (e.g., reduced emissions, increased food security, etc.); Work with neighbouring municipalities, local business, farmers/ producers, chamber of commerce, etc. to implement a “buy local” campaign in the region. Promote the benefits of buying local via websites, in local stores, etc • Continuing promoting home composting programs. • Supporting partners by promoting bicycle safety education programs that teach drivers and riders the laws, riding protocols, routes, safety tips and emergency manoeuvres. • Supporting partners by promoting workplace-and school-based initiatives that encourage more sustainable and efficient commuting patterns.			

		• Continuing to implement community-based social marketing (CBSM) campaigns focused on waste reduction (e.g., no junk mail, smart purchasing, Metro Vancouver's Love Food Hate Waste campaign, reducing contamination in recycling).			