COMMUNITY RENEWABLE ENERGY AND RURAL RESILIENCE IN NORTH AMERICA AND WESTERN EUROPE

by © Mohammad Nazrul Islam

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I declare that I am the primary author of each of these manuscripts, having completed all the data collection, analysis and writing with guidance and suggestions throughout the process from Dr. Vodden. I also thankfully acknowledge that both Dr. Vodden and Dr. Richards provided feedback and editorial comments on the full thesis and all these chapters.

Abstract

This research seeks to address the role that a decentralized, democratic renewable energy system, i.e., Community Renewable Energy (CRE), can have (and that such systems have had) in enhancing rural resilience in North America and Western Europe. In both settings, it further examines how different conditions influence the growth and maturity of CREs in specific contexts, as well as why certain CRE initiatives have been effective in achieving intended community results while others have not. Derived from existing literature, this study formulates a conceptual framework for application. Through a systematic review based on a four-step process, including identification of data sources, screening, eligibility and inclusion, and analysis, the study found that CRE significantly impacts rural resilience, including diversity, networks and connectivity, equalization and adaptive capacity. However, diversity is the major contribution of CRE, followed by networks and connectivity, equalization, and adaptive capacity. CRE assists in enhancing rural diversity, particularly economic diversity and regional development, along with energy diversity. This diversity, in turn, affects various networks and connectivity and facilitates energy justice, including procedural and distributional justice. Consequently, there can be a desirable effect of assisting rural community self-organization and enhancing their social learning processes; subsequently, local community adaptability, including the ability to learn to survive in a challenging and uncertain environment, is increased. Various contextual, motivational and project-related factors, particularly policy, the culture of localism and trust, access to natural resources, and economic regeneration, including ownership structure, are the most important for achieving community benefits from CRE in North America and Western Europe. While Western Europe has effectively implemented CRE projects through these factors, North American jurisdictions have faced impediments in achieving comparable results due to the influence of these factors.

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Thank you.

Mohammad Nazrul Islam

DEDICATION

This thesis is dedicated to our spiritual leader

Allamah Abdul Latif Chowdhury Fultolee (Rahimullah)

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List of Acronyms

COMFIT = Community Feed-in Tariff

CRE= Community Renewable Energy

FIT = Feed-in-Tariff

MECISE = Mobilizing European Citizens to Invest in Sustainable Energy

NA= North America

PV= Photovoltaic

RE= Renewable Energy

REScoops= Renewable Energy Source Cooperatives

RR= Rural Resilience

VAT= Value-Added Tax

WE= Western Europe

CHAPTER 1: INTRODUCTION

The following introduction chapter consists of three sections: i) an introduction to the problem and purpose and research question of this research, ii) defining key concepts and terms, and iii) a conceptual framework and methods section.

1.1 Problem and Purpose Statement

Energy is the "lifeblood of society" as it plays a crucial role in human existence and advancement across the world (Mercer, 2016, p. 1). Hydrocarbons, including fossil fuels (oil, natural gas, coal), are the main sources of the world's energy supply. However, fossil fuels are also responsible for climate changes like global warming, increasing extreme weather events and other greenhouse effects (Soed & Soeder, 2021). Many human societies have been threatened as a result of these climatic changes, together with global economic pressures. In particular, many rural communities across the globe are experiencing a period of rapid and ongoing economic, social, and environmental changes as a result of factors such as globalization, economic downturn, public sector budgetary pressures, demographic ageing, and climate change (Augère-Granier & McEldowney, 2021; FCM, 2018). These pressures include the need for carbon emission reductions to mitigate climate change and to achieve energy security to meet household and industry needs. Rural areas in both Canada and Western Europe, for example, are more vulnerable because of extreme weather events (Sauchyn et al., 2016), global pandemics (Breen & Robinson, 2021), the loss of services and infrastructure (Zarifa et al., 2019), economic deprivation (Slee, 2019; Shucksmith, 2012), and changes in population dynamics (Markey, 2015). All these factors influence the resilience of rural communities, and their capacity to adapt to changing circumstances is increasingly important (Islam, 2016).

This situation creates a key challenge of the 21st century: building sustainable rural communities for the present as well as future generations. As a result, governments are seeking solutions for a sustainable recovery, which will ensure long-term socio-economic and environmental benefits for rural residents and their communities (Nelson et al., 2021). In such circumstances, a green economy and particularly renewable energy can provide a key opportunity to achieve these goals (Gasparatos et al., 2017).

Renewable energy comes from replenishing natural sources at the surface of earth such as wind, solar, tidal, biomass and from deep within the earth's crust like geothermal, which can be renewed naturally within a human lifecycle (Hossaina et al., 2017). Energy sufficiency, economic degrowth regarding limiting growth of energy use, transformation of the energy system, and environmental protection are common driving factors for expanding renewable energy projects in the pursuit of sustainable regional development (Dornan & Shah, 2016; Sen & Ganguly, 2017). Economic degrowth in the context of limiting the growth of energy use and transforming the energy system refers to a deliberate strategy to decouple economic activity from increasing energy consumption (Rommel et al. 2018). This approach challenges the traditional paradigm of continuous economic growth by prioritizing sustainability and reducing the ecological footprint (Tsagkari, et al., 2021). The goal is to transition towards a more resource-efficient and environmentally friendly model, emphasizing conservation, efficiency, and the adoption of renewable energy sources (Gunderson, et al., 2018). However, different studies also show that many renewable energy projects have failed to provide such outcomes (Boksh, 2015; Gasparatos et al., 2017; Karunathilake et al., 2016; Kunz et al., 2007). In particular, benefits for rural communities have often been limited. Why have some renewable energy projects been successful in reaching expected community outcomes and others not? One possible explanation suggested in the literature is differences in a project's ownership and management structure (Sen & Ganguly, 2017). Many energy projects are deployed in countryside areas but managed and controlled from urban centres where corporate headquarters and the technical and financial decisions lie (Johnson & Lewis, 2017; Plum, 2020). Karunathilake (2016), for example, revealed that although a majority of renewable energy projects are registered in urban areas, they are operated and deployed in rural areas by private or individual organizations with private investment. Therefore, local people do not see substantial financial benefits from these projects as most of the revenues, including taxes, go to the urban or provincial/national budgets (Ceborary et al., 2017).

Furthermore, the current renewable energy system across the globe is dominated by centralized energy systems, including large-scale power stations and 'national grid' infrastructure to distribute electricity to centres of demand that are mostly dominated by a few powerful utility groups (Brummer, 2018; Huang et al., 2015). The centralized renewable energy model uses extended high-voltage transmission networks, super-grids, to connect renewable megaprojects (CSI, 2010; García-Olivares, 2015) and seeks to decarbonize the existing economy rather than transform it (Weinrub & Giancatarin, 2015). Consequently, these projects tend to serve the interests of the politically and economically powerful, empowering corporations rather than communities (Johnson & Lewis, 2017; Weinrub, 2017). The Muskrat Falls hydroelectricity project, for instance, is associated with adverse environmental impacts, primarily due to elevated levels of methylmercury (Agarwal, 2021). This poses a significant threat to the local ecology and the overall environment (Barnard-Chumik et al., 2022). Additionally, the project has faced budgetary issues, leading to cost overruns. As a consequence of these budget challenges, Newfoundland's gross debt is expected to rise by 50% which will reduce the economic growth of this provenance (Agarwal, 2021). Again, most of the large centralized renewable energy projects around the world utilize a one-way supply system where energy authorities have no obligation to sell power or electricity regionally (Huang et al., 2015), and energy producers are often not interested in reinvesting their profit in host communities, particularly in remote rural and small-town areas (Allen et al., 2012; Wiersma & Wright, 2014).

Therefore, equalization, including equal sharing of resources, inclusiveness and involvement, does not occur. In addition, these energy projects can have adverse effects on local ecosystems, including pollution, and reduce biodiversity (Walker & Wright, 2008; Cebotari, 2017). Large and centralized renewable energy projects in both Europe and North America also have created local distrust and resource conflicts among local groups (Fernandez, 2021; Maleki-Dizaji et al., 2020).

One alternative for ensuring collective ownership, locally-driven management practices, and local benefits is called community renewable energy (CRE). However, different studies describe and define CRE based on multidimensional aspects, including socio-technological innovation, regional and spatial distribution of energy, multiple organizations and legal structures, and environmental and psychological well-being. Consequently, there is no universal definition of CRE, and several research mentioned CRE as ambiguous, flexible, and problematic concept (Becker & Kunze, 2014; Hoffman et al., 2013; Seyfang et al., 2014). For instance, Walker & Devine-Wright (2008) define CRE as energy projects having both process and outcomes, whereas after a systematic literature Bauwens (2022, p. 4) suggests that the notion of CRE has shifted from a process to place, with declining focus among scholars on the collective participation aspect of energy transitions. Thus, it is essential to review all of these aspects of CRE and provide a common definition of CRE that can assist both the academic and policy sectors in determining the features of CRE.

CRE relies on decarbonized/low-carbon (renewable) energy production that focuses on a decentralized and democratized energy system (Becker & Kunze, 2014; Pohlmann, 2018; van Veelen, 2017). As described further below, such a system can help local inhabitants to tackle various challenges related to energy projects and be actively engaged to assure their regional development, providing benefits such as economic diversification and empowerment of local disadvantaged groups through the community network and engagement (Karanasios & Parker, 2018; McCarthy & Morrison, 2021). Wiersma and Wright (2014) also observe that CRE projects are often able to adapt to adverse conditions and bounce back after any kind of negative change. Consequently, communities with CRE may be more resilient than other rural communities (Slee, 2015; Hallett, 2016). Though many studies have described diversity (or lack thereof) in rural agricultural, forestry, and fishing communities (Gasparatosa, 2017; Rogers et al., 2008), few studies have addressed the role of decarbonization in rural diversity and resilience. Again, rural resilience is a relatively new development concept, and the resiliency of rural areas has received limited attention (Heijman et al., 2019). This research seeks to fill this gap by examining links between decentralized and decarbonized energy projects and rural resilience. Key elements of rural resilience that are considered, along with and contributing to adaptive capacity, include diversity, equalization, and network and connectivity, as discussed further below (Section 2.2).

Despite evidence of various potential advantages of decentralized low-carbon energy systems, they have not always performed well because of a variety of reasons. Questions also arise, therefore, about what factors lead to these outcomes within CRE projects. Previous studies have suggested that factors such as weak ownership and poor participation can limit the effectiveness of CRE efforts (Wyse, 2018), but a comprehensive study related to all determinant factors, including various contextual, motivational, and project-related factors for CRE that contributes to rural community resilience is needed and a contribution of this thesis (Curtin et al., 2017).

This study focuses on Western Europe and North America (Canada and USA only) because, firstly, both settings are industrialized with huge energy production demands and access to a variety of energy production technologies; secondly, the feasibility of energy-generating ventures is increased due to high levels of socio-economic development and resulting access to finance; thirdly, there is a substantial amount of literature regarding renewable energy for both of these contexts. More specifically, numerous CRE projects have been launched and studied within these regions from which to draw lessons in this study.

However, according to the World Economic Forum report on Fostering Effective Energy Transition 2021, Western European nations lead the overall rankings for energy transition, while North America is ranked relatively low among industrialized countries; for example, Canada and the United States are ranked 22nd and 24th, respectively (Bocca et al., 2021). By 2030, the EU aims to produce 27% of its total energy from various renewable sources, with the UK, Germany, and France being leaders in solar energy and Germany, France, Sweden and the UK being leaders in wind energy (ABB, 2017). Since 2008, there has been a marked rise in initiatives focused on CRE in Europe, particularly renewable cooperatives, with more than 2,800 energy cooperatives in operation in 2015 (Sequeira & Santos, 2018). REN21 (2018) shows that the number of renewable energy cooperatives in Germany, for example, increased from 67 to 772 from 2008 to 2014. The Netherlands has experienced similar growth, with the number of energy cooperatives increasing from 19 in 2008 to 500 in 2015. In Scotland, an estimated 508 MW of community and locally owned energy capacity began operation in 2015, already exceeding the government's 2020 target of 500 MW (REN21, 2018).

On the other hand, Canada is the second-largest country in the world and has enormous natural energy resources, but due to carbon emissions, declining conventional fossil fuels reserves, and volatile energy values, it has been experiencing challenges related to energy security, particularly in remote rural areas (Canada's First Ministers, 2016; Government of PEI, n.d.). Consequently, provincial and federal governments have emphasized renewable energy sources for energy security and community development (Fisher et al., 2008). Canada is the seventh-largest renewable energy producer among countries and obtains 68 percent of its energy from various renewable sources. Renewable energy production has increased 23% in Canada over the last 15 years, due especially to growth in solar and wind. Environmental and renewable technology contributed around 3.3 percent of the total Canadian GDP in 2020 (Natural Resources Canada, 2023). However, these renewable energy sources are often clean but not green (e.g. large-scale hydro development) or community-based. Large-scale hydro projects contribute to renewable energy generation and can help address climate change concerns, however, the ecological impact, displacement of communities, sedimentation issues, infrastructure vulnerability and high initial environmental costs have led to debates about their overall 'green' status (Agarwal, 2021; Barnard-Chumik et al., 2022).

Subsequently, some additional important questions arise, including: Why is the growth of CRE projects slower in North America particularly Canada and USA compared to Western Europe despite the potential of renewable energy, particularly for rural regions? What existing political and institutional realities facilitate or hinder the development of rural CRE projects? While a growing body of research on CRE projects exists both in North America and Europe, only a few studies like Fisher et al. (2009), Boksh (2015), Jame et al. (2017), and Boxer and Jame (2016) have compared renewable energy between Canada and Western Europe, and very few have focused on comparing the policy aspects of CRE between Canada and Europe (along with other factors). This study addresses these issues by exploring opportunities and barriers for CRE projects both in North America (Canada and USA only) and Western Europe, primarily through a systematic literature review, with anticipated lessons for Canada from successes in the energy transition in Western Europe.

1.2 Research Questions

Given the knowledge gaps mentioned above and the need to further examine the role of low-carbon, renewable energy projects, particularly CRE, in rural resilience, the key questions addressed in this study are as follows:

1) How have community renewable energy projects (CRE) contributed to rural resiliency in North America and Western Europe?

   i) In what ways have CRE projects affected rural community diversity?

   ii) In what ways have CRE projects affected rural networking/connectivity?

   iii) In what ways have CRE projects affected rural resource equalization?

   iv) In what ways have CRE projects affected rural adaptive capacity?

2) What conditions have led to these contributions both in North America and Western Europe?

   i) How have contextual, motivational, and project-related factors enabled or constrained the CRE systems in North America and Western Europe, particularly in rural regions?

   ii) How do these factors compare within the two settings?

3) What policies would be required to support the expansion of CRE systems in Canada in support of rural community resilience

1.3 Defining Key Concepts and Terms

1.3.1 What is the Meaning of Community?

Generally, a community is defined as a group of people living in a specific area who have an emotional relationship based on their place attachment. A wide range of literature describes a community as a group of humans who share a common set of values, attitudes, and behavioural patterns (Berka & Creamer, 2018; Parkhill et al., 2015; Wirth, 2014); Brint (2001), for instance, refers to the community as a small group of individuals, who are acquainted with one another, practicing the same culture and tradition, and who have multiple emotional bonds. Therefore, a community consists of some essential aspects, such as community sentiment, collective tradition, and responsibilities (Becker & Kunze, 2014; Wirth, 2014). Continuing with this notion, Musall and Kuik (2012) mentioned two key types of community: i) community of interest—which refers to individuals with similar interests but may be geographically separated from each other; and ii) community of localities, or communities of place—where people live in a particular geographical area and have a familiarity with one another as well as place-based attachment (Walker, 2008). Other studies, like Rudolph et al. (2017) and Becker and Kunze (2014), describe the 'community' as comprised of a community of interest and social relations within a certain geographical area. It can also denote a form of organization that follows its own institutional rules, often overlapping with communities of place (such as a local government and its boundaries being used to delineate community of place). On the other hand, in an ecological sense, the term communities refers to groups of interacting organisms living together in a specific habitat or ecosystem. Ecological communities are characterized by the relationships and interactions between different species and their physical environment (Aoki, 2012). The focus of this study is geographic communities, or communities of place, particularly those located in rural areas (outside of urban centres).

1.3.2 Definition of Community Renewable Energy and Related Debates

Climate change and the global obligation to fulfil sustainable development goals have provoked initiatives regarding CRE, which are described as group-based renewable energy-related activities (Schoor & Scholtens, 2019). The activities of communities that constitute CRE range from renewable energy generation to distribution, from investing in renewable energy to encouraging community involvement in energy projects (Behrendt, 2014). CRE is typically described as locally or regionally-based, citizen-driven renewable energy production system (Walker & Devine-Wright, 2008). The majority of the immediate benefits from such energy systems are shared locally, facilitating the transition to a sustainable energy structure that integrates environmental, economic, and social dimensions of development (Brummer, 2018; DECC, 2013; Pohlmann, 2018; Schoor & Scholtens, 2019; van Veelen, 2017). Different authors have attempted to define CRE from different perspectives—for example, Kalkbrenner and Roosen (2016) and van der Horst (2008) focused on the decentralized technological aspect of defining CRE, where the use of renewable energy is the key issue. This perspective also emphasized the small-scale, decentralized energy system, which could be solar, biogas, geothermal, wind, or other energy-related renewable sources. Although the size of such energy projects depends on various factors, including grid capacity, communities' financial ability, local energy demand, policy, and regulation (Mey, 2017; Susser & Kannen, 2017), generally, community bioenergy projects might vary from 300 kW to about 10 MW, whereas community wind energy projects might vary from 300 kW to about 100 MW (Behrendt, 2014).

On the contrary, other studies have addressed miscellaneous non-technical benefits in the definition of CRE, such as public engagement, procedural justice like participation in the decision-making process, and distributional justice including ownership (Fairchild & Weinrub, 2017; Heiskanen et al., 2018; Johnson & Lewis, 2017)). Instead of financial gain, these studies highlight other socio-economic and environmental improvements. They define CRE as a communal energy initiative that triggers resident involvement in the entire energy system (Caramizaru & Uihlein, 2020; Cox & Bryant, 2012; Mey, 2017). However, the extent and nature of citizen participation, including benefit sharing and involvement in the decision-making process, is likely to depend on the particular community and project (Walker & Devine-Wright, 2008). Regional or spatial distribution of energy output and energy use are other prevalent features that define CRE, with a focus on community mobilization and positive psychological and behavioural transformations that increase renewable energy acceptance and encourage responsible energy use (TREC, 2016).

CRE literature often characterizes the involvement of any government, corporate or large organization's direct involvement negatively, although they can play roles as project partners (Bauwens, 2022). According to this viewpoint, CRE is a non-corporate energy setting where citizens, social entrepreneurs, and public organizations participate directly through investments, manufacturing, trade, and distribution of renewable energy to achieve economic and social advancement for the local community (Community Energy, 2020). Based on the regional or spatial distribution, CRE is typically serving a community of place, where energy participants live in the same territorial area and collectively manage their renewable energy projects (Cervas, &

Giancatarino, 2017). On the other hand, there are some examples where individuals not living in the same geographical location have common interests, including financial, environmental, or social, in deploying renewable energy and that work together on energy initiatives (Johnson & Lewis, 2017).

Still other studies define CRE based on the organizations and legal structures involved, from the most common form of energy infrastructure, like cooperatives, to different non-profit energy entities, such as housing associations devoted to providing stable and affordable energy facilities for the native community (Caramizaru & Uihlein, 2020; McMurtry, 2018; Wyse, 2018). These organizational and legal structures of renewable energy have adopted different business frameworks but in CRE have three standard features, including i) local residents have at least half of the entire organization's equity, ii) a community organization works as a voting authority for energy participants, and iii) the majority of project benefits are shared among the local community (Martiskainen, 2016; Ruggiero et al., 2014; World Wind Energy Association, 2016). These organizational and ownership structures can serve multiple functions like sharing, managing, and purchasing different goods and services besides energy (DECC, 2014), or the structures can serve a single purpose, such as energy production.

In addition, two innovation approaches, including technological innovation and social innovation, are applied in different studies, specifically Seyfang & Smith (2007) and Hargreaves et al. (2013), to help define the CRE concept. According to these ideas, renewable energy technology has undergone technological innovation, whereas social innovation has been initiated through collective community action (Süsser et al., 2017). Therefore, these perspectives on innovation view CRE as a grassroots initiative that develops a socially and culturally acceptable, bottom-up, sustainable energy solution focusing on a particular community. These community-owned innovation activities and supporting social structures may lead to various institutionalized organizations—for example, renewable energy cooperatives, energy communes, and so on. They also assist in building social capital among the government, other organizations, and local communities and are stimulated by push factors from specific community members (Tanimoto, 2012). These renewable energy projects have a large proportion of communal ownership, ranging from whole community-owned to cooperative structures across the energy properties (Campney, 2019; Islam, 2018). Consequently, participation in energy governance and the decision-making process is increased (McMurtry, 2018; MacArthur, 2016).

This existing literature shows that CRE is an umbrella concept that can be defined in various ways. In line with Verde and Rossetto (2020), this study develops a comprehensive definition which defines CRE as *a local energy initiative/program/project based on different renewable sources, including wind, solar, bioenergy, geothermal, wave, and tidal energy, primarily compelled by a community's necessities, motivation, culture, and values*. These needs and values may be:

- economic, like decreased energy costs, earning more revenue (Lehtonen & Okkonen, 2019; Lipp & Bale, 2018; RESCOOP, 2017);
- institutional, such as developing support for the deployment of renewable energy, reducing the energy dependence from large-scale commercial energy projects (Fernandez, 2021; Ruggiero, 2019);
- environmental, including decreasing carbon emissions, proper energy establishment siting, and conserving biodiversity (Boon & Diepernik, 2014; Kalkbrenner and Roosen, 2016);

- technical, namely energy self-sufficiency, sustaining energy supply (Hentschel et al., 2018; Menniti et al., 2018); and
- social, such as capacity building, procedural and distributional justice (Islam & Kelly, 2023; Simcock, 2016).

Walker and Devine-Wright (2008) focused on involvement in energy project process, and a fair and localized distribution of project benefits, however they did not extensively describe ownership related issues. Again, while recent sustainable energy literature has focused on CRE for establishing and operating renewable energy projects (Hoffmann & High-Pippert, 2010; Kalkbrenner & Roosen, 2016; van der Horst, 2008), the above review illustrates a lack of common agreement on the meaning and characteristics of CRE in literature (Soeiro & Dias, 2020; Fernandez, 2021). Therefore, this study synthesized the definitions and key characteristics of CRE under three main categories. The next section describes these three key features identified in the existing literature (Hicks et al., 2014).

1.3.3 Three D's (Decarbonized, Decentralized, and Democratized): Key Features of CRE

1.3.3.1 Decarbonized Energy

De-carbonization, a process of mitigating the greenhouse effect by decreasing or removing greenhouse gases, including methane, carbon dioxide, and nitrous oxides, from the atmosphere, is pursued through efforts to "consume less and consume better" (Szulecki et al., 2015 p. 12). Consequently, it emphasizes energy efficiency, energy sufficiency, using different renewable sources, and deploying various carbon capture technologies (Engie, 2021). With the importance of energy de-carbonization increasing rapidly, it encourages the minimization of carbon emissions by growing new, renewable power sources, enhancing fuel efficiency, and developing new economic activities based on carbon-neutral initiatives. Various renewable energy sources significantly contribute to de-carbonization, including decarbonizing energy grids and electricity supply systems (Zhang, 2022). Energy de-carbonization requires energy transition through a structural transformation of energy production, distribution, and consumption based on clean, efficient, and alternative energies. Promoting renewable energy is considering the best strategy for decarbonizing energy (Euklidiada, 2021). However, some renewable energy sources have significant greenhouse gas (GHG) emissions throughout their lifecycle stages, including construction, operation, and decommissioning. Large-scale hydroelectricity and the manufacturing of wind turbines are examples of such sources, with emissions mainly arising during construction and decommissioning (Amponsah et al., 2014; Nugent & Sovacool, 2014). Research also indicates that, in comparison to other renewable energy options, solar photovoltaic (PV) systems contribute higher GHG emissions, ranging from 13 to 731 tonnes per gigawatt-hour (GWh) (World Nuclear Association, 2011).

Small-scale hydropower, biomass energy systems, inshore and offshore wind power, marine electricity, and different solar installation technologies like solar photovoltaic energy, solar thermal panels, solar ventilation systems, and geothermal electricity are the common types of community decarbonized energy. Wind power, including onshore and offshore, is the most common CRE technology, particularly in the UK and other European countries (Energy Saving Trust, 2017; TREC, 2016). By utilizing the force of the wind, wind turbine blades propel, resulting in the spin of magnets and producing electricity. Now, Europe generates 236 gigawatts (GW) of wind electricity and plans to establish 116 GW more new wind installations from 2022 to 2026

(Hausman, 2022). The UK, Sweden, Germany, Turkey, and the Netherlands were the countries that most installed various wind energy, respectively (Wind Europe, 2022).

The second-most common CRE technology is solar energy, generating electricity in two ways, including photovoltaic and concentrated solar power (IRENA, 2020). A solar photovoltaic is a solar cell which transforms sunlight into energy. This solar technology increasingly contributes to the energy supply for both personal energy consumption and mini-grids, particularly for small and medium communities. Consequently, solar PV installation rose from 156 TWh to 821 TWh in 2020 (IEA, 2022). On the other hand, concentrated solar power utilizes optics to focus sun radiation. By heating fluid, sunlight generates steam, which turns the turbine and produces energy. According to the IRENA (2021), after 2018, the world's installed solar heating capacity is 483 GWh, and around 60% of solar installations are small-scale thermosiphon energy systems. For instance, in 2021 the United States deployed around 1813 MW of community-based solar energy, and by 2027 it is expected that this community solar energy will increase up to 7 GW (Hausman, 2022).

Hydropower, including both small and large hydro projects, are one of the most significant renewable energy sources, providing half of the world's electricity (IRENA, 2020). However, after the 2000s, energy production from large hydropower has decreased by around 17%, and compared to the last decade the expansion of hydro energy is projected to slow down by 23% in 2021-2030 (IEA,2021)—for instance, in North America, most of the hydropower is becoming old; consequently, electricity production from this source has fallen (IEA, 2020). Hydropower uses the gravitational flow of rivers, which is condensed from an extensive run into a single point with a water channel or dam. Consequently, opportunities arise in locations where concentrated waterpower and flows can be utilized to spin a turbine or water wheels that propel an automatic mill or an electric generator. Hydro-energy depends on the runoff water, including flow volume per unit of time, “the change in elevation” etc. (ENERGY.GOV, 2023). The small type of hydro project, which refers to 10 MW or less, does not impound water; subsequently, it does not require the construction of massive dams or reservoirs, which are environmentally destructive (IEA,2021). As a result, specific subsets of small-scale hydro energy, namely "mini hydro (<500kW)" and "micro hydro (<100kW)", are considered eco-friendly, non-polluting renewable energy sources (Sharma et al., 2013, p.10).

Biomass is defined as any organic material—for example, agricultural residues; purpose-grown energy crops and wood, oil-rich algae, various types of waste such as animal manure, municipal, food grain, or plant waste, that contains various chemical building blocks like carbon, hydrogen, or other energy components (NREL, 2022; Madrali & Blair, 2020). Biomass is called a process of “waste to watts” (Perrio, 2022, p.2). Biomass power can provide energy through biofuels like ethanol and biodiesel (NREL, 2022; Johansson et al., 2004). Consequently, biomass is considered a flexible and widely available renewable energy source—for example, in Europe, biomass provides about 60% of all renewable energy sources (Perrio, 2022). Approximately 6% of Canada's energy supply comes from bioenergy (Zurba & Bullock, 2020). However, Amponsah et al. (2014) found that dedicated biomass technologies have a high potential for GHG emissions. Geothermal energy means drawing on heat energy found underneath the earth. This energy can be acquired through the drilling of two wells. One well pushes water into the ground, and the hot rocks underneath the earth create steam that emerges through the other hole, driving a turbine to generate electricity. Geothermal has different applications, including: i) heat pumps that operate to exploit the earth's underground temperature for cooling and heating, ii) electricity generators used to produce electricity from the earth's underground heat, and iii) direct use, generating heat straight from warm water within the ground (NREL, 2022).

Tidal energy, the transfer of tidal action to electric power, is derived from "moon-gravity-powered" tides through the influx of seawater (Sharma, 2013, p. 14). This energy can be obtained in different ways, including tidal streams, lagoons and barrages. Canada, China, England, France, and Russia have the greatest potential for using tidal energy—for instance, Canada has 20,000 MW, 37,000 MW, and 340 GW potential capacity of tidal, wave, and river current respectively (Marine Renewables Canada, 2022). However, due to the technical challenges, high development cost, lack of proven technology, and regulatory and permitting challenges many tidal energy projects have been unsuccessful in Canada (Carlson, 2017).

In summary, decarbonization is the process of reducing or eliminating carbon dioxide (CO2) emissions and other greenhouse gas emissions from various sources, like energy production. These efforts involve various strategies and technologies, including renewable energy sources like solar, wind, bio, tidal, geothermal and hydropower, energy efficiency improvements, and transitioning to more sustainable, including decentralized and low-carbon, energy practices.

1.3.3.2 Decentralized Energy

Generally, decentralized energy refers to small-scale, local, distributed energy sources near the energy consumer, with a scale ranging from households to local communities (Becker, 2015; Vansintjan, 2015; Weinrub & Giancatarino, 2015). The two most vital features of decentralized renewable energy are small size and localism (Moroni et al., 2019; van Veelen & Haggett, 2016). Localism consists of two concepts, including "physical geography" (referring to a specific place) and "geography of ownership" (Moroni et al., 2019, p. 23). The second concept focuses on how an energy project is managed, including energy planning, maintenance, and consumption (Callaghan & Williams, 2014). Instead of large, "outsider" energy operators or networks, decentralized renewable energy: emphasizes local, community-based energy activities with decentralization of authority; permits a higher degree of autonomy, local acceptance and provision; and involves greater local commitment and responsibility for the social and economic consequences of energy use (Burke & Stephens, 2018). Consequently, energy consumers in the decentralized renewable system are not only consumers but also prosumers who can generate, use, and control their energy projects, including decision-making (Moroni et al., 2019). Decentralized renewable energy also addresses the different technical, economic, political, and social aspects of local energy production and distribution (Devine-Wright & Wiersma, 2009). Various studies define decentralized renewable energy as a group of energy initiatives where residences, business organizations, and local governments like municipalities can generate and use local electricity for their self-reliance (Community Energy, 2020; Gui & MacGill, 2018; Muller et al., 2011). Most participants in decentralized energy systems are living in a certain geographical area, such as a village, municipality, or small town with a defined area that can individually or jointly hold their energy resources and share energy infrastructure through a community microgrid or a combined community energy structure (Gui & MacGill, 2018).

Decentralized renewable energy projects can offer energy-saving infrastructure, integrate heat and power, manage transport and waste, and reduce carbon emissions. Decentralized renewable energy is significant for several reasons, including: i) the energy system is sited close to the energy user; consequently, transport of renewable energy resources is less expensive, leading to an increase in the capacity of energy supply, ii) various renewable energy technologies like solar

PV, micro-generation, timber-based district heating systems, and geothermal based heat pumps are appropriate for distributed, small-size energy initiatives, assisting in promoting the autonomy of energy producers and consumers to select their preferred technologies and expand their prospects for regional development (Caramizaru & Uihlein, 2020; Muller et al., 2011).

1.3.3.3 Democratized Energy

Energy democracy relates to energy and democracy. Szulecki (2018) describes three important features of energy democracy: popular sovereignty, participatory governance, and civic ownership. Popular sovereignty refers to the idea that the authority and legitimacy of a government or decision-making body are derived from the consent and will of the people (Skelcher, & Torfing, 2010). In the context of renewable energy projects, popular sovereignty involves giving local communities or stakeholders a significant role in the decision-making process regarding the development, implementation, and operation of these projects (Van Veelen, & Van Der Horst, 2018). Participatory governance in renewable energy projects, on the other hand, refers to an approach that involves the active and meaningful participation of various stakeholders, including local communities, in the decision-making processes related to the development, implementation, and management of renewable energy initiatives (Jenkins et al., 2016; Szulecki, 2018). It emphasizes inclusivity, transparency, and collaboration to ensure that diverse voices are heard and considered (Jenkins et al., 2016). Finally, civic ownership in renewable energy projects involves the active participation and ownership of renewable energy assets by local communities or civic entities (Morris, & Jungjohann, 2016). This model aims to decentralize control and benefits, allowing communities to have a direct stake in, and influence over, the development and operation of renewable energy projects (Morris, & Jungjohann, 2016; Szulecki, 2018).

Generally, democratized energy focuses on energy sovereignty and energy decolonization. It seeks to reform traditional, centralized, corporate energy to decentralized, democratized energy systems related to the collective rights of ownership and the management of energy resources where all the stakeholders can equally contribute to the energy project (Miller et al., 2019). Energy democracy emphasizes democratization and public engagement through a democratically planned and community-based-and-operated renewable energy structure that fulfils community interest and provides various substantial collective benefits including decent and reliable work opportunities, empowerment of disadvantaged communities, and creation of new public institutions (Szulecki, 2018; Johnson & Lewis, 2017). Energy democracy not only opposes the centralized commodity-based energy system but also eschews existing energy inequalities and large corporate-based business and power structures (McEwen, 2012; Furlong, 2020). Thereby, procedural justice and distributional justice are vital issues for democratic energy. The former refers to fair treatment, equal involvement, and transparency regarding energy participation and the decision-making process, while the latter refers to equal distribution of energy expenditure, revenue, profit, and other benefits (Shaw et al., 2015). Energy democracy also promotes a decentralized power system, transfers monopoly energy ownership to communal ownership, and accelerates regional and democratic decision-making abilities related to profit, employment, and energy capital (Scott, 2020).

This study defines energy democracy based on four key features, including: i) participatory—individual engagement in all aspects of the energy decision-making process; ii) associative—self-governance where different voluntary organizations and democratic associations can play a significant role in addressing community energy needs; iii) deliberative—public deliberation is encouraged, including open debate to obtain more legitimate and valid decisions regarding energy governance; and iv) material—provides fair access to energy resources (Van Veelen & Van Der Horst, 2018). Renewable energy can contribute to energy democracy through the flexible nature of renewable technology and the opportunities for innovative economic arrangements, though it can also erode energy democracy (Agarwal, 2021; Miller et al., 2019). Local residents can sell renewable energy, finance renewable enterprises, make themselves as a prosumer, and/or support the deployment of renewable energy through energy cooperatives or other community investment models (REN21, 2017).

CRE tends to increase social acceptance and reduce community tensions among different stakeholders through comprehensive and dynamic public engagement in the decision-making process (Becker et al., 2017; Munro et al., 2018; Rahmani et al., 2020). For instance, CRE can decrease community resistance and increase fairness and trust in energy activities or technology through the engagement opportunities in the early project stage. CRE projects assist local citizens in getting directly involved with different phases of energy projects, including construction, energy installation, managing and operating, and funding (Cowell et al., 2010; Rogers et al., 2012; Seyfang, 2013). Strategies might include face-to-face conversations, regular individual meetings, and sharing technical knowledge and skills, all of which may improve community confidence, contributing to successful energy projects (Ruggiero et al., 2019). It is worth noting, however, that community ownership and involvement may be restricted in some locales due to unfavourable energy policies and existing government and institutional rules, which tend to prefer centralized energy infrastructure; lack of energy investment opportunities for disadvantaged groups; and a poor and/or undemocratic decision-making process (Plum, 2020; Schallenberg-Rodriguez, 2017).

Each of these features of CRE can assist to improve a community's ability to adapt in the face of any kind of change including shock and disruption. This is referred to as resilience (Allen et al., 2019; Martiskainen, 2016). The next section describes the characteristics of resilience and how CRE contributes to resilience in rural areas.

1.3.4 What is the Meaning of Resilience?

Resilience typically describes a system (people, groups, larger societies, or ecosystems)'s ability to adapt to shock, disturbance or disruption (Roberts et al., 2015). The term shocks refer here to short-term external aberrations from long-term patterns, which negatively impact an individual's well-being, level of resources, livelihood, security, and/or protection (Galappaththi et al., 2019). Similarly, disturbance means any incoherent occurrence or event interrupting any system and changing the patterns of resources or other physical environments (Cumming et al., 2005). IPCC (2014), for instance, defines resilience as the capacity of a system, including its socioeconomic and ecological or environmental components, to absorb various destructive forces, distress events, or trends. According to Shaw et al. (2009), resilience is the ability to cope with a hazardous, uncertain, or disturbing event by resistance or adaptation, and responding positively to adverse conditions. Likewise, Resilience Alliance (2022) described resilience as the system's ability to adapt to shocks and absorb adverse conditions by maintaining its existing identity, function, and structure. Different studies define resilience based on various perspectives; however, the key similarity among these is the characteristic of positive adaptation capacity in response to a shock, disturbance or stress. After synthesis of various definitions this study defined resilience with an emphasis on the ability to maintain a system's functions, uniqueness, and structure, as well as the ability to adapt, learn, and transform in a way that results in bounce back, a system's endeavour to return to its previous state before the change transpired, or bounce forward, which entails a system's proactive efforts to effectively cope with changing circumstances and transition into a new state after experiencing a shock or change (Saja et al., 2021; Quaranta & Salvia, 2014).

Resilience is dynamic and context-specific, consisting of various ex-ante characteristics (the features, attributes, or conditions that exist or are considered before an event, decision, or action takes place like financial planning, risk assessment) that help explain the connection between stress and development effects (Barrett & Constas, 2014; Food Security Information Network (FSIN), 2014). Energy security, a stable and reliable access to affordable energy resources in order to meet the energy needs of a population, economy, or nation, is a vital factor for resilience (Szulecki, 2018). In the context of climate change and the growing importance of low-carbon energy, the availability of renewable sources, decentralized energy systems, and local community-based resource networks are also significant for creating energy system resilience (Wiseman & Bronin, 2013). This study focuses on resilience and the role of CRE particularly in rural settings.

1.3.5 Rural Resilience and its Characteristics

Low density and a long distance from other settlements are two common features of rural areas (Lauzon et al., 2015). Socio-economic restructuring, climate-related changes, and changes in population dynamics create various challenging situations for rural communities in North America and Western Europe (Vodden & Cunsolo, 2021; Augère-Granier & McEldowney, 2021; FCM, 2018). For example, the substantial transformation of primary industries, reductions in the manufacturing sector, changes in trade situations and international business competition, a global pandemic, and new labour-saving technologies have negatively impacted the rural labour force and other services in many areas (Heijman et al., 2019). Changes in population dynamics, such as depopulation, youth migration, and an ageing population, also lead to social and economic disruptions in rural regions. For instance, the rural population in Europe declined by 0.8 million from 2014 to 2019, a decline which will continue until 2050 (Augère-Granier & McEldowney, 2021).

Similarly, Canada's non-metro population increase rate is meagre compared to the overall population growth rate. Again, factors such as the rearrangement of the agriculture sector and the transition of primary and secondary sectors to tertiary industry have led to youth outmigration (Vodden & Cunsolo, 2021). For example, in rural Canada, youth aged between 15 to 19 declined by an estimated ten percent between 2011 and 2016 (FCM, 2018). On the other hand, the low fertility rate and rise in life expectancy have led to ageing populations in rural areas. A study by FCM (2018) also shows that the potential retiree rate in rural Canada increased by around 40.3% between 2001 and 2016. Along with these socio-economic changes, climate change is a key reason for various disturbances and vulnerabilities in rural areas, including risks related to extreme events such as floods, heat waves, and wildfires, causing population displacement in those areas, the risk of native species decline, deterioration of water quality and diminished aquatic resources, and declining food production in rural areas due to the invasive pest and diseases (Sauchyn et al., 2016; Zarifa et al, 2019).

In this circumstance, a resilient rural structure with a better capacity to restrain and/or cope with these unexpected disturbances is significant for rural sustainability. A rural community's resilience needs to be understood from both "outcome" and "process" perspectives (Skerratt, 2013). Viewed from an outcome perspective, rural resilience emerges from the effective deployment and implementation of adaptive capacities. However, rural resilience is not solely an outcome; it is also a "process" that involves the integration of community knowledge and learning, and the capacity to manage development initiatives (Kim, et al., 2020). As per these perspectives, rural community resilience is contingent upon a combination of responsive and reflective activities that emerge from planning, strategic initiatives, and ongoing learning processes (Franklin et al., 2011). Such proactive and responsive initiatives significantly strengthen the rural community's ability to effectively navigate diverse changes within rural regions (Scott, 2013) Thereby, rural resilience encompasses a diverse range of capabilities that collectively contribute to rural revitalization. These capabilities include maintaining the stability of the ecosystem, adapting financially and culturally to a changing environment, and providing a protective safety net that shields the rural structure from various hazards, uncertainties, and disturbances (Li, 2023; Spector et al., 2019).

Rural resilience is associated with i) regional or local specialization and ii) regional capacity to transform (Heijman et al., 2019). In the rural landscape, resilience can be multifaceted and relies on various stakeholders, networks, and organizations ranging in scale from individual to community and regional to international (MacKinnon & Driscoll-Derickson, 2013). Roberts and Townsend (2016), for instance, mentioned different factors for rural resilience, including manifold paths and recurrent techniques for ability building, diversification, different types of social capital, leadership, effectiveness and agency, and a sense of belonging. Similarly, Magis (2007) illustrated five types of capital for rural resilience: social, physical or economic, human, political, and cultural. Different types of social and economic capital assist in creating community spaces in rural areas, which can result in gathering, learning, and networking more efficiently and effectively among rural residents (Islam, 2016). Moreover, rural communities also require various economic resources, shared skills, knowledge, and capabilities to anticipate and react to change, and community members who can dynamically participate in community planning (Vodden &

Cunsolo, 2021). From the perspective of Canadian rural resilience, Caldwell (2015) stated eight key factors: i) redundancy, ii) diversification, iii) efficiency, iv) autonomy, v) strength, vi) interdependence, vii) adaptability, and viii) collaboration. These characteristics contribute to taking new and more sustainable paths for rural communities where they can sustainably manage their natural resources while meeting their economic and social needs. After synthesis of all of these features rural resilience refers to the various strengths inherent in rural communities that play a role in sustaining and, in certain instances, rejuvenating these communities. These strengths encompass the stability of the community's ecosystem, its financial and cultural functions within an evolving environment, and the presence of a safeguard or support system that shields the rural structure from uncertainty and potential disruptions (Franklin et al., 2011; Heijman et al., 2019). Thus, in a broad sense, rural resilience has four crucial variables identified through this literature: i) adaptability, ii) diversity, iii) equalization and iv) network and connectivity (Heijman et al., 2019; Sajaet al., 2021; Quaranta & Salvia, 2014). The sections below describe the features of these variables.

1.3.5.1 Adaptability and Adaptive Capacity

Along with coping capacity and transformability, adaptability is a fundamental component of resilience. These terms are defined as:

i) "Coping capacity," referring to the system's ability to recover and regain stability after experiencing disturbances or shocks;

ii) "Adaptability," denoting the system's capacity to adjust and thrive in the face of changing circumstances; and

iii) "Transformability," which signifies the system's potential for transformative change within a supportive and enabling institutional framework (Hidalgo et al., 2021; Li, 2023; Saja, et al., 2021).

Others use the term “adaptive capacity” to encapsulate coping capacity and adaptability. Adaptive capacity is a key feature of resilience that indicates agency, the capacity of an individual (or community or organization) to act independently and make decisions autonomously that allow for anticipation and response to threats and opportunities (Brown & Westaway, 2011; Magis, 2010). Resilience can be enhanced via economic development and increased social and political agency (Vallury, et al. 2022). In this context, capacity denotes the characteristics inherent in a system, individual, or group that impact their capability to integrate, perceive, and effectively respond to various challenges and needs (Hegney et al., 2008). In addition, capacity entails the practical application and utilization of knowledge, expertise, and other resources that play a crucial role in driving a system's transformation (Bahadur et al., 2016). Through active utilization, these capacities are transformed into adaptive capacity, which, in turn, enables the system to mitigate the impacts of new stressors, risks, or uncertainties (May, 2019). Again, adaptive capacity is intricately linked to agency and pertains to the capability of individuals, systems, or communities to act autonomously and exercise their freedom of choice (Vallury, et al. 2022). Therefore, adaptability is the capacity or agency of an individual, system, or group to adjust or transfer its features or actions/activities to adapt better to existing or anticipated stress – or even opportunities (Heijman et al., 2019). Adaptability represents a responsive strategy, encompassing both bounce-back and bounce-forward approaches, driven by proactive and autonomous actions of communities (Bahadur et al., 2016; Skerratt, 2013; Vallury, et al. 2022)

Adaptive capacity has four crucial elements (which overlap with and complement other key features of resilience described below): i) multidimensionality, including cultural, financial, and biological aspects, ii) social learning, with a focus on the societal structure and its patterns of change, iii) experimentation and innovation, and iv) collaboration for appropriate solutions (Chapin et al., 2009). This adaptability depends on tangible or physical resources like available technology, funds, renewable energy, and other less tangible features such as knowledge and skill, learning, and habits (Roberts & Townsend, 2016). In addition, adaptive capacity depends on place attachments, kinship, and power structures, including political support, institutional arrangements and social networks (Smit & Wandel, 2006). Thus, in context of rural resilience, adaptability is the ability to learn to survive in a challenging and uncertain environment where the rural system is exposed to various unforeseen circumstances on an ongoing basis; however, the individual, community, or system can learn from such crises. As a result, a resilient rural system fosters diversity for reconstruction and renewal by combining diverse knowledge and creating opportunities for self-organization (Brown & Westaway, 2011).

1.3.5.2 Diversity

Diversity, linked to the concept of multidimensionality described above, is one of the most significant components of rural resilience, as a greater diversity or richness of multiple options in a system promotes a higher level of resilience (Heijman et al., 2019). Diversity means the mixture of diverse elements and relationship which shape the socio-ecological structure, allowing individuals, ecosystems or communities to adapt, adjust, or control the impacts of stress, disturbances, or constant transformation (Sietz & Feola, 2016). More diversity creates more variation, leading to redundancy or availability of a wider range of options as a coping mechanism for dealing with ongoing change and uncertainty (Missimer, 2013). Consequently, diversity is not only protection from unexpected situations and stressors but also, after a disturbance or catastrophe, it facilitates rebuilding, innovation and the ability to deal with resulting changes (Ayers et al., 2014). It also provides a framework for creativity and fosters learning at the system, organization, and individual levels. For instance, a diversified energy mix, including renewable sources like solar, wind, and hydropower, contributes to energy resilience. If one energy source faces disruptions or price fluctuations, others can compensate, ensuring a stable and reliable energy supply (see details in 2nd chapter).

Regarding rural resilience, diversity refers to the possibilities of a broad range of resources, organizations, or institutions within rural systems that provide a diverse range of response choices, such as numerous options for livelihoods, landscape utilization, or adaptive infrastructure options (Quaranta & Salvia, 2014). These diversities can assist in minimizing the exposure and sensitivity of a community to outside stressors (Sánchez-Zamora & Gallardo-Cobos, 2019). Diversity in the context of climate change, for example, may entail access to various knowledge sources and perspectives that enable multiple creative solutions to mitigate climate impacts (Reidsma & Ewert, 2008). A diverse community has differences based on variations of age, culture (including language), norms and values, and socio-demographic features; however, these differences bring diverse prospects, skills and knowledge, networks and connections, strengths and durability for the local community and its organization (Schippers et al., 2015). Different studies show that rural diversity—including crop varieties, livelihood opportunities, social networks, and stakeholder perceptions—helps rural people act and respond in multiple ways against challenges such as rural poverty, including energy poverty, climate change, and youth outmigration (Hegney et al., 2008; Ospina & Heeks, 2010; Sietz & Feola, 2016).

1.3.5.3 Equalization

Equalization means equal access and allocation of the community's benefits, rewards, and expenses among all the members of society (Qian, 2017). Equalization focuses on four key issues: i) equal sharing of resources, ii) inclusiveness and involvement, and iii) openness, transparency and accountability; iv) and emphasis on the different ethnic and religious minorities, marginalized and non-mainstream groups (Ospina & Heeks, 2010). In terms of resilience, equalization refers to the degree to which a system provides equal access to resources, and opportunities to its members (Adam-Hernández & Harteisen, 2020). Equalization is crucial for resilience as any unequal system—for example, a system with unequal access to benefits and uneven opportunities for involvement in decision-making—is less resilient and less able to adapt to change (Islam, 2016). In the context of rural change, equality may entail: various community-based initiatives; facilitation to enhance the knowledge, skill, and capabilities of the rural community based on collective needs and aspirations; the inclusion of different genders and ages to ensure participatory and meaningful engagement; and the acknowledgement of conventional or Indigenous knowledge and technologies for the creation of a regional adaption plan (Heijman et al., 2019). Equalization from a rural energy perspective significantly contributes to absorption and recovery from shocks (Berka & Creamer, 2018; Fuller & Bulkeley, 2013). Firstly, energy planning and implementation need to be completed in a non-discriminatory way where all rural residents are able to utilize energy resources to prepare for, adapt to, and recover from energy disruptions (Goedkoop &

Devine-Wright, 2016). Secondly, justice requires attending to the vulnerabilities in energy generation, supply, and transmission, which ensures that different marginalized and lower income groups can bear the impacts of these vulnerabilities (Miller et al., 2019).

1.3.5.4 Networks and Connectivity

Networks and connectivity, the cornerstone of resilience (Timpane-Padgham et al., 2017), are key features of socio-ecological relationships and interactions (Sietz & Feola, 2016). A network is a means of coordination where different actors connect with each other through the flow of resources, including both natural and other resources, such as information and knowledge (Bruce et al., 2021). A strong connection assists a system or individual in adapting during hardship, and supportive and caring individuals enhance the network (Roberts & Townsend, 2016). Thus, a network is a form of social capital (Cassidy & Barnes, 2012). Networks and connectivity create different ties, including bonding, bridging, and linking ties (Parag et al., 2013). Bonding ties consist of trust, cooperation, and mutual exchange among the members of a particular community. These ties facilitate resource sharing, such as information and knowledge exchange among group members. During disasters, for example, survivors may collaborate closely with one another to help each other cope with, adjust to, or recover from the stress or disturbance (Martiskainen, 2016). Bridging ties refers to bonds created between different social groups, such as ethnic, geographical, age, or language groups, that may have shared interests but not share a sense of common identity (Pelling and High, 2005). Connections between these groups can facilitate the introduction of new innovations, ideas or sharing of resources in new ways. Linking ties, on the other hand, entail the connections and interactions that exist among individuals and groups belonging to diverse social strata within a hierarchical framework, where various groups have differing access to power, social status, and resources (Smith & Frankenberger, 2018). These various types networks, ties, and connectivity promote rural resilience in several ways, including i) cooperation through collective initiatives, ii) increasing collaborative effort, iii) sharing and distributing various types of capital and resources, iv) social learning and exchange of knowledge, and vi) access to and utilization of social influence (Bruce et al., 2021).

Moreover, in a group network system, the group's role is to help individuals "bounce forward or bounce back" while the individual can help enhance the group's adaptability and suggest further support for group members (Hegney et al., 2008 p. 10). In addition, networks like families and community organizations create a sense of belonging among community members. This belonging can create strong communal bonds within the group, develop a unique identity for them, or help build connections with other external organizations that can help the region by providing more social, economic, and political resources. Thereby, connectivity and networking strengthen the system's ability to buffer, cope with, and even shape change through the availability of various necessary resources to adjust to different external and internal disturbances and stresses—increasing the ability of individuals to organize social innovation and collective action (More & Westley, 2011; Newman & Dale, 2005; Rockenbauch & Sakdapolrak, 2017).

1.3.6 CRE and Rural Resilience

CRE projects primarily focus on decentralized and democratic energy governance through active and fair local involvement, including involvement in the management, ownership, and control of local/regional renewable energy projects. They create alternative, equitable energy access based on democratic principles and seek to replace the centralized and corporate energy establishment with decentralized authority (Burke & Stephens, 2018). A decentralized energy authority is intended to achieve greater self-reliance through local accountability, roles, and responsibilities. Renewable energy cooperatives, a common type of CRE initiative, for example, provide different energy services, including power production and consumption for their own purposes, energy production for trading on the national grid, proprietorship or serving energy storage facilities in micro-grids and other energy distribution infrastructure, energy efficiency and other relevant services, and measuring and controlling the local energy demand (Bauwens et al., 2016). CRE projects also tend to place greater emphasis on planning development initiatives to minimize negative socio-economic and environmental impacts of energy generation and use (CSI, 2010; Tokar, 2015;).

Community benefits are important to CRE projects, including strengthening multiple aspects of community resilience (DECC, 2014). Diversity can be seen as an inherent strength of CRE, making it adaptable and responsive to local contexts (Becker & Kunze, 2014; Seyfang et al., 2013). CRE projects tend to provide stable, meaningful jobs and keep local money circulating within the community. Due to the collaborative approach and active participation in the decision-making process, CRE projects can also create local acceptance and minimize regional conflicts among community residents and others (Becker et al., 2017; del Rio & Burguillos, 2009; Faulin et al., 2009). Community residents can build social networks and interpersonal relationships through CRE projects that improve trust and cohesion (Greenius et al., 2010). Therefore, social cooperation is observed to be higher among participants in CRE than in traditional renewable energy projects (Toke et al., 2008). Local energy solutions are seen as offering the potential to build relationships among neighbors and for self-reliance among communities, allowing people and communities greater autonomy (Suškevičs et al., 2019).

CRE projects allow community citizens to participate directly in a project's creation, installation, operation, and financial aspects (Cowell et al., 2010; Rogers et al., 2012; Seyfang, 2013), allowing for more engaged and empowered citizens able to see beyond financial gains to realize the prospects of community vibrancy and long-term viability. A CRE model can be considered a tool for increasing public engagement, particularly among disenfranchised and non-mainstream groups in rural areas. Typically, CRE cooperatives have a unique form of economic and legal ownership that contributes to a more democratic energy system, through for example, 'one member-one vote' and the goal to maximize regional benefits rather than the return on capital (Schoor & Scholtens, 2019). Renewable energy projects can also provide a range of educational opportunities for people and accelerate their efforts to create a sustainable, low-carbon future (Lovekin & Kilpatrick, 2010). Small-scale localized renewable energy governance, with a higher degree of community ownership and involvement, has promoted rural diversity and adaptability, enriched networks and connectivity, and enhanced equal access to capital, social inclusion, and transparency, therefore enhancing rural resilience (Martiskainen, 2016). See Chapter 2 for further findings related to CRE and rural resilience.

1.3.7 Factors that Enable or Disable CRE

CRE is local or regional-based (decentralized) renewable energy production (decarbonized), governed and owned by the local community (democratic). Various contextual factors have a significant role in the deployment of CRE. Motivation also shapes project outcomes.

In addition, different project-oriented issues, including leadership, funding, investment and ownership, are key determinant factors for CRE (Hicks & Ison, 2018). Each of these is described briefly below, with the findings of this study related to these factors presented in Chapter 3.

1.3.7.1 Contextual Factors

Contextual factors refer to the context or place-oriented issues which promote (or inhibit) the birth and growth of different forms of CRE (Perlaviciute & Steg, 2014; Verde & Rossetto, 2020). These factors describe how different conditions influence the growth and maturity of CREs in specific contexts and why certain CRE initiatives have been effective in achieving intended community results while others have not (Dall-Orsoletta et al., 2022; Hicks & Ison, 2018). Existing literature has identified technical, physical/environmental, economic/financial, policy and institutional, and socio-cultural factors that can influence CRE outcomes (Ruggiero et al., 2019). Different technical, technology, and scale opportunities for CRE are available to different communities based on their resource availability—for example, solar, wind, hydro, or bioenergy resources in the vicinity (Hicks & Ison, 2018). Physical/environmental factors, thereby, are fundamental to the viability of a particular CRE project (Magnani et al., 2017; Kerr et al., 2017). While navigating these physical factors requires technical skills, the options are relatively clear. Technology factors are perhaps the most universal as technology maturity, modularity, and cost are largely consistent across countries and communities (Becker et al., 2017; Rogers et al., 2012; Seyfang, 2013).

Economic factors, such as cost and available financing options, affect which technology a community pursues. Many early CRE projects favoured wind technology, which is the cheapest per-kWh RE option (Alamaniotis et al., 2016). As the cost comes down, many of the newer case studies are utilizing solar PV, which has the benefit of being a more modular technology applicable in a greater range of physical contexts (Park, 2012). Other economic issues such as local jobs and contracts, local revenue, cheaper energy alternatives, and the potential for energy savings, regional development, and income diversification are also important motivation factors for the deployment of CRE (Gancheva et al., 2018; Hall et al.,2018; Haggett & Aitken, 2015; Khan & Khan, 2019).

The viability of a CRE project is also influenced by a range of institutional factors, such as policy support available and regulatory barriers or opportunities (IRENA, 2020; Walker, 2008). Other institutional factors, including political mobilization, the structure of the energy market, and laws and governing legal structures, are also important factors for CRE (REN21, 2017; Plum, 2020). For instance, a monopolized energy market system is centralized and dominated by only a few energy actors who govern and control energy production, supply, and distribution. Consequently, this energy structure is considered a key hindrance for deploying CRE (Plum, 2020). Similarly, policy schemes, including legislation and regulatory frameworks, have been contributing to mobilizing as well as creating barriers to the growth of these initiatives, notably when policymakers or regulatory agencies have failed to adapt laws and regulations in accordance with new energy market situations (REN21, 2017).

Literature also shows that various social and cultural factors such as community building/volunteering, empowerment and skills development, community assets, local history and culture, relationships or social capital, and social perceptions of, and appetite for, certain technologies can also contribute or be a barrier to CRE (Fernandez, 2021; Hicks & Ison, 2018; Simcock et al., 2016). These enabling or disabling factors are context-specific and therefore vary in different places, including between North America and Europe (Hicks & Ison, 2018). Thus, it is important to explore how these factors enable or disable CRE projects in more detail and in specific contexts.

1.3.7.2 Motivational Factors

Motivational factors refer to subjective characteristics, including individuals' values, understanding, and perceptions, that encourage or discourage CRE creation and participation (Ruggiero et al., 2019). As the members of a CRE project come from various perspectives and backgrounds, their motivations for the formation and deployment of CRE can vary based on these various psychological and motivational factors (Hicks & Ison, 2018; Proudlove et al., 2020). There are multiple motivational factors behind CRE in rural areas; however, three that are commonly observed are a desire to conserve the natural environment and reduce climate change impact, economic regeneration, and increasing social cohesion by accepting renewable energy (Bauwens, 2019; Becker & Kunze, 2014; Hicks & Ison, 2018; Seyfang et al., 2013; Verde & Rossetto, 2020)).

Motivation for economic regeneration is the most cited psychological factor in literature for forming and developing CRE (Verde & Rossetto, 2020). These factors mostly relate to the features of CRE projects. CRE projects can provide stable, meaningful jobs and keep local money circulating within the community. They can foster a diversified economy, entrepreneurism, and local innovation and are welcome sources of additional income in rural areas that may otherwise rely heavily on a single sector (Walker, 2008; Seyfang et al., 2013). Thus, rural community members typically agree to participate in and contribute to the CRE project (Bauwens, 2016).

Concerns about protecting the environment—from regional pollution and its effects on health to global warming—are also significant drivers for CRE initiatives (Susser & Kannen, 2017). Global climate change became a prominent psychological factor in the deployment of CRE both in Europe and North America (Bauwens, 2016; Verde & Rossetto, 2020). Similarly, Becker and Kunze (2014) and Van der Schoor et al. (2016) highlight the desire to influence environmental and energy policies as an important motivating factor for CRE.

Much of the literature on CRE shows that the lack of community participation and community interest is a key hindrance to renewable energy initiatives (Brisbois, 2019; Furlong, 2020; Goedkoop & Devine-Wright, 2016; Hicks & Ison, 2011; Roberts et al., 2014; REN21, 2017; Slee, 2015). Effective CRE has been shown to increase social acceptance among rural community members through ownership and decision-making processes and to motivate community members to engage with renewable energy (Furlong, 2020; Hicks & Ison, 2011; Roberts et al., 2014).

1.3.7.3 Project-related Factors

Organizational features of renewable energy, referred to as project factors, also have a significant role in the likelihood of success for CRE in rural areas (Devine-Wright, 2013; Warbroek et al., 2019). According to the literature the most commonly observed project-related factors are the structure of ownership and social entrepreneurship (Süsser et al., 2017), the nature of engagement and networking in energy projects, and leadership patterns (Hentschel et al., 2019; Miller et al., 2016; Munro et al., 2018). Social entrepreneurship is an innovative process that adds value to society and pursues increasing individual wealth while addressing social needs and proposing the resolution of particular social problems (Rey-Martí et al., 2016). Social entrepreneurship assists in forming collectively owned and managed organizations, builds trust, and provides relevant support for local community groups. It focuses more on value creation for society than value appropriation for shareholders and management (Crowdhury & Santos, 2010). A focus on self-governance, collectively shared benefits and participation opportunities accelerates the formation of CRE projects such as the formation of renewable energy cooperatives (Caramizaru & Uihlein, 2020; Süsser et al., 2017).

Engagement and networking include social networking activities developing collective goals and visions, and regular efforts and procedures that promote knowledge development, facilitate awareness, foster interpersonal learning and lobby for the CRE project (Gupta et al., 2014; Munro et al., 2018; Rahmani et al., 2020). Leadership patterns, including informal, formal, or quasi-formal leadership, also assist in forming and deploying CRE in rural regions (Martiskainen, 2016). The role of a leader in a CRE project is to inspire others to participate; establish a social, economic, or environmental vision for the group and foster collaboration and agreement (Ruggiero et al., 2014; Rahmani et al., 2020; Seyfang et al., 2014). Project leaders support CRE projects by providing the resources needed to succeed and assisting in overcoming difficulties and challenges (Hargreaves et al., 2013).

1.4 Conceptual Framework and Methods

This study in focused on two key concepts and the relationship between them: Community Renewable Energy (CRE) and Rural Resilience. A conceptual framework was developed related to these two core concepts, along with search methods for the extraction of relevant literature. The main method of this study is a systematic literature review (SLR) following the process used by Łukasiewicz (2022) and Mohammadinia et al. (2018), which maintains six steps in its research protocol: i) setting out a research question; ii) creating a plan; iii) searching for required literature; iv) fixing various exclusion and inclusion principles; iv) performing both quantitative and qualitative methods of analysis; and vi) describing the results. After selecting all relevant literature, the resulting studies were reviewed and analyzed based on qualitative (thematic) and quantitative (percentages) analysis (see the section 1.4.2).

1.4.1 Conceptual Framework

Based on the key elements of CRE and rural resilience described above, this study adopts the following framework to guide the conceptualization of this study and subsequent analysis (see Figure 1.1). In this study, CRE refers to energy systems that are: decarbonized, decentralized, and democratic (See section 1.3.3). Rural resilience refers to rural regions and communities with four key characteristics: diversity, networks and connectivity, equalization, and adaptive capacity (as defined and discussed in 1.3.5).

The literature reviewed above further suggests that the ability of CRE to contribute to rural resilience depends on three categories of enabling or disabling factors:

1. Contextual factors: socio-cultural, political, policy and institutional, physical and technical, ecological and environmental, and economic and financial factors;
2. Motivational factors: economic regeneration, acceptance of renewable energy, and environmental concern; and
3. Project-oriented factors: engagement and networking, project leadership, and project ownership structure.

As a result, the research framework also includes these determinant factors and allows for examining their role in the relationships between CRE and rural resilience (as shown in Figure 1).

Conceptual Framework

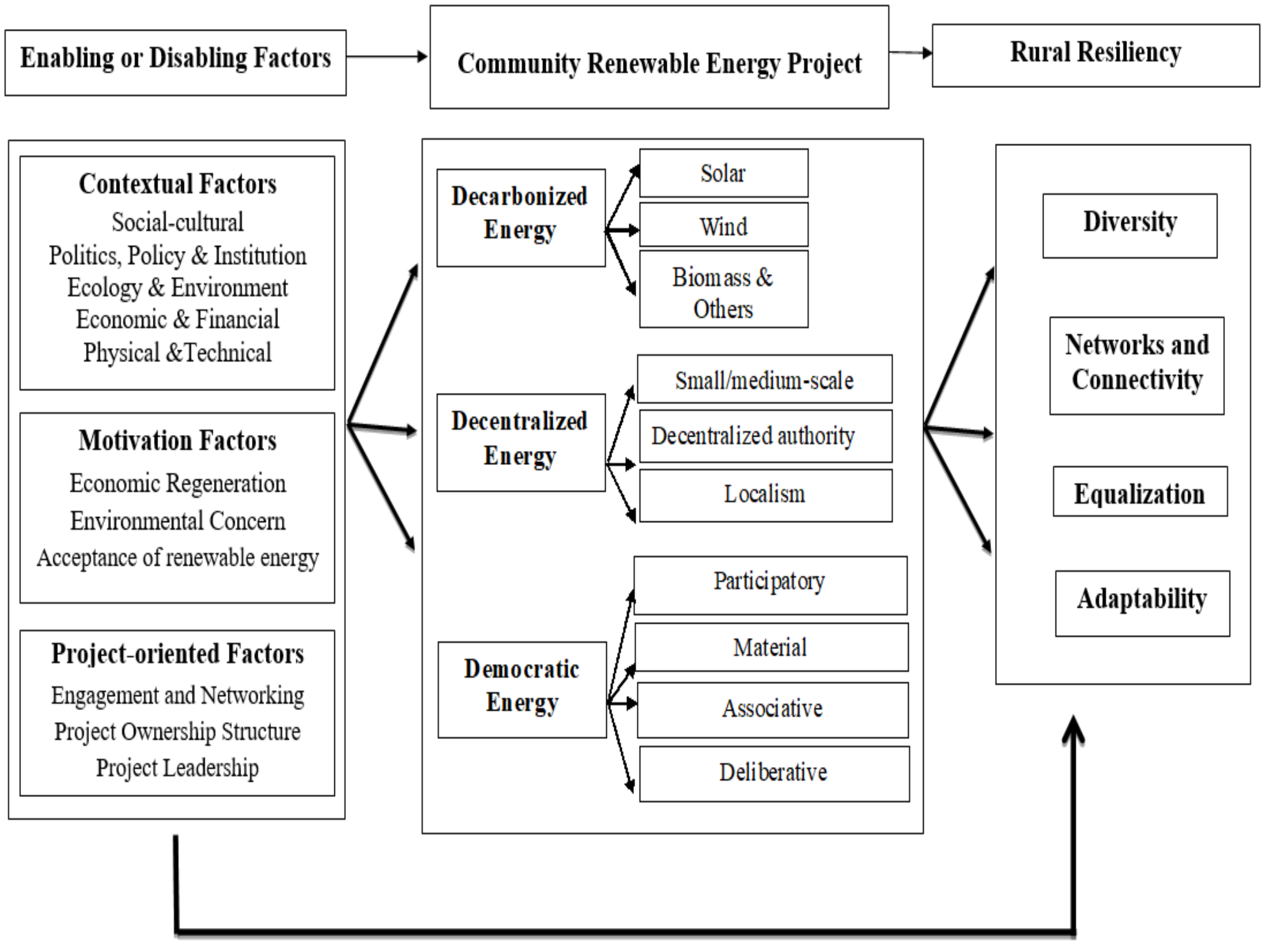

Figure 1:Conceptual Framework of the Present Study (Source: Author)

1.4.2 Materials and Methods

1.4.2.1 Systematic Literature Review (SLR)

A significant body of literature exists concerning CRE; however, the studies to date have yet to synthesize the role of CRE in rural resilience and focus exclusively on comparing the diverse factors that enable or hinder the deployment of CRE within North America (Canada and USA) and Western Europe. Thus, the study applied a systematic literature review (SLR) as a method for retrieving and analyzing required documents, including journal articles, books, theses, conference and working papers, reports, and other documents, following examples such as Gregorio et al. (2018), Malinen (2015), Shamseer et al. (2015), Vij et al. (2018) and Yang et al. (2017). SLR is fruitful for identifying and analyzing secondary data because it follows an organized procedure and maintains a rigorous standard to summarize existing research on a particular topic along with the element of analytical criticism (Okoli & Schabram, 2010).

In particular, this study adopted PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses criteria), a common method of SLR in the field of environmental and health research (Shaffril et al., 2018) that offers three unique advantages: specifying research questions that assist with systematic research, classifying both inclusion and exclusion criteria for selecting research documents, and finally allowing the examination of large databases of scientific literature for a certain period (Sierra-Correa & Kintz, 2015). Following the PRISMA method, this study maintains a particular procedure for research protocol, including i) setting out a research question; ii) creating a plan; iii) searching for required literature; iv) fixing various exclusion and inclusion principles; iv) performing both quantitative and qualitative methods of analysis, and vi) describing the results. A four-step process—including identification of data sources, screening, application of eligibility, and inclusion/exclusion criteria was adopted for collecting literature, following the methodology used by Mohammadinia et al. (2018), van der Schoor and Scholtens (2019), and Shaffril et al. (2018).

1.4.2.2 Step 1- Data Sources Identification

Scholarly and Grey Literature Sources

The study performed a literature search for scholarly literature based on three academic databases—Scopus, Science Direct, and Sociological Abstract—in the date range of 1997 to 2023. This period was chosen because it has been observed as a period when citizen involvement in the energy sector accelerated due to the liberalization of power sectors (Walker & Cass, 2007), with 1997 being the year when different new energy policies started to emerge based on the Kyoto Protocol for reducing greenhouse gas emissions (Bagozzi, 2015). The Scopus database, a comprehensive academic source of 2,800 journals from 5,000 scientific publishers covering an extensive amount of multidisciplinary research (Shaffril et al.,2018), was chosen to maintain and ensure the quality of the literature review. Scopus also offers around 20% more citation coverage and includes various tools allowing researchers to visualize, analyze, and compare the published scientific information to develop a descriptive analysis (Gregorio et al., 2018). However, Scopus has limitations in its publishing coverage of research documents in social sciences and covers relatively fewer journals in arts and humanities and social sciences than other databases (Mongeon & Paul-Hus, 2016). Therefore, Science Direct and Sociological Abstract were also chosen as they provide a wide-ranging view of global scientific production and cover a few important journals in energy, policy, environment, rural development, and management (Malinen, 2015).

To increase the depth of the study and ensure the diversity of data and information, the study also used various grey literature data sources, including ProQuest (theses and dissertations) (Vaska et al., 2019), Google Scholar (Paez,2018), and web search (Kazi, et al., 2022) on different prominent energy organizations, namely REN21, International Renewable Energy Agency (IRENA), World Wind Energy Association (WWEA), and Renewable Energy and Energy Efficiency Partnership (REEEP). Google Scholar has greater coverage and includes all product types—e.g., PDF files, Word docs, theses, dissertations, and technical reports—in contrast to the three databases (Serenko & Bontis, 2013). Similarly, ProQuest (theses and dissertations) is also an important database (Vaska et al., 2019). For the grey literature, given the extent of available possible sources and limitations in the scope of this study, the first ten pages of search results were chosen for selecting relevant articles or documents. Typically, these pages contained the most relevant search results (Raven et al., 2016).

Key terms identification

Key terms identification is an important step for data identification. To acquire the appropriate literature, different key terms were selected based on the principal themes and subthemes of the study. "Renewable Energy," "Community Energy," and "Resilience," for example, were three key initial terms derived from the principal themes of the study: i) the Role of Community Renewable Energy (CRE) in Rural Resilience and ii) Contributing Factors for Community Renewable Energy. These two main themes were divided into three themes and ten subthemes, including:

- Theme 1 - Community Renewable Energy (CRE), divided into three subthemes: “Decentralized Energy,” “Decarbonized Energy,” and “Democratized Energy;”
- Theme 2 - Resilience Outcomes, divided into four subthemes: “Diversity,” “Networks and Connectivity;”, “Equalization,” and “Adaptability,” and
- Theme 3 - Determinant Factors for CRE, divided into three subthemes: contextual, motivational, and project-related factors.

Finally, within these twelve subthemes, ninety terms or keywords were identified for data screening (Table 1).

Table 1: Different Themes, Subthemes and Codes/Keywords

Main Theme	Theme	Subtheme	Codes/Keywords
Community Renewable Energy and Rural Resilience	Community Renewable Energy	Decentralized Energy	Local energy initiatives, Grass roots energy innovation, Place-based energy initiatives, Decentralized authority, Small/medium scale energy.
		Decarbonized Energy	Wind, Solar, Geothermal, Bioenergy
		Democratized Energy	Participation in RE decision making process, Self-governance and energy autonomy, Active engagement in RE system.
		Adaptability/Adaptive Capacity	Sustainable attitudes, Increasing volunteering and strengthening community groups, Transition to renewable energy, Educational means, Awareness of climate change/carbon reduction/ energy savings, Training and development, Capacity building.

	Rural Resilience	Equalization	Ensuring access to local resources or energy, Empowerment of disadvantaged social group/community, Local shares in energy infrastructure, Approaches to collective/ municipal ownership of energy grids and power plants, Social Entrepreneurship, Reduction in community opposition/ increasing local support for RE.
		Network and Connectivity	Information exchange, External and internal networking, Trust and social acceptance
		Diversity	Local employment, Revenue and tax earning, Local reinvestment, Revenues for local business, Investments in community, Grassroot innovation, Energy flexibility, Grid resilience, Easy energy access, Energy/ resources self-sufficient/ autonomy/availability.
Contributing Factors in Community Renewable Energy		Socio-cultural Factors	Organization and Behavioral issue, Civic Movement and Engagement, Social Capital, Tradition of social enterprise and cooperative culture, Community skill, knowledge and acceptance, Community identity and autonomy. Structure of the energy market, Regulatory Framework, Tariff and other

	Contextual Factors	Political, Policy and Institutional Issues	financial support for regional energy production, Political wills, Intermediaries organization.
		Physical & Technical Factors	Availability of natural resources/spaces, Energy storage, Grid connection for RE, Required knowledge and skill for RE technology, Smart technologies.
		Ecological & Environmental Factors	Conserving biodiversity, Reducing carbon emissions, Climate change adaptation, Energy sustainability, Environmental consciousness, Ecosystem nexuses with RE.
		Economic & Financial Factors	Access to financial services, Access to the capital, Project Fundings, Grant and Subsidies for RE, Investment cost, Income from RE project.
	Motivational Factors	Pursuit of Economic Regeneration	Green investment, Revenue earning, Save energy bills, Opportunities for benefit sharing and participation in energy decision-making, Development of new business, Eradication of fuel poverty, Cutting down community expenditures.
		Environmental Concern	Protecting the environment, Reducing regional pollution, Global warming,

			Promoting local environmental projects, Support for environmental conservation, Green and sustainable lifestyle.
		Acceptance of CRE	Community participation, Ownerships, Trusted network, Reducing injustice, Cost and benefits sharing.
	Project-related Factors	Engagement and Networking	Social capital, Culture of collective action, Trusted social networks, Institutional networks and collaboration.
		Project Leadership	Knowledge, Networking and Individual virtue, Local project champions, Influential local people, Personal capacity for energy project.
		Project Ownership Structure	Ownership opportunity, Cost and benefit-sharing opportunities, Opportunities for reinvestment Cooperative ownership.

1.4.2.3 Step Two- Data Screening and Extraction

Literature Search through Various Search Engines

Due to the lack of common agreement on the meaning and characteristics of CRE in the literature (Fernandez, 2021; Soeiro & Dias, 2020), the study commenced its literature search from four databases by selecting two broad primary search terms, namely "renewable" and "community energy," and initially yielded a substantial number of publications (1604) (as described in Table 2). However, recognizing the diversity in terminologies used to describe community energy initiatives, the search was expanded to include three key supplementary terms associated with Community Renewable Energy (as outlined above): "decarbonized energy," "decentralized energy," and "democratized energy." This approach led to a more refined set of 745 publications. From these 745 studies, several commonly used keywords were identified, including "local energy initiatives," "sustainable energy," "grassroots energy innovation," "energy autonomy," "place-based energy initiatives," "low-carbon energy," as well as terms such as "solar," "wind," "geothermal," "bioenergy," "participation in RE decision-making process," "self-governance," and "active engagement in RE system". These newly identified keywords were subsequently employed as additional search terms to facilitate a more comprehensive investigation. This resulted in the identification of an additional 585 studies.

Likewise, for the second theme of "Resilience Outcomes," the study initially conducted a term search using the key phrase "Rural Resilience in Community Renewable Energy," which yielded 415 publications. Additionally, by incorporating four other key terms, namely "Diversity," "Networks and Connectivity," "Equalization," and "Adaptability," the study identified an additional 661 relevant studies. To ensure a comprehensive and thorough literature review, the research further employed a diverse range of search terms (table 2). This extensive search led to the find another 1245 publications.

In a similar manner, this study employed three distinct search terms: “Contextual Factors of CRE”, “Motivational Factors of CRE” and “Project-related factors of CRE” to gather relevant literature pertaining to the factors influencing CRE (3^{rd} key theme). After using these search terms, initially, the study yielded 201 publications, which represents a relatively smaller number compared to the other two themes. To enhance the search coverage, the study expanded the search criteria by incorporating eleven new terms, including "Socio-cultural factors," "Political, Policy, and Institutional issues," "Physical and Technical factors," "Ecological and Environmental factors," "Economic and Financial factors," "Pursuit of Economic Regeneration," "Environmental Concern," "Acceptance of CRE," "Engagement and Networking," "Project Leadership," and "Project Ownership Structure." This led to the extraction of an additional 702 studies. However, to ensure a comprehensive and relevant collection of literature concerning the contributing factors of CRE, the study conducted further searches with a focus on other terms (see Table 2), resulting in an additional 1457 documents for further analysis. list of specific search terms for retrieving literature through various search engines

Table 2: List of Specific Search Terms for Retrieving Literature through Different Search Engines

Terms Searched for - Community Renewable Energy	Searched Engines	Results
1. Renewable and Community Energy	Scopus, Science Direct, ProQuest and Sociological Abstract	1604
2. Decarbonized energy OR Decentralized energy OR Democratized energy		745
3. Local energy initiatives OR grassroots energy innovation OR energy autonomy OR place-based energy initiatives OR low carbon energy OR solar/wind/geothermal/bioenergy OR Participation in RE decision-making process OR Self-governance OR Energy		585

autonomy OR Active engagement in RE system		
Terms Searched for - Rural Resilience		
1. Rural Resilience in Community Renewable Energy	Scopus, Science Direct, ProQuest and Sociological Abstract	415
2. Diversity OR Networks and Connectivity OR Equalization OR Adaptability in RE		561
3. Sustainable attitudes OR Increasing volunteering and strengthening community groups OR Transaction to renewable energy OR Educational means OR Awareness to climate change/ carbon reduction/ energy savings OR Training and development, Capacity building OR Ensuring access to local resources or energy OR Empowerment of disadvantaged social group/community OR Local shares in energy infrastructure OR Approaches to collective/ municipal ownership of energy grids and power plants OR Social Entrepreneurship OR Reduction in community opposition/ increase local support for RE OR Information exchange OR External and internal networking OR Trust and social acceptance OR Local employment OR Revenue and tax earning OR Local		1245

reinvestment OR Revenues for local business OR Investments in community OR Grassroot innovation OR Energy flexibility OR Grid resilience OR Easy energy access OR Energy/ resources self-sufficient/ autonomy/availability.		
Terms Searched for - Factors affecting Community Renewable Energy		
4. Contextual Factors of CRE OR Motivational Factors of CRE OR Project-related factors or CRE		201
5. Socio-cultural OR Political, Policy and Institutional OR Physical and Technical OR Ecological and Environmental OR Economic and Financial Factors OR Pursuit of Economic Regeneration OR Environmental Concern OR Acceptance of CRE OR Engagement and Networking OR Project Leadership OR Project Ownership Structure		702
6. Organization and Behavioral issue OR Civic Movement and Engagement OR Social Capital OR Tradition of social enterprise and cooperative culture OR Community skill OR knowledge and acceptance OR Community identity and autonomy OR Structure of the energy market OR Regulatory Framework OR Tariff and other financial support for regional energy production OR Political wills OR Intermediaries organization OR Availability	Scopus, Science Direct, ProQuest and Sociological Abstract	

of natural resources/spaces OR Energy storage, Grid connection for RE OR Required knowledge and skill for RE technology OR Smart technologies OR Conserving biodiversity OR Reducing carbon emissions OR Climate change adaptation OR Energy sustainability OR Environmental consciousness OR Ecosystem nexuses with RE OR Access to financial services OR Access to the capital OR Project Fundings, grant and subsidies for RE OR Investment cost OR Income from RE project OR Green investment OR Revenue earning OR Save energy bills OR Opportunities for benefit sharing and participation in energy decision-making OR Development of new business OR Eradication of fuel poverty OR Cutting down community expenditures OR Protecting the environment OR Reducing regional pollution OR Global warming OR Promoting local environmental projects OR Support for environmental conservation OR Green and sustainable lifestyle OR Community participation OR Ownerships OR Trusted network OR Reducing injustice OR Cost and benefits sharing OR Social capital OR Culture of collective action OR Trusted social networks OR Institutional networks and collaboration OR Knowledge, networking and individual virtue OR Local project champions OR Influential local people OR Personal		1457

capacity for energy project OR Ownership opportunity OR Cost and benefit-sharing opportunities OR Opportunities for reinvestment OR Cooperative ownership.		
Total Studies		**7515**

Again, through Google Scholar and other web searches, the study acquired an additional 382 publications by using different key terms. Finally, through this rigorous data extraction process, this research yielded a total of 7897 studies from both scholarly and gray literature sources.

Exclusion Criteria for Screening

The data screening for inclusion started with examining titles, abstracts, and texts of 7897 publications based on specific inclusion and exclusion criteria. The inclusion criteria included any studies of community renewable energy, which focused on topics related to the study questions, "How does CRE contribute to rural resilience?" and "What conditions have led to these contributions?". The study followed two categories of exclusion criteria: i) Document Properties Exclusion Criteria, including full text being unavailable, publication date before 1997, and language other than English; ii) Content Exclusion Criteria, including studies about Non-European and Non-North American Countries, studies on topics that were only partially related (e.g. urban renewable energy projects, energy niche, global renewable energy deployment, hybrid energy projects), and studies on totally irrelevant topics (e.g. fossil fuel energy, engineering and physical science).

To expand on the above criteria, regarding literature types, the study selected articles, books, conference proceedings, and book chapters, but editorials, letters, and meeting reports were excluded as these are less comprehensive compared to scholarly publications (Mongeon & Paul-Hus, 2016). The study excluded non-English literature to avoid confusion and complication in translation, which meant only publications written in English were selected for review. The year of the Kyoto Protocol, an international agreement for reducing carbon emissions, was selected as the baseline year; consequently, literature published before 1997 was excluded. As the review process focused on community initiative and involvement in renewable energy, only those publications in the fields of environmental science, social science, economics, and management were selected as they were more important and relevant to local / community development. The application of these criteria reduced the number of documents to a total of 945 for review. The study concentrated on community renewable energy in North America and Western Europe; therefore, publications referring to other jurisdictions were discarded. Again, due to total irrelevance or not precisely falling into the study's major theme-CRE, additional publications were deselected after accessing the full text. Through these rigorous processes, the study selected 427 studies for full text review.

1.4.2.4 Steps 3 and 4- Data Eligibility and Inclusion Criteria based on Well-defined Criteria

Further review of these 427 studies resulted in the exclusion of 239 publications as they did not focus on rural/small town renewable energy projects, did not describe some feature of resilience, (i.e., diversity, equalization, adaptive capacity, and networks/connectivity), or did not focus on at least one of determinant factor of CRE. After completing these eligibility and inclusion procedures for retrieving literature, the study finally selected 188 publications for categorization and thematic analysis (Figure 2)

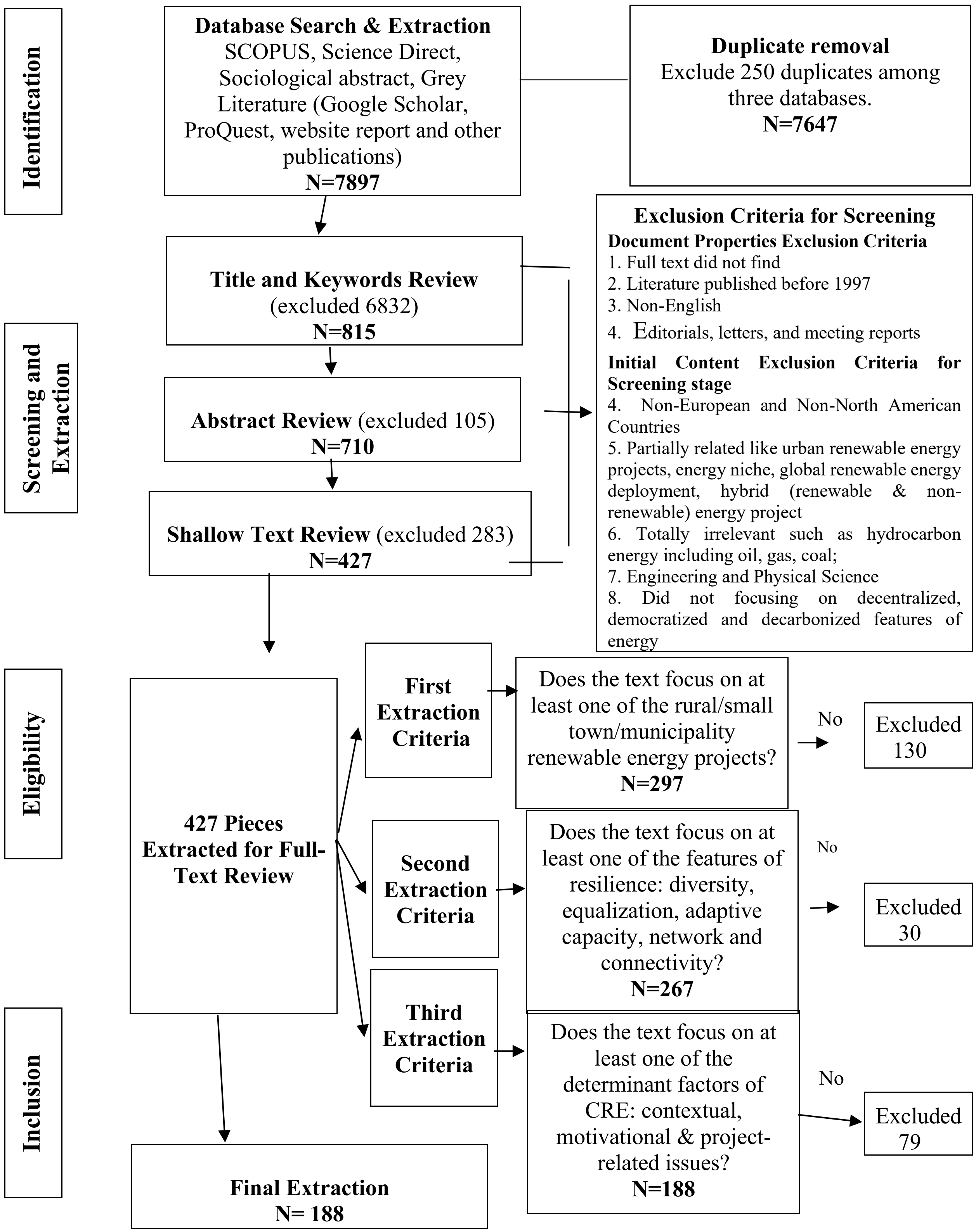

Figure 2: Overall Steps for Conducting the Systematic Review

1.4.2.5 Data Analysis

The study employed a rigorous thematic analysis approach to examine the data extracted from selected publications. All data were manually coded and organized in an MS Excel sheet for graphical representations. Thematic analysis techniques were chosen for data analysis due to their ability to identify, analyze, and report patterns or themes present in the texts (Braun & Clarke, 2006). As Salm et al. (2021) and Thomas and Harden (2008) recommended.

The research utilized three thematic analysis methods, specifically initial, focused, and theoretical coding strategies (Salm et al., 2021; Thomas & Harden, 2008). In the initial coding phase, potential emerging themes from the literature were identified. In contrast, focused coding employed a systematic and inductive approach, categorizing data according to descriptive thematic similarities. Theoretical coding involved integrating these thematic categories into fundamental theoretical constructs, thereby advancing the analysis to a more abstract and conceptual level.

During the initial coding stage, the study remained flexible to accommodate any potential emerging themes found in the extracted research publications. As a result, flexible and elaborative codes were created based on the direct descriptions of the literature, including "Community Renewable Energy (CRE)," "Resilience Outcomes," and "Determinant Factors for CRE." As the review took place, the researcher took notes from each source and coded these notes according to identified themes. For instance, a comprehensive set of notes related to "Resilience Outcomes of CRE" was further coded into four broad categories: "CRE and Rural Diversity," "CRE and Network and Connectivity," "CRE and Rural Equalization," and "CRE and Adaptability."

The researcher then sought to identify general relationship patterns within the openly coded data and between various themes and generated additional coding to describe these relationships. The research questions led to the identification of two key themes: "Community Renewable

Energy (CRE) and Rural Resilience" and "Determinant Factors for CRE." After coding the information related to these two main themes from each publication, additional sub-themes and sub-categories of sub-themes emerged. For example, under the theme of "CRE and Rural Diversity," the study initially generated two sub-themes: "Economic Diversity and Regional Development" and "Energy Diversity and Resilience." However, further coding efforts brought to light other thematic phrases or codes that were subsequently incorporated under five sub-themes, namely "Employment," "Revenues, Rent, and Lease Payments," "Revenues for Local Business," "Investments in the Community," and "Innovation in Traditional Sectors and Sectoral Diversification."

Finally, the study performed theoretical coding to organize and consider the identified themes in relation to the conceptual framework, including the frequency with which various themes arose. For instance, while coding various thematic phrases related to "Economic Diversity and Region Diversity," the study noted that 102 out of 115 studies mentioned different types of economic diversity. Consequently, these findings suggest an important role of CRE in rural diversity, leading to the conclusion that "Economic Diversity" stands as a major diversity outcome of CRE, driven by the utilization of a local labour force (employment), rent and lease payments, revenues for energy supply or local enterprises, various forms of community investment, as well as adaptation and innovation in traditional sectoral diversification.

1.5 Features of Selected Literature

Regarding the literature on CRE and rural resilience in North America (Canada and USA) and Western Europe, this section describes the major types of publications, the number of publications in different years, the distribution of literature across countries, and the key subject matters of the extracted literature.

1.5.1 Publication Types

A total of 188 publications were obtained from the execution stage of the SLR, where 152 of these publications were published by 15 journals and nine of these had published ten or more articles, representing 62% of the total (Table 3). Analyzing the Scimgo Journal Rank (SJR) and Scopus impact evaluation of sources with the most publications, 73% were in the first quartile and 22% in the second quartile, demonstrating the high standard of the publications and the level of interest in the subject. The rest of the 36 publications were book chapters (12 studies), organization reports (20 publications), and working papers (4 papers).

Table 3: Distribution of Publications Based on Scholarly Journals

Journals	Number of Documents	Rankings of Journal (SCOPUS/ Scimgo Rank)
Energy Policy	25	Q1
Energy Research & Social Science	17	Q1
Renewable & Sustainable Energy Review	17	Q3
Renewable Energy	15	Q1
Local Economy	11	Q1
Energy Sustainability and Society	10	Q1
Sustainability10Q2Rural Society	10	Q2
Journal of Rural Studies	10	Q1
Journal of Cleaner Production	7	Q1
Journal of Environmental Management	6	Q1
Applied Energy	4	Q1
Renewable Energy Reports	4	Q2
Society & Natural Resources	3	Q1
Global Environmental Change	3	Q1

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1.5.2 Total Publication by Year

Table 4: Distribution of Published Literature Based on the Year

Types of Energy	1997- 2002	2003-2008	2009-2014	2015-present
Decarbonized Energy	5	33	49	101
Decentralized Energy	2	15	49	80
Democratized Energy	1	10	42	101

Table 4 illustrates the distribution of the literature on CRE and rural resilience in North America and Western Europe regarding three key features (Ds): decarbonized, decentralized and democratized energy and the years studied. Here the number of studies exceeds the total number of extracted studies (188), as studies simultaneously focus on more than one of the features of Decarbonized, Decentralized and Democratized at the same time. It shows that until about 2008, few studies focused on this topic, and most were on decarbonized energy; however, after 2009, the number of studies increased, where large numbers of studies investigated decentralized or distributed renewable energy as well. Similarly, these numbers rose from 2015; however, within this period, studies regarding the democratized features of renewable energy is increased. Due to the Paris Agreement and EU renewable energy directive, the research numbers could be accelerated in the future.

1.5.3 Distribution of CRE–RR Literature across North America (NA) and Western Europe (WE)

Table 5: Distribution of CRE–RR Literature Across NA and WE

Region	Country	Number of Publications
North America	Canada	12
	USA	19
Western Europe	UK	68
	Germany	33
	Denmark	11
	France	14
	Netherland	25
	Italy	7

Table 5 shows the distribution of literature on CRE and rural resilience across countries in North America and Western Europe, where the vast majority of publications (159 out of 188) investigated different topics or used different approaches regarding Western European's CRE. The UK is in the leading position—more than one-third of publications (68 out of 188) focused on the UK's CRE—followed by Germany (33), Netherlands (25), and France (14). A significant number of studies also illustrated CRE in Denmark (11 out of 188 documents) and Italy (7 out of 188 publications). Comparatively, 42 publications out of 188 demonstrated CRE's characteristics in Canada (10) and the USA (19). It reveals a substantial difference in CRE between North America and Western Europe, and in contrast to North America, community initiatives in Western Europe play a major role in the renewable energy sector (Wiseman, 2020).

1.5.4 Subject Matter of Literature on CRE–RR in NA and WE

Table 6: Subject Matter of Literature on CRE–RR in NA and WE

Key Discussed Themes	Numbers of Publications
Definition, objective and motivation of CRE	110
Forms and Features of CRE	90
Functions of CRE	70
Benefits and Values of Energy Communities	150
Determinants factor of CRE	108

Table 6 illustrates five key subject matters of CRE literature based on the systematic literature review. Here, a large number of publications (150) described the various benefits of CRE in Western Europe and North America. These benefits and values of participation in CRE are numerous and heterogeneous. The second largest number of documents (110 publications) illustrated CRE's definition, features and motivation-related issues. Studies show that the definition and features of CRE globally differ based on their scope and nature. Various determinate factors of CRE are the third most discussed subject matters in CRE literature. Research shows that different factors have a significant role on the feature, scope and implementation of CRE. Opportunities for community ownership and control are frequently cited as defining characteristics of community energy. The study found that a significant number of publications (90 research documents) focused on the forms and features of CRE based on the ownership and structures of organizations, including cooperatives, non-profit societies, trusts and municipalities. Finally, a number of publications (70 documents) discussed the functions of CRE, such as different activities regarding energy supply, demand management, distribution and system management, and retailer services by locally rooted actors.

Adaptation and adaptive capacity are essential features of rural resilience. Adaptive capacity is generally broader in scope compared to anticipatory and absorptive capacities, as it encompasses a broader range of adaptive responses to various challenges and changes (Singh & Osbahr, 2016). Hence, the focus of this study was not on providing individual descriptions for anticipatory and absorptive capacity; instead, it aimed to elucidate the contribution of CRE to adaptive capacity in rural settings. Again, anticipatory capacity is not relevant to renewable energy projects (Mercer, 2023). Consequently, this study excluding both anticipatory and absorptive capacity.

Again, energy justice consists of procedural, distributional and recognitional justice. A large number of studies described energy justice based on procedural and distributional justice; however, few studies like Jenkins (2016), Hoicka et al. (2021), and Hanke et al., (2021) mentioned the importance of recognitional justice for energy justice. In contrast to the two other forms of justice, this study identifies a scarcity of data or studies specifically addressing the recognition of energy justice. As a result, the research does not separately elaborate on recognition justice as like procedural and distributional justice. Nevertheless, various issues related to recognition justice have been discussed sporadically within the other two justice sections.

1.6 Outline of Thesis

This thesis follows a manuscript style which is organized into four chapters. The first chapter, "Introduction", provides a general outline of the thesis by describing the research problem and purpose statement, presenting the research questions, defining key terms and concepts related to CRE and rural resilience (including current debate and features of CRE), and drawing an overall definition for CRE. This introduction chapter has also described the methods and methodologies for the thesis, including conceptual frameworks, the adopted systematic literature review approach (i.e. data source identification, scanning, data eligibility and inclusion criteria, data analysis techniques), and characteristics of extracted literature (i.e. publication types, total publication by year, distribution of CRE literature over North America and Western Europe, different subject matters of CRE literature).

The second chapter focuses on Research Question 1: How does CRE contribute to rural resilience in North America and Western Europe? This chapter's first section reviews the study's rationale. The second describes the methodology and methods employed. The results section illustrates the role of CRE in diversity, equalization, adaptability, networks and connectivity, followed by a discussion of these results and a concluding section that describes key findings in response to our overall research question regarding the role of decentralized, democratic renewable energy systems (CRE) in rural resilience. Finally, the chapter identifies some important issues for further research.

The third chapter focuses on the Research Question 2: What factors contribute to community renewable energy in Western Europe and North America? This chapter is organized into four sections, beginning with the importance of the study and an explanation of the methods and methodology of the research. Second, the chapter describes the systematic review results according to three major categories of enabling or disabling factors: contextual, motivational and project-related factors. Third, it compares Western Europe and North America, considering these factors. Finally, the chapter ends with a discussion, conclusion, and set of recommendations for further study.

The last chapter, "Conclusion," provides an overall synthesis of the findings of this research, resulting in recommendations, including policy recommendations (related to Research Question 3), for deploying CRE in Canada.

CHAPTER 2: HOW DOES COMMUNITY RENEWABLE ENERGY CONTRIBUTE TO RURAL RESILIENCE IN WESTERN EUROPE AND NORTH AMERICA?

2.1 Introduction

Rural resilience describes different capabilities possessed by rural communities that contribute to the maintenance and, in some cases, revitalization of these communities, including stability of the communities' ecosystem, financial and cultural function in a changing environment aided by the existence of a shelter or padding of protection for the rural structure in the face of uncertainly and hazardous disturbances (Franklin et al., 2011; Heijman et al., 2019). Diversity, networks and connectivity, equalization, and adaptability are considered crucial issues for rural resilience (Caldwell, 2015; MacKinnon & Driscoll-Derickson, 2013; Roberts & Townsend, 2016). Diversity refers to the variation or mixture of diverse elements and relations that shape the socio-ecological structure of communities, allowing individuals, ecosystems, or communities to adapt, adjust, or control the impacts of stress, disturbances, or constant transformation (Sietz & Feola, 2016). Similarly, networks and connectivity support the system's ability to buffer, cope with, and any change through the availability of various necessary resources to adjust to external and internal disturbances and stresses; these relational resources also increase the ability of individuals to organize social innovation and collective actions (More & Westley, 2011; Newman & Dale, 2005; Rockenbauch & Sakdapolrak, 2017). Equalization within a community includes attempts to ensure equal sharing of resources and capital, as well as inclusiveness, participation, openness, transparency, and accountability within community processes (Ospina & Heeks, 2010). Finally, adaptability refers to the capacity or agency of individuals, groups, or institutions to adjust or transfer their features or actions/activities to better adapt to existing or anticipated stress (Heijman, et al., 2019, Skerratt, 2013).

Rural landscapes and communities contribute to food and energy production, environmental stewardship, and various sociocultural amenities for larger, increasingly urbanized societies (Vodden & Cunsolo, 2021). However, these rural areas, and the often small settlements and towns within them, have faced multiple interacting disruptions due to: climate change, including extreme weather events; the global pandemic; changes in demographic structure, like the ageing population, youth migration, and low birth rates; and various socio-economic reformations, such as the transformation of primary industries, reduction of the manufacturing sector, and international business treaties, that have affected rural resilience both in North America and Western Europe (Augère-Granier & McEldowney, 2021; FCM, 2018). In these circumstances, renewable energy can assist significantly with rural revitalization through energy access and efficiency, economic development, and environmental protection. However, research also reveals that many of the renewable energy projects undertaken in rural areas to date have been unsuccessful in achieving such outcomes, largely due to current renewable energy systems often being operated as part of a large-scale centralized energy structure mostly concentrated on low-price carbon-neutral energy production rather than on a democratic energy structure, environmental justice, and social inclusion (Boksh, 2015; Brummer, 2018; Gasparatos et al., 2017; Johnson & Lewis, 2017; Karunathilake et al., 2016; Plum, 2020).

Thus, increasing rural resilience will require shifting the renewable energy structure to a more decentralized, democratic renewable energy system, known as community renewable energy (CRE). *Decentralized energy* refers to small-scale and localized energy initiatives, where localism consists of "physical geography" and "geography of ownership" (Devine-Wright & Wiersma, 2009; Moroni et al., 2019; vanVeelen & Haggett, 2016). Instead of large and outsider-operated energy networks, decentralized renewable energy emphasizes local community-based energy activities with decentralization of authority, including a higher degree of autonomy, local acceptance and provision, as well as greater local commitment and responsibility for the social and economic consequences of energy use (Burke & Stephens, 2018). The related concept of *energy democracy* describes both procedural and distributional justice, formed through various features of democracy (Furlong, 2020; Shaw et al., 2015; Van Veelen & Van Der Horst, 2018). The question this paper seeks to address is: What role can CRE, a decentralized, democratic renewable energy system, play (and what roles have they played) in enhancing rural resilience?

While several previous studies have focused on the impact of CRE on economic, social, and environmental development in rural areas (Becker & Kunze, 2014; Hoffman et al., 2013; Seyfang et al., 2014), few studies explain these outcomes based on the framework of rural resilience, including aspects of diversity, networks and connectivity, equalization, and adaptation (Heijman et al., 2019). Examples of these few studies include Spijkerboer et al. (2016), who show in Europe a CRE energy landscape that is integrated with the physical and socio-economic landscape and which enhances the regional socio-economic fabric and potential to adapt to changes in the future. Similarly, Chodkowska-Miszczuk (2021) describe local community energy literacy, including awareness, attitude, and behaviour, as a pathway to rural resilience in Poland. This study expands on the initial existing literature to provide a more comprehensive, comparative review.

The next section of this manuscript describes the methodology and methods (primarily a systematic literature review) employed by this study. The results section then illustrates the role of CRE in rural diversity, equalization, adaptability, networks and connectivity, followed by a discussion of these results and a concluding section that describes key findings in response to our overall research question regarding the role of decentralized, democratic renewable energy systems (CRE) in rural resilience. Finally, we identify some important issues for further research.

2.2 Methodology and Methods

The overall approach of this study is explorative, adopting a systematic literature review following the methodology used by Łukasiewicz (2022) and Mohammadinia et al. (2018),. We selected North America and Western Europe as regions of focus to examine the features of CRE and how it has contributed to rural resiliency because, firstly, both settings are industrialized with large energy production demands and have access to a variety of energy production technologies. Secondly, due to adequate government and other private finance opportunities, various renewable energy-generating ventures were formed in both North America and Western Europe. Thirdly, there is a substantial amount of literature regarding renewable energy for both of these contexts to draw from.

For data source identification, the study performed a search based on three academic databases: Scopus, Science Direct, and Sociological Abstract. The date range was 1997, the year when new energy policies started to emerge based on the Kyoto Protocol for reducing greenhouse gas emissions (Bagozzi, 2015), to 2023. To increase the depth of the study and ensure the diversity of data and information, the study also used various gray literature data sources, including ProQuest (thesis and dissertations) (Vaska et al., 2019), Google Scholar (Paez, 2018), and web search (Kazi, et al., 2022) on different prominent energy organizations, namely REN21, International Renewable Energy Agency (IRENA), World Wind Energy Association (WWEA), and Renewable Energy and Energy Efficiency Partnership (REEEP). For the gray literature, the first 10 pages of search results were chosen for selecting relevant articles or documents because, typically, these pages contained the most relevant search results (Raven et al., 2016).

To acquire the appropriate literature, key terms based on the principal themes and subthemes of the study were selected for searching; "renewable energy," "community energy," and "resilience," for example, were three key initial terms derived from the principal theme of this study—the role of CRE in rural resilience. Based on the subthemes (key identified aspects of resilience), seven additional key terms were selected: "decentralized energy," "decarbonized energy," "democratized energy," "diversity," "adaptability," "equalization," and "networks and connectivity". Based on this strategy we initially identified 7897 studies. After that, these identified sources, including the title, abstract, and text (a shallow read), were reviewed with two exclusion criteria in mind: (i) document properties exclusion criteria, including full text, not published before 1997, or was not written in English; and (ii) content exclusion criteria, for example, non-European and non-North American countries, works only partially related, like large scale renewable energy projects, energy niche, global renewable energy deployment, hybrid (renewable & non-renewable) energy projects, editorials, letters, and meeting reports, entirely irrelevant subjects like hydrocarbon energy, including oil, gas, and coal, and Engineering and Physical Science related documents. Through these rigorous processes, the study yielded 427 publications for full-text review; however, of those studies, a total of 312 additional publications were removed as they either did not focus on small-town/municipality renewable energy projects (130 publications), did not focus on wider community aspects beyond the household level or leak of involvement of local government/municipalities (90 publications), or did not describe some feature of resilience i.e. diversity, equalization, adaptive capacity, engagement and connectivity (92 publications). Finally, 115 publications were selected for thematic analysis (Figure 3).

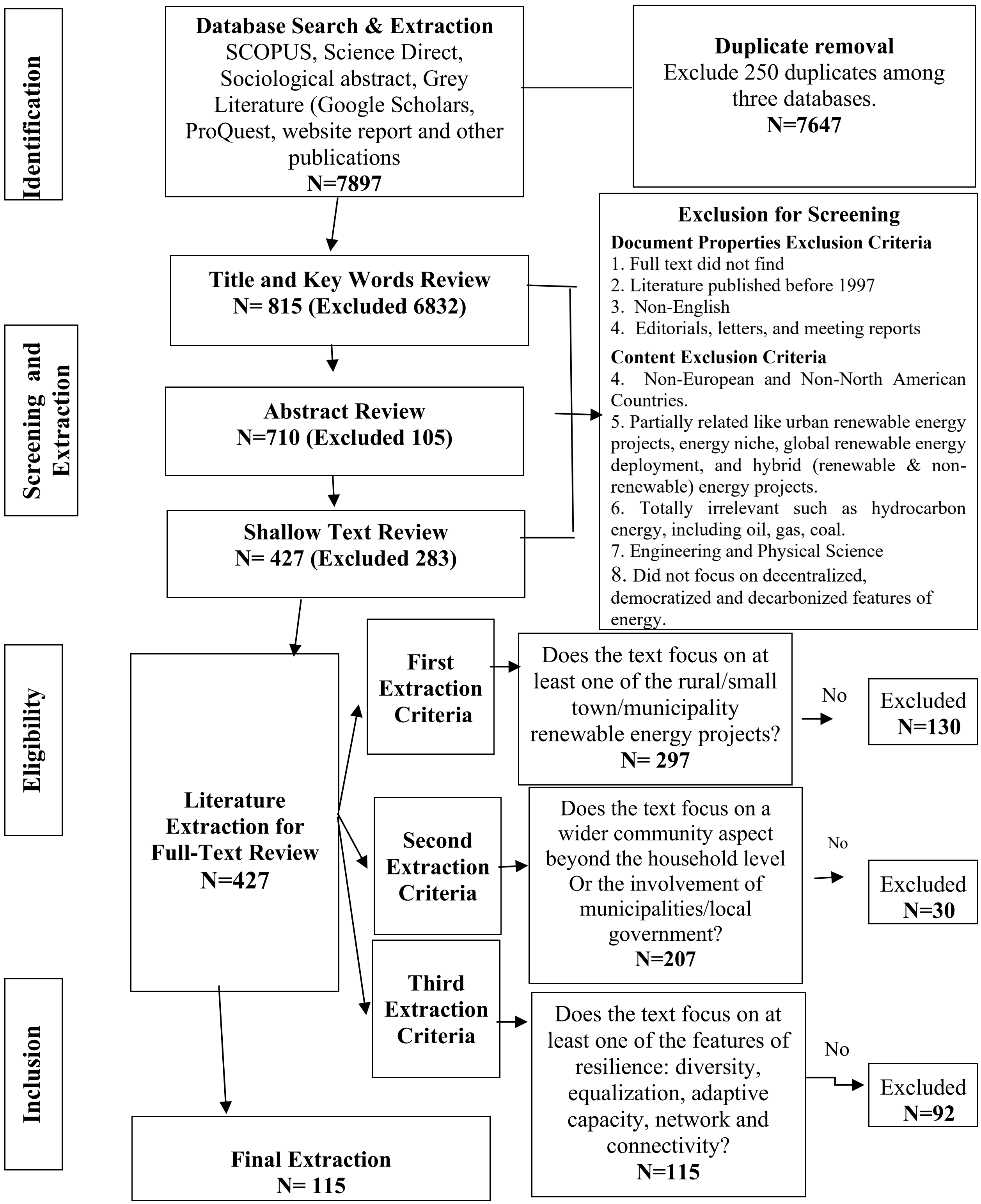

Figure 3: Systematic Review's Steps for CRE and RR

The study applied three patterns of thematic analysis techniques including initial, focused, and theoretical coding strategies (Salm et al., 2021; Thomas & Harden, 2008). The initial coding stage allows any potentially emergent themes that may arise from the literature. Focused coding, on the contrary, adopts a systematic and inductive approach, wherein data is classified based on thematic similarities at a descriptive level. Theoretical coding involves the integration of these thematic categories into core theoretical constructs, thereby elevating the analysis to a higher level of abstraction and conceptualization.

2.3 Results

Considering the three key dimensions of CRE (decarbonized, decentralized, democratic energy) and the four key features of rural resilience including diversity, networks and connectivity, equalization, and adaptability outlined above, this study reviews the evidence from the literature for how CRE contributes to each of these dimensions of CRE and rural resilience in the study regions.

2.3.1 CRE and Rural Diversity

The findings of this study point to two keyways that CRE projects contribute to diversity and in turn to resilience, particularly when compared to other forms of renewable energy initiatives: economic diversity (and regional development) and energy diversity. Figure 4 illustrates multiple ways mentioned (in the literature covered by the review) that each of these forms of diversity are enhanced, with renewable energy access being the most commonly noted followed by increased diversity in employment opportunities, lower energy cost, earning revenue from CRE projects, investment in local communities, and improved flexibility of the main grid. CRE has the potential to create more income and job opportunities for the local community than commercial, non-locally owned energy projects (Paulos, 2019). These projects promote economic activity, including social entrepreneurship and local innovation, and supplement incomes by developing a localized value-added chain in rural areas. Alternatively, the Distributed Energy Resources (DER) system in CRE provides a wide range of services like frequency management, voltage and load control, recovery of the energy system, and improved power quality (Chrobak, 2019). Again, various CRE business models increase access diversity in renewable energy initiatives and in energy supply overall (Delicado et al., 2016).

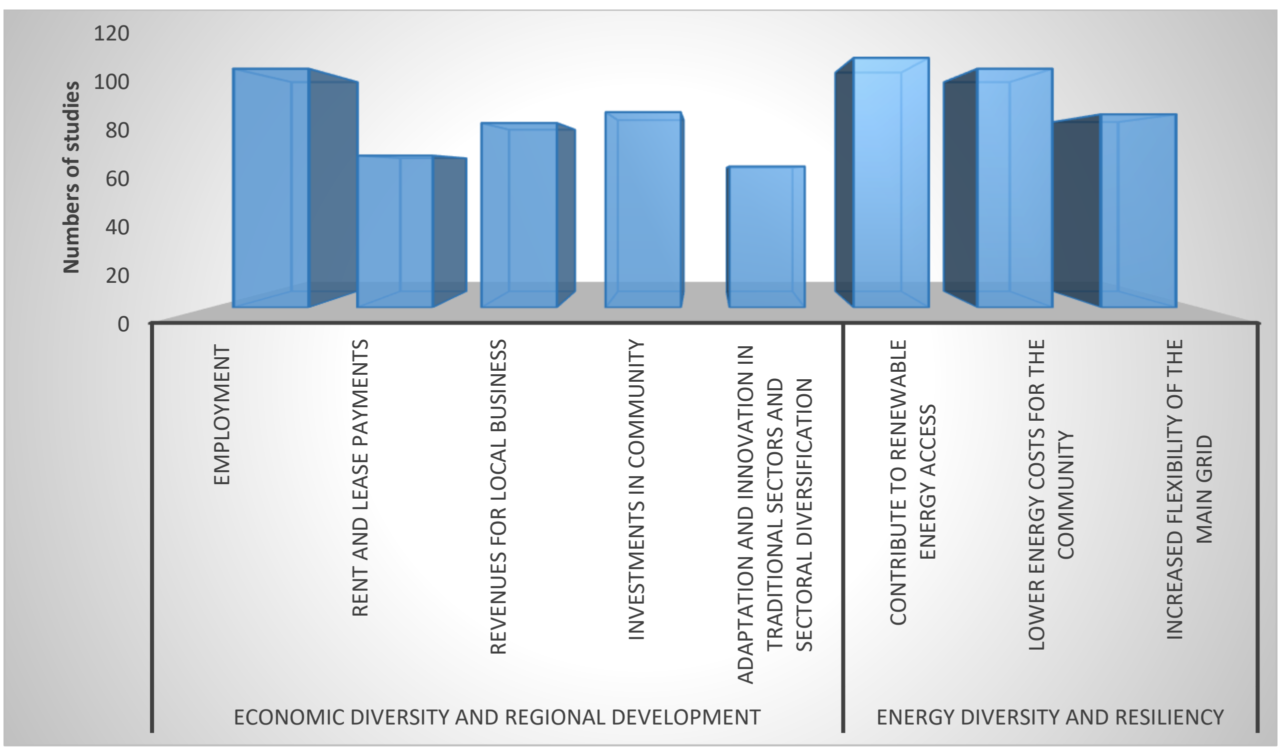

Figure 4: Emerging Themes for the Relationship between CRE and Rural Diversity

2.3.1.1 Economic Diversity and Regional Development

Economic diversity is the major form of diversity outcome of CRE, as mentioned by 102 (out of 115) studies. Economic diversities are generated through the use of a local labour force (employment), rent and lease payments, revenues for energy supply or for local enterprises, various forms of community investment as well as contributions to local supply chains and business networks, and adaptation and innovation in traditional sectors as well as sectoral diversification (Figure 4).

Employment

Creating both direct and indirect job opportunities is a key benefit of CRE initiatives. Different studies show the positive effects of CRE on regional labour markets (Delicado et al., 2016; Lehtonen & Okkonen, 2019; Munday et al., 2011). For instance, Lipp and Bale (2018) and Parkhill et al. (2015) found that creating more employment opportunities for local communities is the primary motivating factor and benefit of CRE projects. Similarly, Paulos (2019) shows that installing one megawatt of a locally owned solar energy project in St. Louis, USA, created at least 28 local jobs. CRE has the potential to create more jobs for the local community than commercial, non-locally owned energy projects (Farrell, 2014). In Minnesota, USA, for example, ten permanent jobs were created by a non-local Spanish firm through building a 20-MW wind energy project, whereas a similar project owned and operated by a local farm organization created 20 long-term jobs and generated three times more economic benefits, including revenue and tax earnings for the local community (Paulos, 2019). Likewise, Lantz (2009) compared the employment creation impact of CRE projects to hypothetical corporate projects developed by out-of-area organizations and found that the impacts of community-owned projects on employment creation are 1.1 to 1.3 times higher during the construction period and 1.1 to 2.8 times higher during the period of operations. Further, minority groups, including Indigenous communities, also gain more employment opportunities because of the CRE initiatives compared to private energy ownership models. Data from the Canadian Indigenous clean energy project Lumos Energy (n.d.), for example, estimated that 15,300 person-years of direct Indigenous employment had been achieved.

Revenues, Rent, and Lease Payments

CRE projects can earn revenue for supplying electricity based on mechanisms such as feed-in tariffs (FIT), net metering, net billing, or power traded immediately in the wholesale market (RESCOOP, 2017), providing additional income for the local community members. CRE has also benefited communities through the payment of land rental and royalties. In Scotland, Slee and Harnmeijer (2017) found that the local community receives more than £100,000–150,000/MW per annum, including rent, employee wages, and local entrepreneurship, versus about £10,000/MW in rental income and £3,000–4,000/MW in other economic benefits from a non-local commercial windfarm. A report conducted in 2006 for Umatilla County, Oregon, US, estimated that five wind turbines could generate approximately $13,335 per year in land lease payments or, if owned, $72,000 per year in equity payments over the project's life (Torgerson et al., 2006). Subsequently, landholders in community wind energy projects who own the turbines on their land, as opposed to merely leasing their land to an absentee owner, have the potential to double or triple revenues per turbine (GAO, 2004). Muller et al. (2011) revealed that farmers, landowners, and rural communities perceive CRE projects as a way to earn additional income and services without losing or leaving their land.

Revenues for Local Business

CRE may also generate additional opportunities for local businesses that service the project's construction, operations, and maintenance. For instance, a wind project has many input needs, ranging from road construction to cement pouring, security, and catering. Apart from direct construction and project management jobs, sub-contracts can be issued to businesses from the community, thereby creating spin-off opportunities. For example, the M'Chigeeng First Nation in Ontario was able to use several local contractors, labourers, and cement products from their community to construct their community-based wind project; they found that local businesses, such as campgrounds, restaurants, and other services also benefitted from the construction activities (Lipp & Bale, 2018). During the construction phase of a 900-kW wind turbine in Scotland, local contractors involved in on-site civil and electrical works were able to earn about £10,000 over the course of the project (Muller et al., 2011). CRE can support the local supply chain by preferentially choosing local suppliers (Delicado et al., 2016). One such example is in the Western Isles, UK, where priority is given to suppliers who are living in the greater Western Isles area. Moreover, increased incomes in communities, including through rent or wages to individuals and landowners, also translate into increased spending in local enterprises (Miller et al., 2019). In addition, residents involved with energy production save energy costs as they produce their own energy from local resources instead of buying energy from outsiders. Consequently, the local community can spend these savings on their other local economic activities (Lehtonen & Okkonen, 2019) which are fostering economic diversity, strengthening community bonds, and promoting sustainability.

Investments in Community

CRE offers diversified options for community revenue generation, including investment funding, which can accelerate other financial advantages and encourage investment in various sectors within the community, including housing, human capital, forestry, and tourism for the local community (Callaghan & Williams, 2014; Haggett & Aitken, 2015). A study focused on US community energy by Moroni et al. (2019), for example, shows that different communities receive various energy efficiency and innovation grants for deploying the CRE projects. From 1998 to 2007, the Samso energy project in Denmark received 57 million euros as an energy investment from local communities, NGOs as well as 4 million euros from the government to deploy renewable energy activities. Similarly, the Scottish government distributes 13.7 million euros per year from 2009 to 2015 among different community groups to install small and medium-scale renewable energy projects (Bomberg & McEwen, 2012). A study conducted in Iowa, US, by Galluzzo (2005), revealed that financial resources that remain in the host community are five-fold for small-scale wind projects owned by the local community compared to large-scale wind projects owned by out-of-state companies. A German study also showed that a seven-turbine community wind park of 21 MWs generated 58 million euros in regional income over a 20-year operating period, while the same-sized park in the hands of commercial developers produced only 7 million euros ($8.6 million) for the local economy. The difference lay in the profit, tax revenue, and job creation that stayed in local hands (Hockenos, 2021). This revenue is invested in local services including community transportation, recreation, and other locally prioritized issues (Ruggiero et al., 2019; IRENA, 2020). van der Waal (2020), for instance, shows that the Shapinsay Community wind project in Orkney Island, Scotland, has prioritized both energy and transportation services including community buses, e-bikes, and out-of-hours boat services as the community is located in a remote island area. Similarly, in Scotland, Okkonen and Lehtonen (2016) found that community wind projects contributed to local basic services by reinvesting wind energy revenue into basic services like food production, local marine and freshwater aquaculture farming, and health and education facilities.

Innovation in Traditional Sectors and Sectoral Diversification

CRE focuses on economic prosperity and other socio-ecological goals, often in innovative ways. These projects promote economic activity—including social entrepreneurship and local innovation—and supplement incomes by developing a localized value-added chain in rural areas that may otherwise rely heavily on a single sector (Walker, 2008; Seyfang et al., 2013). Local communities work together with other groups, sharing both risk and rewards and consequently minimizing individual investment exposure (Tarhan, 2015). In the process, other linked industries can also grow (Callaghan & Williams, 2014; REN21, 2017) and employment opportunities are further increased (Entwistle, 2014; Miller et al., 2019). Berka and Creamer (2018) show that in Freiamt, Germany, for instance, CRE projects—including biogas, a solar plant, and wood chip-based district heating system—have led to savings as well as changes in the traditional economic and farm structure. Due to available local resources, for example, local farmers cultivate grain and grass instead of traditional cattle breeding, resulting in changing farm structures (Munro et al., 2016). By giving the community access to electricity, CRE can enhance livelihoods by facilitating activities like agro-processing, cold storage, irrigation and desalination, or other micro-enterprises. Furthermore, CRE helps produce self-sufficient energy services through social enterprise—resulting in value creation for society rather than value appropriation only for shareholders and management (Crowdhury & Santos, 2010). This leads not to only economic but also energy diversity.

2.3.1.2. Energy Diversity and Resilience

Energy diversity is another major form of diversity outcome of CRE, as described by 107 (out of 115) studies. Improved flexibility of the main energy grid and increased access to renewable energy, including lower energy costs, are accelerating energy diversity and energy resilience overall (see Figure 4).

Improved Flexibility of the Central Energy Grid and Enhanced Grid Resilience

Centralized, large power plants and grid systems become vulnerable to widespread electricity outages from natural or human-caused disasters (IRENA, 2021). Decentralized, smaller community-based renewable energy projects can diversify electricity production and supply, reducing the possibility of widespread power disruptions, particularly in remote rural areas (Menniti et al., 2018; Alamaniotis et al., 2016; Hargreaves et al., 2015). CRE tends to utilize Distributed Energy Resources (DER) to supply energy and other grid-related supplementary services. Small-scale distributed and micro-grid systems can assist in sustaining energy operations for remote communities and enhance energy reliability by, for example, eliminating the need for an extensive network of overhead wires to transfer power (Chrobak, 2019).

Local communities can also increase energy system adaptability and resilience by redistributing loads and decreasing peak demand through demand-side measures. For instance, a CRE in Machynlleth, Wales contributed to forming a local energy fund to offer free support program to community members in efforts to save energy, such as financially assisting them with upgrades to their house insulation, delivering education regarding energy efficiency, and supplying energy-saving lamps for inhabitants (Becker & Kunze, 2014). Enercoop in France established "Dr. Watt," a smart energy package including smart energy software and online tools to assist consumers in making a self-diagnosis of their specific electricity consumption, as well as providing an online manual for saving energy (Sifakis et al., 2019). A small-grid, community-owned power project can serve in rebalancing power systems by offering a wide range of services like frequency management, voltage and load control, recovery of the energy system, and improved power quality (IRENA, 2019).

Again, CRE facilitated the increase of local self-resilience through energy transition like building various green infrastructures and decentralizing energy storage systems (Armstrong, 2015; Hentschel et al., 2018; Koirala, 2016). Energy transition permits local communities and entrepreneurs to invest in regional renewable energy and induces them to move toward decentralized and sustainable energy systems (Rieger et al., 2016), hence bringing new actors into energy sectors, which increases the diversity and collaboration opportunities for the local community (Kaphengst & Velten, 2014; van Summeren, 2020). In the Netherlands, for example, Schoora et al. (2016) discovered that recent local initiatives have established new regional clusters for deploying renewable energy and attempted to organize the governance of energy production in a decentralized, sustainable way.

Increased Access to Renewable Energy in Rural Regions

Increasing the use of decentralized energy sources helps communities access energy and work toward their decarbonization objectives (Geels et al., 2017; Mathiesen, 2015). For instance, Eigg Electric on Eigg Island in Scotland disconnected from the mainland electricity supply system and formed a CRE project to serve clean energy for their residents through three 110-kW (kilowatt) hydropower generators, four 24-kW tiny wind turbines, and a collection of 50-kW solar electric panels spread over the island according to where resources are most abundant. These renewable energy initiatives are producing 95% of the energy demand on this island (The Isle of Eigg, n.d.). Similarly, the St. Gorran CRE project in Cornwall, UK, was formed to generate renewable energy through community ownership, to create funds for local renewable energy investment, and to promote the growth of CRE in the rural region (Community Power Cornwall, 2020). Different CRE business models trigger access diversity in renewable energy initiatives and in energy supply overall (IRENA, 2019). CRE helps to reduce energy costs and ensure a reliable power supply for local communities (Becker, 2014; Brummer, 2018; Furlong, 2020; Hoicka & MacArthur, 2018). Farrell (2010), for example, compared several CRE projects to non-CRE projects in the USA and found that the net installed cost of a 2.1 kW solar array is around $1,800 for a member of the Community Solar project, and the repayment period for this cost is two years, whereas the calculation for a non-member is $5,500 and 5 years, respectively. Similarly, a study on Abergynolwyn community biomass heating in Wales shows that 76% of households joined this CRE scheme, reducing annual domestic fuel bills by an average of £134.42 to £488.58 (Cato et al., 2008).

2.3.2 CRE and Rural Networks and Connectivity

CRE enhances networks and connectivity in rural communities in three different ways, primarily increased trust and social acceptance, followed by external and internal networking and the improvement of information exchange (Figure 5). CRE generates a common platform and works as a knowledge and networking broker, increasing bonding and bridging networks between energy participants and other stakeholders and contributing to sustainability through assistance in acquiring relevant information and ensuring resource access (Van Der Waal, 2020; Veelen, 2018). These enhanced networks and connectivity further assisted in growing a positive perception of renewable energy technology and forming trusted social networks (Figure 5).

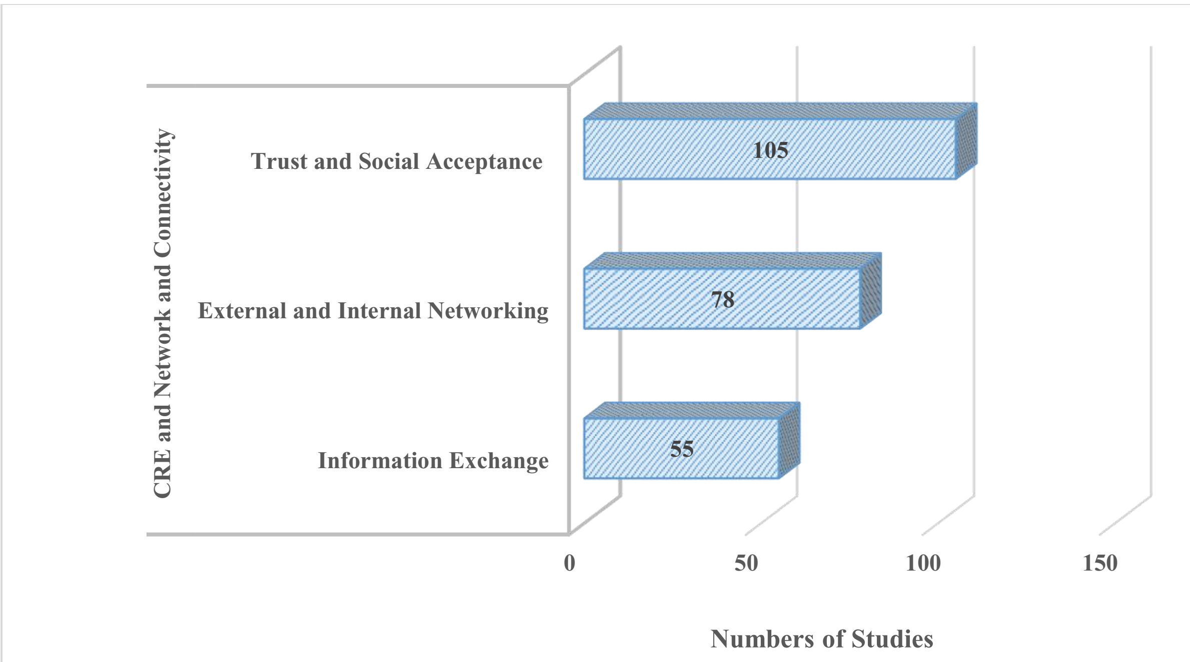

Figure 5: Emerging Themes for Relationship between CRE and Rural Networks and Connectivity

2.3.2.1 Trust and Social Acceptance

Networking and engagement with a CRE project can generate a culture of collective action and collaboration within and between communities. Research shows that this networking can substantially contribute to the formation of trusted social networks, which assist in knowledge development, facilitating awareness, fostering interpersonal learning, and lobbying for the CRE project (Gupta et al., 2014; Munro et al., 2018; Rahmani et al., 2020). Studies also reveal that CRE triggers social acceptance through democratic energy governance, including inclusive decision-making processes (Furlong, 2020; Goedkoop & Devine-Wright, 2016; Hicks & Ison, 2011; Roberts et al., 2014), accountability (Brisbois, 2019; REN21, 2017; Slee, 2015) and dispute resolution (Becker et al., 2017; Flieger, 2011; Miller et al., 2019). CRE implies an equity partnership between different project partners—which contribute capital—and local community members, including residents, municipalities, and NGOs—which provide land, rights, and required social assistance (REN21, 2017). Consequently, CRE can maintain accountability and resolve disputes. A study in Scotland by Veelen (2018) shows that CRE projects adopted different procedures, like regular board meetings, taking advice from different legal institutions, and volunteer workshops, to ensure accountability regarding energy decisions. On the basis of a case study among thirteen local community initiatives in the northern provinces of the Netherlands in the period of 2010–2013, Van Dar Schoor and Scholtens (2015) found that through organizing, including informal and formal means, local residents developed a strong shared vision and set a wide spectrum of activities. These organizational developments, shared vision, and multiple activities contributed to resolving various disputes and maintaining the accountability of energy projects. CRE involves a diverse range of stakeholders related to the project, such as citizens, multiple institutions and organizations, planners and developers, and financiers; this diversity assists in overcoming the injustices that often underpin local opposition to RE projects. A study conducted by Hockenos (2021) in Europe shows that due to diverse ownership in CRE projects, local residents enjoy a high level of trust; subsequently, social acceptance increases dramatically compared to other commercial developer-led projects. To evaluate the impact of community ownership on social acceptance, Warren and McFadyen (2010) carried out a comparative study among two neighbouring communities in southwest Scotland. They found that although the underlying perceptions were not significantly different between the two groups, positive attitudes related to local ownership led to less weight being placed on concerns such as disruption, visual impact, and bird strikes. In southeast Germany, Musall and Kuik (2011) similarly compared public opinion regarding the deployment of renewable energy by two energy groups, namely fully commercial wind power projects and partial community co-ownership wind energy farms, demonstrating that community-owned wind farms have higher social acceptance and less negative perception about visual impacts, shadow flicker, and noise pollution.

2.3.2.2 External and Internal Networking

Both external and internal networks bring people together, creating a common identity, pride in joint accomplishments, and increased self-worth among those involved (Schoor & Scholtens, 2015). Networking can also protect social and cultural identity and strengthen relationships between communities and other stakeholders (Goedkoop & Devine-Wright, 2016). CRE projects can facilitate both bonding and bridging networks between energy participants and other stakeholders and contribute to sustainability through assistance in acquiring relevant information, ensuring resource access, and decreasing energy transition costs (Berka & Creamer, 2018; Bere et al., 2017; Brummer, 2018; Lakshmi, and Tilley, 2019; O'Keeffe, 2016). Networking also encourages and promotes different social and technological diffusions (Allen et al., 2019). In the UK, Martiskainen (2016) found that the Hyde Farm CRE project produced both internal and external community networking. The project leader communicated with external stakeholders like the government and other funding agencies and technical support organizations and motivated local residents by utilizing online resources. Subsequently, within a few months, this CRE project built a network nationwide and allowed people with similar interests to come together. Similarly, Seyfan et al. (2014) showed that community leaders, specifically CRE project leaders, are creating various formal and informal networks, which are accelerating different opportunities, including sharing knowledge, technology, and funding. Parag et al. (2013) described CRE as a knowledge and networking broker, while Yildiz et al. (2015), in Germany, found that energy cooperatives produce and improve different kinds of bonding and bridging social capital. The study pointed out that this networking assisted in growing a positive perception of renewable energy technology as a realistic option. This support, in turn, led them to take on further larger-scale energy projects.

2.3.2.3. Information Exchange

Access to information is a fundamental issue for sustainability, particularly in group action for energy deployment and community development (Gross, 2007). In a CRE context, local residents get energy information through a two-step communication system: first, they receive information from the wider world; second, they filter this information through their interpersonal interactions and connections with other organizations, including energy cooperatives, government organizations, or funding agencies (Knudsen et al., 2015; Parag et al., 2013). People receive information from different sources; however, they prefer a trusted source nearby (Parag et al., 2013), including different actors involved in CRE (Becker & Kunze, 2014). Parag et al.'s (2013) UK survey, for instance, shows that despite the available data from the internet, most participants of the CRE project perceived that energy development ideas from their nearby communities were more useful for them, as these communities' socio-economic conditions are similar to their own.

The local energy community obtains information from municipalities, NGOs, and other community groups, such as Energy Saving Trust and Green Communities. These groups facilitate a common platform through various formal and informal community gatherings, which also assist in increasing informal networking as well as knowledge sharing (Ayers et al., 2014; Callaghan & Williams, 2014; Van Der Waal, 2020). Parag et al. (2013) also showed that different low-carbon community groups (LCCGs) in Oxfordshire, UK arranged community events, such as Green Business Breakfasts, Green Drinks, and Green Suppers, that contribute to information sharing and raising bonding social capital among local residents and other stakeholders. Likewise, Simcock (2016) also demonstrated that the CRE project employed multiple public engagement methods, including leaflets, public manifestations, websites, and community surveys, resulting in the local community smoothly sharing and accessing required information. However, transparency is an important issue for CRE as it supports procedural justice by ensuring that information is accessible, decisions are clear, and community members have an equitable opportunity to participate in the decision-making processes related to CRE (Knudsen et al., 2015).

2.3.3 CRE and Rural Equalization

CRE contributes to equalization in rural and small communities by ensuring procedural and distributional justice. Procedural justice most often refers to public participation in energy governance, and the characteristics of that participation (Hanke et al., 2021), whereas distributional justice refers to sharing and distributing energy system benefits and costs (Goedkoop & Devine-Wright 2016). Figure 6 shows that, while both procedural and distributional justice are discussed commonly in the extracted literature, more studies describe distributional justice (85 on the formation; 75 on the outcomes) than procedural justice (65 on the formation; 60 on the outcomes). CRE implies the "consult-consider-modify-proceed" (Phadke, 2023, p 5) process instead of the "decide-announce-defend" model (Elmallah & Rand, 2022, p 89) accelerating local acceptance and participation in the CRE project and reducing conflict (Walker & Baxter, 2017). Alternatively, distributional justice in CRE initiatives forms through different community ownership, resulting in inclusivity, community empowerment and fulfilling local needs. It could also examine where a project is located and who can access it's outputs (Goedkoop & Devine-Wright, 2016).

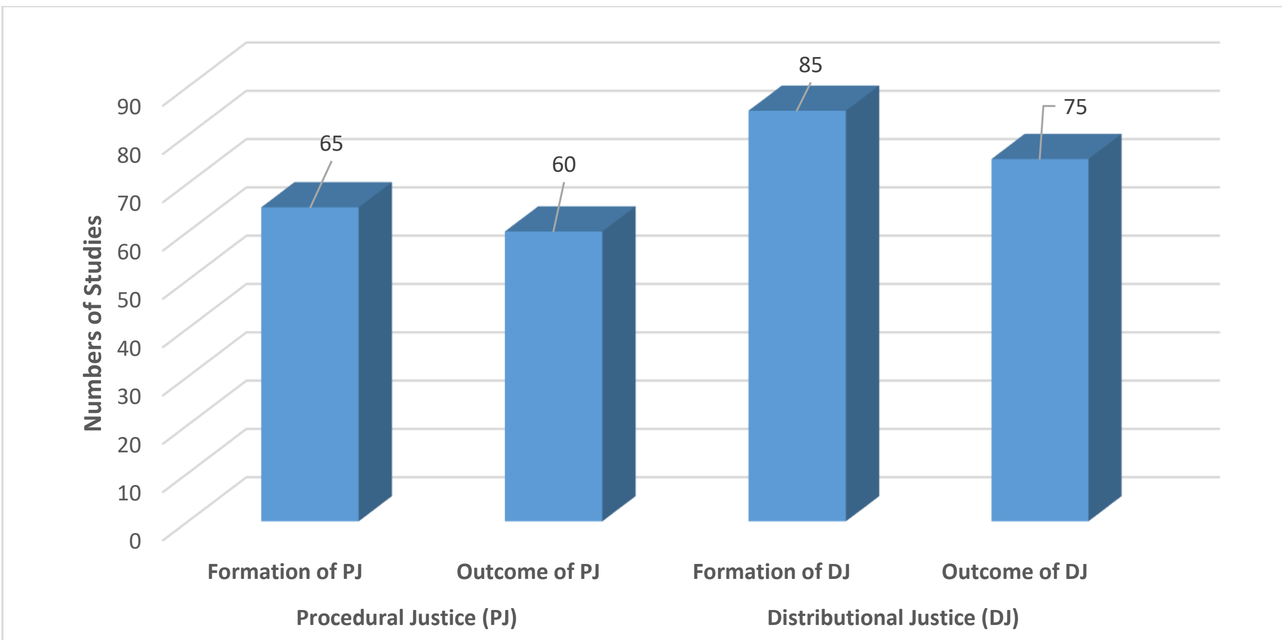

Figure 6: Emerging Themes for Relationship between CRE and Rural Equalization

2.3.3.1 Procedural Justice in CRE Projects

Formation of Procedural Justice in CRE Projects

Typically, procedural justice investigates the fairness of decision-making processes and mechanisms (Hanke et al., 2021). In energy justice, procedural justice primarily focuses on the conditions of participation and the involvement of local residents in energy planning (Suškevičs et al., 2019). Norton, a CRE project in South Yorkshire, UK, for example, has implemented multiple engagement methods, like an information booklet, public exhibitions, website, online forum, community poll, and resident input into specific decisions (Simcock, 2016). In this project, local households were first informed about the energy project through a booklet sent to them by local postal services. Following this, a series of public exhibitions were held, with further public meetings and updates to the project website. A local organization then undertook a community-wide vote in which every household was polled, asking whether the proposed project was acceptable and could be constructed. The options given on the form were a simple 'Yes or 'No', with votes allocated on a one-per-household basis. Households could participate either by post or online, with an independent team at a university assembled to collate and count the responses to ensure impartiality and legitimacy (Simcock, 2016).

To ensure more effective participation, CRE implies the "consult-consider-modify-proceed" process instead of the "decide-announce-defend" model (Walker & Baxter, 2017). Citizens' concerted involvement and benefit from renewable energy technology create 'communities of interest', which develop into an 'energy citizenship.' Ideally, a citizen can easily participate in the entire energy process through the CRE project, including energy site selection, energy production, and other decision-making processes (Suškevičs et al., 2019). Looking at procedural justice, including information, site selection, dealing with a developer, and the ability to affect outcomes in the Canadian wind energy context, Walker and Baxter (2017) showed that a bottom-up community-based initiative in Nova Scotia led to better experiences of procedural justice compared to the top-down technocrat method used in Ontario.

Communication and collaboration between stakeholders are crucial for maintaining procedural justice. Literature shows that CRE projects have created multiple partnerships with other organizations to ensure local participation in the decision-making process (Becker & Kunze, 2014; Roby & Debby, 2019). A CRE project in the US, for example, employed a two-step participation model where participants first get the required information from the energy organization and then get opportunities to participate in the ownership structure (Becker & Kunze, 2014). Here members are united under the premise of 'one member, one vote' and also earn and make decisions about produced revenues. Findings from a UK CRE project focused on local community participation showed how a partnership with multiple stakeholders—namely universities, smart energy SMEs, the local council, a community support group, a software developer, and a satellite data provider—made an interactive online information platform to support communities and local authorities in developing community energy projects (Roby & Debby, 2019).

The Outcomes of Procedural Justice in CRE Projects

Due to the collaborative approach, and active participation in the decision-making process, CRE creates local acceptance and minimizes regional conflicts (Becker et al., 2017; Mundaca et al., 2018; Stein, 2018). A substantial body of literature focuses on procedural justice as the most important justice variable in shaping public acceptance of the CRE (Munday et al., 2011; Rogers et al., 2012; Seyfang, 2014). Jacquet (2015) found that in community-led wind energy projects in the rural US, for example, local landowners were better informed about the energy project and could participate and negotiate in the energy development process. Consequently, they were more supportive than non-participating landowners. Early engagement reduces community opposition and increases transparency and trust toward an energy initiative or technology. Community engagement activities—for example, talking face-to-face and organizing personal meetings and expert presentations to share technical information—imply constant and open communication, and these initiatives generate mutual understanding and support for successful energy projects (Ruggiero et al., 2019). A study by Ek and Persson (2014), for instance, found that public support for wind farms grew when local communities wholly or partly owned them and even that they were willing to pay more for electricity generated by wind power projects in which the local residents can participate in the planning and situating of wind farms. Residents who have a stake and are engaged and empowered in such projects are often able to see beyond just financial gains to realize the prospects of community vibrancy and long-term viability.

2.3.3.2 Distributional Justice in CRE Initiatives

The Formation of Distributional Justice in CRE Initiatives

Studies of energy distributional justice tend to focus on the output of energy projects, including how the project's benefits and burdens are socially and spatially shared or distributed between the project owners and other stakeholders (Goedkoop & Devine-Wright, 2016). CRE tends to induce collaborative regional solutions to facilitate economic and social development and distribute the benefits widely among local communities (Berka & Creamer, 2018; Fuller &

Bulkeley, 2013). For example, a community windmill that a whole village or community can use has more benefits than a giant wind turbine built by a project developer that only helps one farmer sell (or lease) a piece of land. Returns from CRE investments are used for specific local purposes and may be shared with people who belong to one or more disadvantaged groups (Berka & Creamer, 2018). Many CRE projects share benefits with residents through a community development fund or trust, where community energy groups tailor these funds to meet local community needs (Pigeon et al., 2022). For instance, in the UK, Wadebridge Renewable Energy Network (WREN) created a community enhancement fund of approximately £70,000 annually through government grants and a small fee from local renewable energy producers. After the reduction of government energy subsidies, WREN began to provide funding to various energy groups through a network of neighbourhood committees (Soutar, 2015). Some community funds finance environmental initiatives like energy efficiency. For example, Repowering London, an energy cooperative in London, Ontario, Canada, uses their community energy efficiency fund to improve the energy efficiency of local households through energy surveys and audits (Stefanelli et al., 2019).

In most cases community ownership of CRE can promote fairness in the distribution of resources and more connectivity with local community members and organizations than externally controlled energy projects. CRE can be adapted to different types of community ownership. In most cases, CRE companies are social enterprises wherein the business has one or more social objectives that profits are invested to achieve. A renewable energy cooperative is an ideal type of social entrepreneurship (Johanisova et al., 2013) as it is formed with the principles of independence and democracy, self-governance, equality, fairness, and solidarity in mind (Caramizaru & Uihlein, 2020). Cooperatives, the most common form of CRE, enable citizens to collectively own and manage energy projects and typically follow the democratic principle of "one member, one vote" (Yildiz et al., 2015 p. 15). Maximizing return on capital is usually not a key objective. In this type of ownership model, there is limited profit sharing, and surpluses are reinvested to support members and/or the community. In this model, local residents (and/or organizations) can often invest in renewable energy generation by buying shares to finance a project (Walker, 2008). In some cases, co-ops can also consume and share energy. For example, Edinburgh Community Solar Cooperative was formed as a Society for the Benefit of the Community ('BenCom'), intended to provide renewable energy and benefit the community as a whole (Roberts et al., 2014). Becker's (2017) study of two renewable energy cooperatives in Spain and Italy found that local renewable cooperatives can combine local energy generation with an ecological investment endowment and community ownership through local shares. Local residents became co-owners and implemented a set of comprehensive socio-environmental values, aiding energy transition through political and financial participation of cooperative members, autonomy and independence for local groups, and education and recognition of ecological importance (such as using nonagricultural land for renewable energy production).

Community development trusts are the second most common form of CRE ownership (Haggett & Aitken, 2015), ensuring distributional justice through: local ownership and management, commitment to sustainable regeneration of a community, independence, aims that reach beyond private profit, working in partnership with others, and reduced dependency on grant support through income generation and the ownership of assets. In this model, a local community group owns the renewables installations, raises funds through grants and loans, and distributes income from renewables to community projects (Bomberg & McEwen, 2012). In Scotland, for instance, the Isle of Eigg is an off-grid system that provides electricity for the whole island. The stand-alone system is managed by a community-owned, operated, and maintained company, Eigg Electric Ltd., a wholly owned subsidiary of the Isle of Eigg Heritage Trust, a community organization that owns the island (Chmiel & Bhattacharyya, 2015).

Non-profit, customer owned CRE is another collective ownership energy model formed by investments from members responsible for financing the energy project, but members do not take profits. In this not-for-profit ownership model, profits are returned to the members in the form of lower energy prices. This ownership model is used in all over the Denmark (Caramizaru & Uihlein, 2020).

Finally, public-private partnerships can also contribute to distributional justice (Roberts et al., 2014). Through the public-private partnership, local authorities like municipalities can agree with local community actors and businesses to host CRE and thus ensure the provision and other benefits for the community. The public-private partnership model is becoming particularly popular for wind parks in Germany (Busch et al., 2019). However, complexity and lengthy decision-making processes, risk allocation, financing challenges, regulatory and policy uncertainty, and dependency on government support are key challenging issues for this ownership model (Eitan, et al., 2019).

The Outcomes of Distributional Justice

Most CRE projects are formed within a trusted network, creating a credible premise of public benefits that contributes to reducing injustice in the distribution of costs and benefits (Goedkoop & Devine-Wright, 2016; Schoor & Scholtens, 2015). Rather than being 'economically marginal communities'—where unjust distributional energy processes occur—peripheral, rural, and culturally distinct communities, particularly Indigenous groups, have gained the ability to mobilize and use resources for their goals through CRE initiatives (Hoicka et al., 2021; Hoicka &

MacArthur, 2018). For example, the Dokis First Nation was crucial in developing the 10 MW Okikendawt run-of-river hydroelectric facilities in north-central Ontario and owns 40% of the project. With the revenues from electricity sales, the Nation established a trust fund to help pay for community infrastructure, health, education, and cultural initiatives (Lipp, 2018). Due to government financial and policy support, more Indigenous communities are becoming partners with Canadian CRE projects (Karanasios & Parker, 2018; McCarthy & Morrison, 2021). A recent national survey report shows that one-fifth of Canadian power is now supplied by facilities fully or partly owned and run by Indigenous communities (McDiarmid, 2017). However, Hoicka et al. (2021) shows that less than 1/4 of these projects have Indigenous ownership. Other minority communities living in remote areas are also empowered through the equity of CRE. For instance, Cooperative Energy Future (CEF) in Minnesota, US, is built with over 90% minority labour, including many workers from the neighbourhood. The authority offers a no-money-down subscription with no credit check program in order to attract low-income people to participate in this community-based solar project, which saves about 8% of energy bills (Ruggiero et al., 2019).

Again, CRE brings together different groups of people based on a common purpose, motivating them to collectively change based on their socio-economic and technical context and create a platform to negotiate the opportunities, constraints, and risks regarding the transition towards renewable energy (Brisbois, 2019). Callaghan and Williams (2014) show that for different CRE projects in Scotland, various organizations—like the national government, local municipalities, and "Community Energy Scotland"—educated local communities regarding the potential of renewable energy schemes in their local area. These projects teach and train communities how to generate revenue as well as deal with other stakeholders. Similarly, Heiskanen et al. (2010) have argued that collective action in communities striving for carbon reduction can help overcome social dilemmas and feelings of helplessness experienced by individuals. Slee (2015) also found that different funding schemes for CRE assist local communities in overcoming the risk of refusal in onshore wind energy development and ensure the democratization of the energy system through a co-ownership model. Energy co-ownership schemes offer 12 to 13 times more reinvestment value in the local area than the other centralized ownership models (Caramizaru & Uihlein, 2020). Greater revenues result in economic empowerment, including financial sustainability and leverage, asset control and security, and influence.

Through a sustainable income stream, CRE often contributes to different community facilities and amenities such as community parks, swimming pools, nurseries, and cultural revitalization, including traditional music events, language courses, historical events, and community museums, which can encourage people to remain, return, or move to the area, and contribute towards the flourishing of cultural practices and traditions (Berka, & Creamer, 2018; Simcock et al., 2016). CRE projects can enhance feelings and aspects of community culture like language, literature, heritage, and more (Fernandez, 2021; Haf & Parkhill, 2017; Soeiro & Dias, 2020). Inward investment through the community wind turbine on Tiree Island, Scotland, for example, makes the island a more attractive place to live, benefiting the island's culture (Haf & Parkhill, 2017). The Tiree Trust has been donating funds for the annual Tiree Music Festival, bringing hundreds of people to the small island and helping the whole island's tourist industry and income stream. In addition, the 'Windfall Fund' funded a local drama group, which developed Gaelic language performances, a community tapestry project depicting the island's history, and contributed to the Tiree Maritime Trust. All these community activities encourage local people to socialize and come back into contact with each other, thus encouraging the resilience of traditional cultural activities (Haf & Parkhill, 2017).

2.3.4 CRE and Rural Adaptability

CRE promotes adaptability in the rural context in three ways: facilitating the renewable energy transition, increasing sustainable attitudes and climate change awareness among energy practitioners, and creating various leadership, training, and development opportunities (Berka & Creamer, 2018; Ford et al., 2019; Sifakis et al., 2019). Figure 7 illustrates that the transition to renewable energy and technology adoption is the most mentioned (108 publications) in the literature, followed by leadership, training, and development (90 publications), and sustainable attitudes and awareness (75 publications). To elaborate, the transition to renewable energy can be furthered with smart technology common in CRE. Self-organizing, social learning, and practicing sustainable lifestyles in CRE projects improve sustainable attitudes and awareness in rural areas. Moreover, leadership, training and skill development can encourage the CRE community to form a local think-tank to assist in adapting to new local challenges.

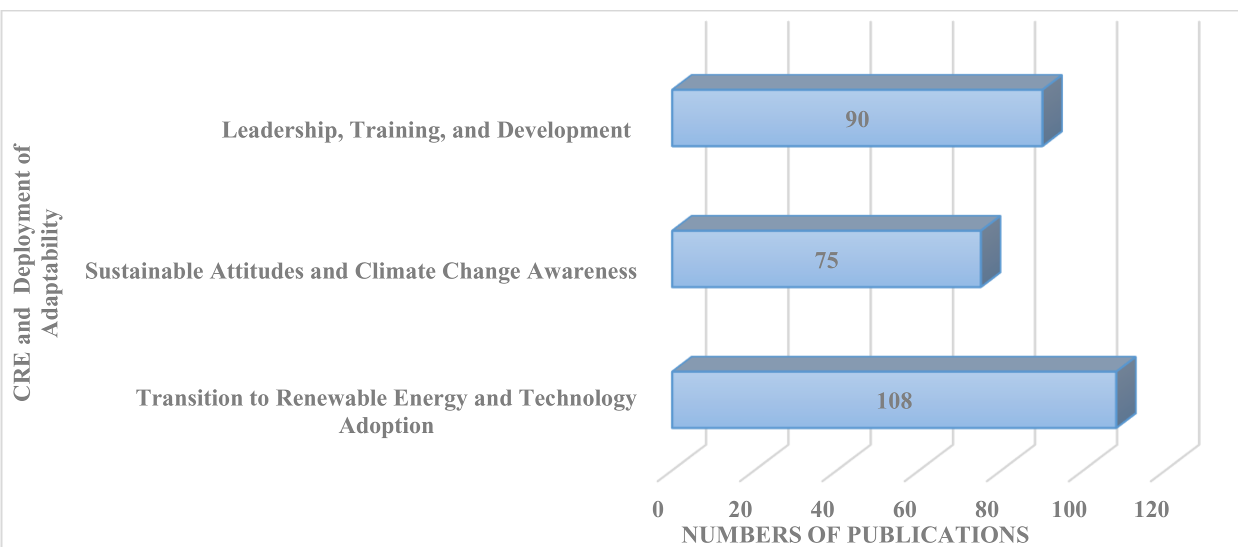

Figure 7: Emerging Themes for Relationship between CRE and Rural Adaptability

2.3.4.1 Transition to Renewable Energy and Technology Adoption

Experimentation and innovation are the key components of adaptive capacity (Chapin et al., 2009). As CRE mobilizes the local community through grassroots innovation, like renewable cooperatives employing smart technologies, it can assist in coping with various adverse situations, such as energy disruption due to natural disasters and energy poverty (Community Energy, 2020; IRENA, 2021).

CRE often employs smart energy systems, including i) automation and self-regulation systems; ii) a combination of Information and Communication Technology (ICT); iii) an ability to learn consumer preferences; and iv) smarter engagement with users (Ford et al., 2019; Lund et al., 2017). OECD (2012) and Sapkota et al. (2014) revealed the importance of decarbonization for adaptability; in particular, they found that CRE greatly facilitates energy transition through smart energy systems—including smart meters, energy monitors, software, and wearable technology—which assist in transferring existing energy systems into a structure of automation and self-regulation. Smart energy systems have a number of benefits, such as enhanced availability of energy data (and therefore more accurate power metering and billing), proper signalling for energy demand management and response activities, self-regulating demand response systems (including load shifting and curtailment), and improved control, monitoring, and optimization of energy performance through communication between distributed generators or stores (Connolly et al., 2013). Consequently, the whole energy system's adaptive capacity is increased and can reduce risk or uncertainty; for example, smart systems offer better energy security with regard to grid outages, increasing the guarantee of energy supply and reliability and reducing the probability of expensive system failures (Alamaniotis et al., 2016; Hargreaves et al., 2015; Menniti et al., 2018;).

A combination of demand response management technologies, storage, and smart grid software affords greater control over supply and demand (Lund, 2014), which allows more renewable energy resources to connect to and supply the grid and helps capture energy surplus, which can then be sold back to the grid in times of greatest demand (Lund et al., 2017; Palensky & Kupzog, 2013). Smart systems open new opportunities for energy export, further bolstering financial performance, improving the feasibility of decentralized energy generation, as well as facilitating peer-to-peer trading platforms that provide a route to market (Connolly et al., 2017; Lund et al., 2017). Renewable energy sources can be remotely controlled and digitally intelligent; for example, the combination of the Internet of Things (IoT) and renewable energy generation allows technicians to use cloud-based controllers to deploy distributed generation based on different stages of electricity demand (Ding et al., 2011). As well, based on sensors' perception of ambient environmental information, such as light intensity and wind speed, power generation equipment can start and stop automatically, and this significantly improves energy efficiency and equipment life (Tian et al., 2021). In Ireland, for example, Templederry Wind Farm, a CRE project, introduced a Community Virtual Power Plant. The community manages their energy system through artificial intelligence, ICT-enabled communication methods, and a universal smart energy framework for trading and distributing reliable energy use (van Summeren, 2020).

2.3.4.2 Sustainable Attitudes and Climate Change Awareness

CRE assists in improving awareness and promotion of sustainable lifestyles, including saving energy, participating in energy management, and encouraging or compelling others to change their energy-consuming behaviour, which are all habits helping in climate adaptation, self-organizing, and the social learning process in communities (Assadourian, 2008; Berka & Creamer, 2018; Creamer, 2015; DECC, 2012; Gupta et al., 2014; RESCOOP, 2017; Sifakis et al., 2019). For example, the UK government spent around £10 million through CRE initiatives from 2010 to 2012, installing different low-carbon infrastructures and technology while also investing in public engagement and behaviour change (DECC 2012). Consequently, some communities installed various renewable energy infrastructures but also conducted surveys regarding energy use, introduced recycling services, and demonstrated more positive attitudes toward local CRE (Creamer, 2015; DECC, 2012).

It is clear that CRE triggers social learning among CRE project members by encouraging or enforcing certain behavioural rules, leading to lifestyle changes and maintenance of more sustainable energy use (Creamer, 2015; Pellicer-Sifres et al., 2018). For example, on the island of Eigg, Scotland, for domestic purposes, the energy supply is capped at 5 kW per household and 10 kW for large-scale properties. To deal with inappropriate use or abuse of energy, the meter is locked after exceeding these limits, and the consumer incurs a penalty of £25 for restoring the service (Hockenos, 2021). Similarly, different CRE groups in Spain have encouraged a new pattern of energy consumption based on roles and responsibilities and energy democracy in producing renewable energy, as well as having promoted energy efficiency and savings that have led residents to change their energy behaviours and become more conscious about energy consumption (Pellicer-Sifres et al., 2018). Renewable energy cooperatives in Europe are promoting the utilization of smart energy management and self-consumption techniques, reducing energy consumption between 9% and 30% on average (Sifakis et al., 2019). A study by REScoops, the European Federation of Citizen Energy Cooperatives, revealed that memberships in renewable cooperatives have increased knowledge levels about energy use; subsequently, energy consumption has decreased by more than 45% (RESCOOP, 2017). Berka and Creamer's (2018) study in Oxfordshire, UK, showed that due to a CRE project, more than one-fourth of its residents had installed low-cost domestic microgeneration systems, and around two-thirds of community members had reduced their daily energy consumption.

A large number of studies support the argument that CRE projects have a significant role in climate protection and sustainability through everyday practices and conscious awareness (Armstrong, 2015; Berka & Creamer, 2018; Creamer, 2015; Gubbins, 2010). Through self-organization and social learning processes, CRE creates a trusted source of information for its members to increase knowledge and awareness about the physical world, including global climate change (Creamer, 2015; Gupta et al., 2014). This ultimately increases local residents' ability to learn to survive in a challenging and uncertain environment. A study by Berka (2017) showed enhanced awareness of climate change and a sense of purpose. Between 2002 and 2008, in Scotland, there were more than 800 CRE initiatives developed; Along with the economic development, these CRE projects also empowered and trained regional volunteers to cope with and adapt to climate change (Gubbins, 2010). Likewise, Bomberg and McEwen (2012) revealed that the level of awareness about global warming and climate change is very high among members of CRE projects, also contributing to reducing carbon emissions.

2.3.4.1 Leadership, Training, and Development

A wide range of research reveals that active participation in CRE initiatives promotes the development of knowledge and skills across several areas, including organizational management and leadership, project management, collective teamwork, public consultation and engagement, business and entrepreneurship development, project finance and fundraising, and technical capacity regarding renewable energy technology (Bomberg & McEwen, 2012). This diverse knowledge assists in developing a systematic thinking approach for planning and determining the best strategies for adaptive capacity (Ayers et al., 2014; Van Der Waal, 2020). Drawing on both surveys and interviews from 57 European renewable energy cooperatives, Ayers et al. (2014), for instance, found that CRE contributes to three types of knowledge within the local community, including 1) business, 2) engineering and ecological, and 3) politics, which may encourage the community to form a local think-tank group to aid in coping with new local problems. Similarly, in a community-led wood fuel initiative in rural England, Rogers et al. (2012) showed that a group of local volunteers established a resident-led renewable project where local residents became the project directors. Each director's knowledge and experience played a certain role, such as community relationships and vision, technical input to project design, and fundraising. This wide range of knowledge accelerated the deployment of different skills and personal capacities (Van Der Waal, 2020; Callaghan & Williams, 2014). In Minnesota, a CRE project is providing different local groups with skill development training so that workers can obtain jobs in local energy projects or beyond. Similarly, in an African-American neighbourhood in North Minneapolis, where employment opportunities are scarce, local CRE groups trained up to 200 workers (Gallucci, 2019). An Indigenous-owned renewable energy project in Vancouver, Canada, provided tutorials and training to students and youth about renewable energy and as well offered opportunities to install sample solar panels (Cram, 2017).

2.3.5 Challenges for CRE in Facilitating Rural Resilience

CRE contributes energy diversity and resilience through various cost-effective innovative technologies. However, energy transition through CRE employing these kinds of technologies has some key limitations, including a lack of technological maturity, energy storage problems like grid interface, protection and safety, and technological, functional, and regulatory obligations with regard to connection to the existing grid infrastructure (Rae, 2020).

Likewise, a lack of required time and pressure to complete tasks by the deadline, lack of understanding and awareness, and the rising difficulties of the project and other organizational systems caused difficulties in collective action and collaboration within and between communities (Veelen, 2018)

On the other hand, opportunities for participation may be unequal in CRE projects due to factors such as education and income differences (Shaw et al., 2015). Discrepancies in culture, economic situation, and the average welfare of citizens can create barriers to energy procedural justice (Walker & Baxter, 2017). Similarly, lack of agency, high share prices, lack of targeted information campaigns, and lack of targeted engagement activities are major challenges to ensuring procedural justice in CRE projects (Lennon et al., 2019).

Again, In the case of distributional justice, membership is the key barrier (Anchustegui, 2020; van Bommel & Höffken, 2021). In addition, geographical location and different socio-demographic conditions, such as age and skills, can create distributional injustice in a CRE project (Fuller & Bulkeley, 2013). Moreover, policy instability can reduce various benefits of the CRE project, affecting CRE's growth (van Bommel & Höffken, 2021), for instance, the Feed-In Act and the German Co-operative Law in Germany accelerated the expansion of decentralized renewable energy from 2005 to 2016 (Suwa & Dreyfus, 2018; Wagner et al., 2021). However, the number of

CRE projects has dramatically dropped when Germany revised these regulations and implemented an auction policy (IRENA, 2020).

Furthermore, smart technologies increase rural adaptability and contribute to the energy transition (Juan & Mceldowney, 2021). However, these technologies can also produce unfair access, particularly for residents uneducated regarding internet use or opportunities for participation in these initiatives and for those who do not have access to reliable internet (Knox, 2022). Consequently, wealthy residents are often better able to utilize and enjoy more benefits from energy transition through smart technology.

2.4 Discussion

This chapter examines how CRE has contributed to rural resilience in North America and Western Europe (the first research question). Based on this research question, the discussion section that follows highlights the key findings of this study, comparing them to findings from the previously existing literature. Various studies separately illustrate the impact of CRE in rural regions of Western Europe and North America. Busch et al. (2021) describe the role of CRE projects in rural Europe, for instance, whereas Tsuji et al. (2021) examine the effect of CRE on the socio-economic conditions in rural Canada. Other studies compare the consequences of CRE projects in North America and other regions or in Western Europe and other countries. For example, while Hoicka and MacArthur (2018) compare CRE and its significance in rural Indigenous communities in Canada and New Zealand, Simcock et al. (2016) show the importance of CRE in rural Europe and South America. However, a comprehensive study regarding the role of CRE both in rural Europe and North America has previously been lacking despite the potential for valuable insights as both regions have similar socio-economic conditions and can therefore share their knowledge to support rural community resilience in a period of the energy transition. This chapter fills this knowledge gap by focusing on Western European and North American CRE projects. In addition, several studies document various impacts of CRE, including financial, socio-cultural, and environmental progress in rural regions (Becker & Kunze, 2014; Okkonen & Lehtonen, 2016; Van Veelen & Haggett, 2017). However, few studies describe these outcomes using a rural resilience framework, particularly with attention to the key resilience characteristics of: diversity, networks and connectivity, equalization, and adaptation (Heijman et al., 2019). An exception includes Beeton and Galvin (2017), who show in western Montana that wood-based CRE could assist rural forest community resilience through different socio-environmental changes. Again, this chapter attempts to fill this knowledge gap.

The study found that CRE greatly contributed to rural resilience in both regions. For instance, in line with the findings of Caramizaru and Uihlein (2020) and Van Der Waal (2020), this review found that CRE accelerates rural diversity in two keyways: through economic diversity and regional development and energy diversity and resilience. CRE projects are creating greater economic health and diversity for rural communities by generating employment, rent and lease payments, revenues for local businesses, investments in the community, adaptation and innovation in traditional sectors, and sectoral diversification. Perhaps CRE's most significant economic contribution is that it has created more jobs for the local communities than those generated by commercial, non-locally owned energy projects (Farrell, 2014). Speaking also to equalization as an aspect of resilience, only mainstream groups but also different minority groups, including Indigenous workers and communities, have been able to secure more employment opportunities through CRE compared to private energy ownership models. This is illustrated, for example, by studies of Canadian Indigenous-based CRE projects (Hoicka et al., 2021; Hoicka & MacArthur, 2018). Studies like Delicado et al. (2016) and Haggett and Aitken (2015) show that CRE also creates varied revenue and investment opportunities for rural communities. CRE projects have generated benefits through the payment of land rental and royalties to landowners, for example. Notably additional benefits occur because investments in and revenues generated by CRE projects tend to stay local. In addition, this review found that local residents and enterprises can save energy costs by producing their own energy and investing these savings in other economic activities. Through investment, funding and revenue generation, CRE inspires further investment in different sectors within the community, including housing, human capital, forestry, and tourism. CRE also promotes adaptation and innovation in traditional sectors through social entrepreneurship and generating localized value-added activities in rural areas (REN21, 2017; Miller et al., 2019). Islam and Vodden (2023) explain, for example, how, aided by cooperative organizing and local culture, CRE projects can assist the formation of social entrepreneurship and the flourishing of a localized value-added supply chain in Western Europe. By working collectively through the CRE project, communities can share both risks and rewards, minimizing their investment exposure while pursuing innovation and new opportunities. However, CRE projects and these economic outcomes are found to be more common in rural communities of Western Europe compared to North America.

While many previous studies, such as Lipp & Bale (2018), Lehtonen & Okkonen (2019), and Slee and Harnmeijer (2017), focus on CRE project contributions to local economies in rural areas, this study also found that CRE improves energy diversity and resilience. Firstly, it provides a new avenue for addressing local energy needs. Secondly, CRE assists in improving grid resilience by distributing energy between energy generators and developing micro-grid energy networks, which do not need a vast network of overhead lines to distribute power and function securely during a disaster (Chrobak, 2019). Thus, CRE has facilitated increased local self-resilience and resilience through the energy transition, provision of green infrastructure, and decentralized energy storage and distribution systems (Armstrong, 2015; Hentschel et al., 2018; Koirala, 2016). Finally, CRE projects induce improved access to renewable energy through community ownership with flexible payment systems (IRENA, 2020).

Rural and small-town communities often have strong communal relationships and connectivity; however, economic deprivation, the global pandemic, demographic and environmental change have been impacting these social relationships (Augère-Granier & McEldowney, 2021; de Jong Gierveld, 2006). This review found that CRE initiatives and related activities can trigger various types of networks and connectivity within and across communities in rural areas, including information exchange and different forms of external and internal networking. These connections have positive consequences for building trust and social acceptance for CRE (and ultimately other community activities). Several studies (e.g. Berka & Creamer, 2018; Fernandez, 2021; Koirala et al., 2018) mention that lack of trust is a crucial challenge for the energy transition in rural areas. However, this study found that due to the CRE, energy transition in rural areas allows local communities and entrepreneurs to invest in regional renewable energy and induces them to move toward decentralized and sustainable energy systems (Rieger et al., 2016), hence bringing new actors into energy sectors. This increases the diversity of community networks and collaboration opportunities (Kaphengst & Velten, 2014; van Summeren, 2020). Further, CRE projects employ a variety of public engagement techniques, assisting people to obtain information and share their knowledge. Ayers et al. (2014), and Van Der Waal (2020) add that many CRE projects initially bring energy information in from outside of their community then filter this information through interpersonal interactions and existing connections within and outside the community, including with other organizations such as energy cooperatives, government organizations, and funding agencies. Therefore, CRE is seen as a broker of information and networks, facilitating the formation of both bonding and bridging networks between energy participants and others.

Another key objective of this study was to explore the role of the CRE in equalization, a third key characteristic of rural community resilience. This review found that economic diversity, networks, and connectivity can, in turn, assist environmental justice, including procedural and distributional justice in the energy equalization process. A large number of studies illustrate efforts to ensure both procedural justice, through participation and engagement, for example, as well as distributional justice measures, such as ownership and benefit sharing, which provide positive social and ecological outcomes (Becker & Kunze, 2014; Ruggiero et al., 2019; Van Veelen & Van Der Horst, 2018). Regarding procedural justice, in line with Suškevičs et al. (2019) and Simcock (2016), this review found that CRE contributes significantly to access to information and the decision-making process through multiple engagement processes and resident input. This review found that CRE typically adopts the "consult-consider-modify-proceed" process rather than the "decide-announce-defend" model (Walker & Baxter, 2017); consequently, local residents can be involved with the whole energy process, including energy site selection and production and other decision-making processes (Becker & Kunze, 2014; Roby & Debby, 2019). These collaborative processes increase project acceptance and decrease regional conflicts. Further, various community ownership models are triggering fairness in the distribution of resources and benefits. Consequently, distributional justice assists in inclusivity, community empowerment, and meeting local and regional needs including contributions to local culture.

Finally, this review finds that CRE has been demonstrated to aid in adaptation and adaptability in rural regions. As CRE mobilizes the local community through grassroots innovations like renewable cooperative activities adopted with smart technologies, it assists in coping with adverse situations such as energy disruption due to natural disasters or energy poverty, and it reduces the probability of expensive system failures (Alamaniotis et al., 2016; Community Energy, 2020; Menniti et al., 2018; IRENA, 2021). van Gevelt et al. (2018) and Benedek et al. (2018) describe the importance of smart renewable technologies for rural regions; however, without a focus on how smart technologies increase rural adaptability. This review found that smart systems open new opportunities for energy markets and export, bolstering financial performance and improving the feasibility of decentralized energy generation (Connolly et al., 2017; Lund et al., 2017). Moreover, CRE assists in improving awareness and promotes adopting a sustainable lifestyle, including participating in energy management and encouraging or compelling others to change their energy-consuming behaviour, which are all habits helping in climate mitigation and adaptation, self-organizing, and social learning processes that increase local residents' ability to learn to survive in challenging and uncertain environments (Creamer, 2015; DECC, 2012; RESCOOP, 2017; Sifakis et al., 2019). Diverse engagement and knowledge sharing through CRE initiatives can also promote the development of a systematic approach for planning and determining strategies to enhance adaptive capacity (Ayers et al., 2014; Van Der Waal, 2020).

In summary, CRE exerts a positive influence on several aspects of rural regions, including diversity, networks and connectivity, equalization, and adaptability. Diversity is recognized as a foundational strength of CRE, as it fosters a range of economic activities and innovative approaches. The establishment of various social networks and interpersonal relationships, both within and beyond local communities, contributes to equalization by promoting local acceptance and reducing regional conflicts. This, in turn, facilitates rural revitalization, bolsters ecological stewardship, and stimulates socioeconomic and cultural development in rural areas. The interplay of these factors underpins the transformative impact of CRE in empowering rural communities and driving sustainable progress.

2.5 Conclusion and Recommendations for Further Research

Various socioeconomic, population, and ecological dynamics hinder rural resilience both in rural North America and Western Europe. In such circumstances, deploying renewable energy is viewed as a substantial prospect for rural communities to enhance their energy security and overall resilience. However, most of the existing renewable energy systems are highly integrated with a large-scale centralized energy structure, predominantly focusing on carbon-neutral, cheap energy production rather than energy democracy, environmental justice, and social equality. Consequently, to ensure rural resilience, shifting from a centralized renewable energy system to a decentralized, democratic renewable energy model, referred to as community renewable energy (CRE), is essential.

This study focuses on how CRE initiatives have impacted rural resiliency and found that CRE is having significant positive impacts on rural resilience across the dimensions of diversity, networks and connectivity, equalization, and adaptability in North America and Western Europe. CRE accelerates rural diversity; however, contributions to rural diversity are particularly strong with respect to economic diversity and regional development. These diversity enhancements are both furthered by and contribute to a variety of networks and connectivity, as well as facilitate energy justice, including procedural and distributional justice. These also assist rural community self-organization and enhance their social learning processes; subsequently, local community adaptability, including their ability to learn to survive in a challenging and uncertain environment, is increased.

Compared to North America, Western Europe has introduced the CRE model largely in rural areas. Most rural Canadian communities are located in remote areas, highly dependent on fossil fuels, and experiencing economic downturns. As CRE positively contributes to rural resilience, including diversity, network and connectivity, equalization, and adaptability, North America, particularly Canada, may employ this CRE initiative extensively in rural areas to increase the rural revitalization process. For this, provincial and federal governments in Canada should promote a more cooperative culture, adopt various policies, including FIT, and implement various laws and regulations concentrating on community-led initiatives based on the local ownership structure.

This renewable energy model has some significant limitations. Despite the above-noted contributions, unfair access to membership and benefits, lack of technological maturity, energy storage problems, and regulatory obligations with regard to connection to the existing grid infrastructure are among the major challenges for energy transition and CRE more specifically (Knox, 2022; Rae, 2020). The findings of this study offer important insight regarding energy transition and rural revitalization scholarship. However, the results of this study are drawn from secondary sources. Therefore, further research is needed based on both primary and secondary data on these issues and how CRE can best be facilitated in rural regions as part of a global effort toward energy transition.

CHAPTER 3: WHAT FACTORS CONTRIBUTE TO COMMUNITY RENEWABLE ENERGY IN WESTERN EUROPE AND NORTH AMERICA?

3.1 Introduction

Community renewable energy (CRE) refers to a decarbonized, decentralized, democratic energy system that is bottom-up, localized, and primarily determined by the needs, inspirations and socio-cultural values of communities (Brummer, 2018; Islam, 2018; van Veelen, 2017). It is generated and shaped by local socioeconomic, institutional, and environmental issues and technological settings and includes communal ownership, emphasizing collective benefits, public engagement, and other societal goals rather than solely maximizing financial gains (Klein & Coffey, 2016; Pohlmann, 2018). CRE has been demonstrated to result in increased diversity, equalization, adaptability, and networks and connectivity in the local community (Becker & Kunze, 2014; REN21, 2017; Furlong, 2020). A substantial and growing body of literature has illustrated various factors and issues facilitating or creating barriers to the deployment of CRE based on various theories, including the multilevel perspective theory (Magnani & Cittati, 2022); social practices theory (Butler et al., 2016), and triple line theory (Atahau et al., 2021), and with a focus on various dimensions including economic, technical, and policy (Perlaviciute & Steg, 2014; Plum, 2020; Ruggiero et al., 2019); Again, different studies described multiple factors for CRE. However, these factors mostly vary based on various psychological conditions, including local community attitudes, perceptions, and how the project was implemented. For instance, Kracher (2021) and Byrne et al. (2021) demonstrated the importance of different motivational and behavioural factors for the success of CRE in Europe, while Hicks & Ison (2018) and Dall-

Orsoletta et al. (2022) illustrated the role of various organizational and motivational factors for CRE projects in Europe and North America respectively. Subsequently, it is vital to further examine how different conditions, including contextual, motivational and project-related, influence the growth and maturity of CREs in specific contexts and why certain CRE initiatives have been effective in achieving intended community results while others have not. Again, a few studies focused on the various determinant factors of CRE in rural areas. For example, Streimikiene et al. (2021) and Romero-Castro et al. (2022) describe CRE's miscellaneous drivers and barriers factors in rural Europe. Similarly, Olson-Hazboun (2016) explains various determinant factors of CRE for rural USA. However, comparing various enabling or disabling factors for CRE between the rural areas in both settings was not studied.

This research investigates these supporting or disabling factors in the case of rural Western Europe and North America based on the three key categories identified within this growing body of literature, including contextual (socio-cultural, politics, policy and institutional, physical & technical, ecological & environmental, and economic & financial factors), motivational (economic regeneration, acceptance of renewable energy, and environmental concern), and project-oriented factors (engagement and networking, project leadership, and project ownership structure)

This chapter is organized into four sections, beginning with an explanation of the methods and methodology of the study. Second, the study describes the results of the systematic review according to three major categories of enabling or disabling factors. Thirdly, we compare Western Europe and North America, considering these factors, followed by a discussion and conclusion.

3.2 Methodology and Methods

The overall approach of this study is explanatory, adopting a systematic literature review following the methodology used by Łukasiewicz (2022) and Mohammadinia et al. (2018), which maintains six steps in its research protocol, including i) setting out a research question; ii) creating a plan; iii) searching for required literature; iv) fixing various exclusion and inclusion principles; iv) performing both quantitative and qualitative methods of analysis, and vi) describing the results (see Figure 8). We selected North America and Western Europe as regions of focus to describe different enabling and disabling factors for CRE because, firstly, both settings are industrialized with large energy production demands and have access to a variety of energy production technologies. Secondly, due to adequate government and other private finance opportunities, various renewable energy-generating ventures were formed in both North America and Western Europe. Thirdly, there is a substantial amount of literature regarding renewable energy for both of these contexts to draw from.

For data source identification, the study performed a search based on three academic databases: Scopus, Science Direct, and Sociological Abstract. The date range was 1997, the year when new energy policies started to emerge based on the Kyoto Protocol for reducing greenhouse gas emissions (Bagozzi, 2015), to 2023. To increase the depth of the study and ensure the diversity of data and information, the study also used various gray literature sources, including ProQuest (Thesis and dissertations) (Vaska et al., 2019), Google Scholar (Paez, 2018), web search (Kazi et al., 2022) on different prominent energy organizations, namely REN21, International Renewable Energy Agency (IRENA), World Wind Energy Association (WWEA), and Renewable Energy and Energy Efficiency Partnership (REEEP). For the gray literature, the first ten pages of search results were chosen for selecting relevant articles or documents because, typically, these pages contained the most relevant search results (Raven et al., 2016).

To acquire the appropriate literature, key terms based on the principal themes and subthemes of the study were selected for search. For example, “renewable energy,” “community energy,” and “factors for community renewable energy” were three key initial terms derived from the principal themes of this study. Based on the three key subthemes (common types of factors evident in an initial scan of the literature)—contextual, motivational, and project factors—eight additional search terms were selected: “socio-cultural issues,” “politics, policy and institutional issues,” “physical & technical factors,” “ecological & environmental factors,” and “economic and financial factors” (contextual factors) along with “ownership in CRE” and “engagement and networking factors” (project factors). Based on this strategy, we initially identified 7897 studies. These identified sources were reviewed with two exclusion criteria in mind: (i) document properties exclusion criteria such as no full text available, not published before 1997, or not written in English; and (ii) content exclusion criteria, for example, non-European and non-North American countries; works only partially related, like urban renewable energy projects, global renewable energy deployment, hybrid (renewable & non-renewable) energy projects, editorials, letters, and meeting reports; entirely irrelevant subjects like hydrocarbon energy, including oil, gas, and coal; and Engineering and physical science related documents. Finally, 110 publications were selected for thematic analysis (See Figure 8).

The research used three distinct thematic analysis methods, namely initial, focused, and theoretical coding strategies, as Salm et al. (2021) and Thomas & Harden (2008) outlined. The initial phase of coding permits the identification of any potential themes that might emerge from the literature. Conversely, focused coding employs a systematic and inductive approach, categorizing data according to thematic similarities on a descriptive level. Finally theoretical coding incorporates these thematic categories into fundamental theoretical constructs, thereby advancing the analysis to a more elevated level of abstraction and conceptual understanding.

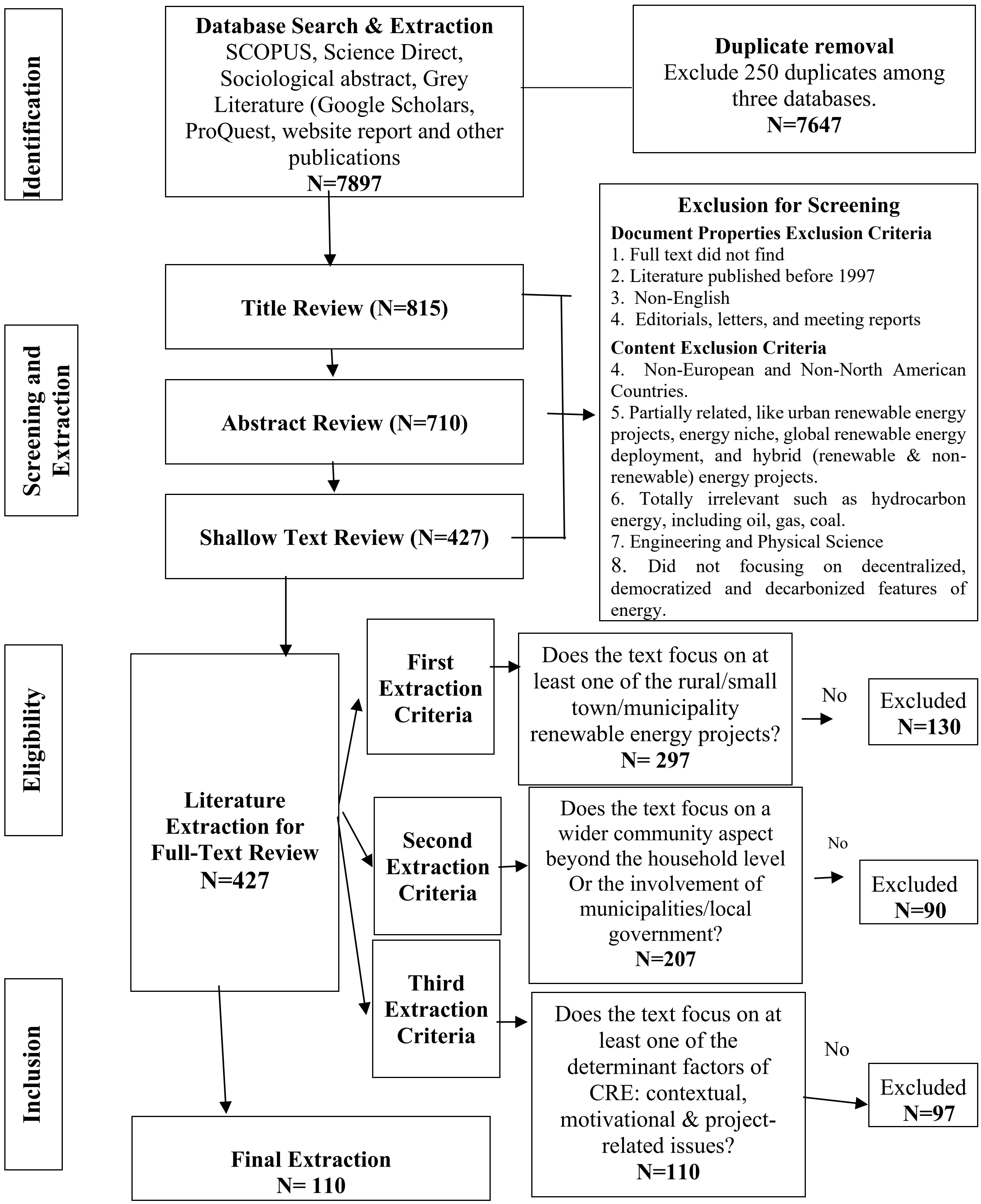

Figure 8: Systematic Review's Steps for CRE and Determinants Factors

3.3 Results

3.3.1 Enable or Disable Factors for CRE in Rural Areas

CRE is local or regional-based (decentralized) renewable energy production (decarbonized), governed and owned by the local community (democratized). Thereby various contextual factors have a significant role in the deployment of CRE. Motivation also shapes project outcomes. For example, community perception and attitudes regarding renewable energy greatly motivate local inhabitants to participate, implement and manage their renewable energy projects (Brummer, 2018). In addition, different project-oriented issues, including leadership, funding, investment, and ownership, are key determinate factors for CRE (Hicks & Ison, 2018). Figure 9 shows the various determinant factors of CRE, where different contextual factors are the most commonly noted. Of those contextual factors, politics, policy and institutional factors, economic and financial factors, and physical and technical factors are the most dominant. Similarly, economic regeneration is the most cited of the motivational factors, whereas project ownership, engagement, and networking were stated most frequently in terms of project-related factors. The remainder of this section elaborates on how the three important categories of factors, namely contextual, motivational, and project-related factors, have accelerated or hindered the expansion of CRE in North America and Canada.

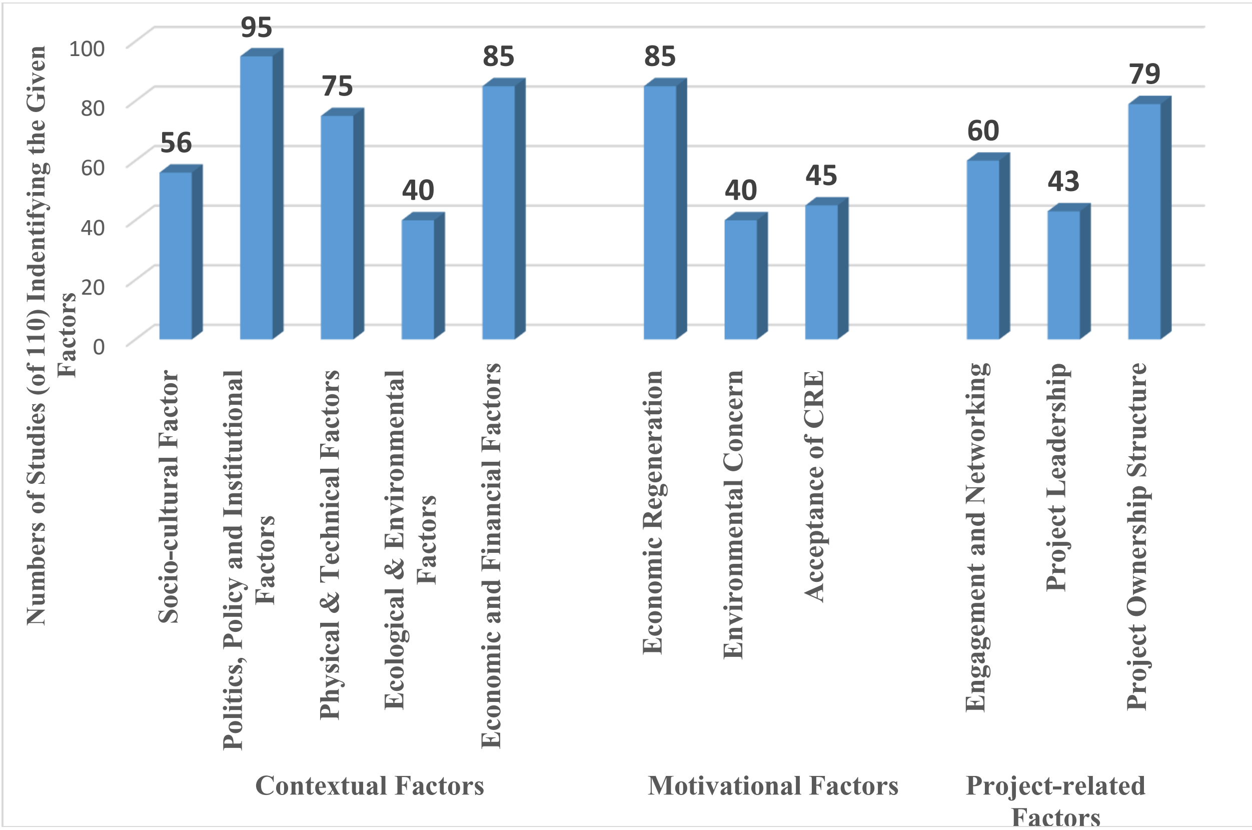

Figure 9: Various Determinant Factors of CRE Cited in the Literature

3.3.1.1 Contextual Factors

Contextual factors refer to the context- or place-oriented issues which promote (or inhibit) the birth and growth of different forms of CRE (Verde & Rossetto, 2020; Perlaviciute & Steg, 2014). Contextual factors can be further categorized into sociocultural factors, politics, policy and institutional factors, physical and technical issues, economic and financial factors, and ecological and environmental issues (Ruggiero et al., 2019).

3.3.1.1.1 Socio-cultural Factors for CRE

Various societal structures and characteristics—including the level of education and wealth, traditions of social innovation and cooperative or non-profit organization culture, social movements and civic engagement, societal norms and trust, and community identity and place attachment—strongly shape the formation of CRE and involvement in those energy projects in rural areas (Fernandez, 2021; Hicks & Ison, 2018; Simcock et al., 2016). Educational attainment, knowledge, and awareness heavily affect the local community's willingness or unwillingness to participate in CRE projects (Magnani & Osti, 2016; Ruggiero et al., 2021), especially when there is a lack of knowledge. This may include a deficiency in technological understanding. Poor knowledge about various regulations and subsidies has also been described as a key barrier to the expansion of CRE (Palm, 2020). In the UK, Mirzania et al. (2019) show that 23% of community-led renewable energy groups have faced inadequate knowledge regarding a proper business framework for a renewable energy project. After reviewing different influential variables regarding the CRE, Koirala et al. (2018) show a correlation between years of schooling, energy literacy, and energy participation in the USA, Germany, Netherlands, and Canada. Similarly, a ten-year (2004–2015) panel of data from 28 OECD countries synthesized by Soukiazis et al. (2019) found that human capital, including educational achievement, positively impacts renewable energy. Highly trained, business-oriented, and environmentally conscious knowledge is essential for the CRE; in the short and long term, vocational training and other skill development knowledge can contribute to the expansion of renewable energy (Sart et al., 2022). In the case of Europe, Palm (2020) recommends further research to explore the role of knowledge and education in the participation of community members in a CRE project.

Human beings learn from their everyday interactions with others and by watching the consequences of others' actions. Social norms influence individuals' socio-cultural behaviour. As social norms are expected or standard behaviour in society, they can encourage or create cooperation among community members and influence them to take positive social and environmental actions (Soeiro & Dias, 2020). Empirical studies focused on the role of societal and environmental norms and trust in forming CRE projects, for instance, observe that various environmental norms, such as i) respect for nature and conserving it for future generations, ii) increase individual energy savings behaviour, further assists in establishing rural eco-friendly energy project (Gadenne et al., 2011; Soeiro & Dias, 2020; Thøgersen & Grønhøj, 2010). Ozaki (2011) also found that norms, such as belief in the importance of climate change mitigation, positively influence sustainable energy innovation. Similarly, after a comparison between 31 European countries, Chan et al. (2002) demonstrated that along with energy policy and technological development, both descriptive norms (the actions and behaviors of other individuals) and injunctive norms (beliefs about what ought to be performed) are positively correlated with support for the renewable energy transition. Further, these correlations are stronger among the countries that have a greater level of cultural closeness. Social norms like community emotions, expectations, and cultural ties also help promote procedural and distributive justice in local CRE projects (Karakislak, 2021), which consequently tend to be more successful than other energy projects (Islam & Vodden, 2023).

Through the strong interconnectivity among community members, social norms produce different types of community confidence or trust (Plam, 2020). Trust assists in building mutual reciprocity and confidence, increasing collaboration, and creating various forms of social capital, which increases through collective activities (Sperling, 2017). Therefore, trust is a precondition for the success and implementation of the CRE project (Berka & Creamer, 2018; Koirala et al., 2018). Many externally led renewable energy activities driven by commercial motivations have resulted in damaged community trust (Soeiro & Dias, 2020). Several energy studies (Fernandez, 2021; Maleki-Dizaji et al., 2020; Walker et al., 2010; Walker & Devine-Wright, 2008) show that a lack of teamwork, local involvement, and consultation also leads to the decline of trust, resulting in various obstacles to implementing renewable energy technologies. Plam (2020) used the case of the European energy system to show that trust is necessary for CRE and that lack of trust has been a significant barrier to the emergence of CRE in Italy and Slovenia, compared to the Netherlands and Sweden. Similarly, in a recent study in New Brunswick, Canada, Comeau et al. (2022) found that, rather of self-interest like NIMBYism (Not-In-My-Back-Yard perspectives), dis/mistrust due to the lack of procedural and distributional justice was the key reason for the failure of a wind energy project. On the other hand, trust is also an outcome of CRE—for example, due to the ownership opportunities and democratic nature of CRE. A CRE member has access to different stakeholders or social groups, including local government, energy experts, and NGOs, which can help to produce new values and societal norms and assist in the creation of trust including interpersonal or institutional trust (Berk &Creamer, 2018; Ruggiero et al., 2014; von Bock und Polach et al., 2015).

Local culture, including social enterprise and cooperative traditions, is another vital enabling factor for the emergence and diffusion of CRE in rural regions (Bere et al., 2017; Creamer, 2015; Mono, 2018). Based on the local culture, different community members organize themselves and desire to facilitate various social, economic, or other forms of regeneration for their community (Fernandez, 2021; Hewitt et al., 2019). Due to the culture of social clubs and associations, the Juhnde community's trust in Germany has been enriched, promoting favourable conditions to build the CRE initiative in that rural region (Simcock et al., 2016). These community-based activities assist in building the culture of business in accordance with their societal needs—often in the form of social enterprises like renewable energy cooperatives (Bomberg & McEwen, 2012). Ruggiero et al. (2019) illustrated that, as of 2016, Germany had 1024 registered renewable cooperatives, primarily wind-based renewable-energy projects formed by local rural farmers inspired by their traditional social enterprise culture and cooperatives. In the case of two English CRE projects, namely Wiltshire Wildlife Community Energy and Brixton, alongside the tradition of community-led activity, social enterprise and collective voluntary actions were the important enabling factors for the origin and development of these CRE initiatives (Community Share, 2015; Simcock et al., 2016).

The clean energy movement and civic engagement are other significant success factors for CRE, as social movements and activists create pressure to adopt various regulations and initiatives in favour of social enterprise, including CRE (Becker et al., 2017; Caramizaru & Uihlein, 2020). Numerous empirical studies have described that the anti-nuclear energy movement, environmental campaigns regarding climate change, and protests against large-scale centralized renewable energy were important drivers for CRE in rural Western Europe and North America (Fernandez, 2021; Ruggiero et al., 2019; Simcock et al., 2016; Stephens, 2019). From three CRE projects in Western Wales, Spain, and Germany, Becker et al. (2017) show that the origination of CRE is connected with local community involvement and social movement. The authors also found that different environmentalist NGOs or activist groups criticized existing energy structures and business practices, creating a favourable environment for a participatory democratic energy system. Simcock et al. (2016) showed that the anti-nuclear movement in Germany has made local communities more interested in alternative energy, such as renewable energy cooperatives.

Whereas in Scotland and Denmark, a lack of opportunities for participation and ownership has led to a social movement against large-scale commercial renewable energy projects, making it easier to diffuse decentralized renewable energy projects. Moreover, Berka & Creamer (2018), Haf & Parkhill (2017), Plam (2020), and Simcock et al. (2016) explained that a strong sense of place, including geographic place, common culture, and history helps to develop a sustainable, self-regulated autonomous energy system in rural areas.

3.3.1.1.2 Politics, Policy, and Institutional Factors for CRE

Various political factors also greatly shape community-oriented development activities. The highest numbers of research (95 out of 110 studies) demonstrate that decisive factors both for enabling and disabling CRE include: political institutions such as the energy market structure (Caramizaru & Uihlein, 2020; Brummer, 2018) and energy actors (Hewitt et al., 2019; IRENA, 2020; Walker, 2008); various policy measures such as legislation and regulations (Suwa & Dreyfus, 2018; IRENA, 2020); subsidies and financial policy (REN21, 2017; Plum, 2020); and different institutional arrangements such as administrative processes (Oteman et al., 2014), requirements for project management (Young & Bran, 2017; Ruggiero, 2019), and acquiring essential permits (Fernandez, 2021; IRENA). These factors determine what types of financial benefits, knowledge, and skills are allocated for a CRE project and how a CRE enterprise enters the existing energy market (IRENA, 2020).

The nature of the energy market has played a significant role in the emergence and expansion of CRE (Suwa & Dreyfus, 2018; Yaqoot et al., 2016). For instance, in a deregulated energy market where energy prices fluctuate based on the demand-supply curve, anyone can produce and distribute energy if they fulfill the minimum requirements. However, the absence of a long-term price guarantee creates various financial barriers for small and medium-sized community-based energy producers (PEMBINA Institute, 2010). Again, most energy markets follow either a monopolized, liberalized (focuses on introducing competition and reducing government control), or hybrid structure, where very few or a variety of actors govern and control energy production, supply, and distribution (Roques et al., 2016). A decentralized system consists of a wide range of actors (prioritize local stakeholders) , facilitating the development of CRE, whereas a monopolized energy structure, centralized and dominated by only a few energy actors, is considered a hindrance to CRE (Plum, 2020). In Germany, for example, there were four major organizations—(i) Eno, (ii) Vattenfall, (iii) EnBW, and (iv) RWE—which produced more than 80% of hydrocarbon-based energy production; as a result, they had a strong lobby and influence in the energy sector. After Germany implemented decentralized and renewable energy strategies, these four large organizations have only a 6.5% share in the renewable energy sector, while individual households, and cooperatives including local farmers own 40% and 10% of renewable energy, respectively (Oteman et al., 2014). The German policy discourse prioritized energy transition via decentralized projects involving multiple levels and actors in the energy production and distribution system (Suwa & Dreyfus, 2018). Seeking to understand the role of policy and energy business structure on CRE projects in six European countries, Plum (2020) found that the energy markets of these countries, except Germany and the Netherlands, are controlled by a few major energy organizations. On the other hand, the decentralized energy market in Germany and the Netherlands offers financial independence for local energy organizations and creates more active participation for various actors, including local government and communities. In the context of Canadian Indigenous micro-grid energy entrepreneurship, Hoicka et al. (2021), Hoicka &

MacArthur (2018), and Indigenous Clean Energy (2020) revealed that different Indigenous actors take the initiative for CRE projects in Canada. This successful inclusion of previously excluded groups has pushed the government to undertake an active role in decentralized energy markets and set up support packages, laws, and rules for CRE projects (Plum, 2020). Considering the energy structure and distributed energy projects in France, Suwa & Dreyfus (2018) similarly show that along with the commitment to renewable energy deployment, reforms in the energy structure, including compulsory local energy strategies and partnerships with public and private energy actors, implemented in the Energy Transition for Green Growth Law, have been enhancing the process of energy decentralization in France. Brummer (2018), in the case of the UK, also demonstrated that a more centralized energy framework and large-scale production through a corporate organization is a key barrier for CRE.

Several policy schemes, including legislation and regulatory frameworks, have been contributing to mobilizing community-based activities as well as creating barriers to the growth of these initiatives, notably when policymakers or regulatory agencies have failed to adapt these laws and regulations in accordance with new energy market situations (REN21, 2017). Different developed countries like the UK, Germany, the USA, and the Netherlands have implemented various laws and regulations concentrating on community-led initiatives based on the local ownership structure, resulting in a double benefit for the local community: social acceptance and meaningful engagement on the one hand and low-cost renewable energy production on the other (Young & Bran, 2017). In Germany, for example, the Federal Electricity Feed-In Act (1991), the New Renewable Energy Source Act (2000), and the German Co-operative Law (2006) accelerated the expansion of renewable energy; particularly the “the 2000 act” offered an attractive energy incentive for renewable energy producers and implemented an equalization scheme to reduce the cost differences covered by the grid operators (Suwa & Dreyfus, 2018). Consequently, from 2005 to 2016, over 150 new local municipal-based utility organizations formed, creating a decentralized decision-making culture and promoting more installation and growth in the energy community (Wagner et al., 2021). However, the number of CRE projects has dramatically dropped as Germany revised this regulation and implemented an auction policy in which a community must meet specific economic, technical, and administrative requirements to succeed in bidding. The USA adopted community choice aggregation (allows local governments or community entities to aggregate the purchasing power of residents, businesses, and municipal facilities to procure electricity on their behalf) and virtual net metering regulations, inspiring the expansion of subscription-based CRE projects. According to these policies, multiple consumers can buy or rent a certain portion of an off-site renewable energy project and get discounts on their bills based on their share in the renewable energy project (Heeter & Fekete, 2020; IRENA, 2020). However, cross-subsidies (redistributing revenue from one group to another) between prosumers (who do not only consume goods or services but also actively produce) and individuals who do not use their own energy are a key challenge for virtual net metering schemes (IRENA, IEA, and REN21, 2018). Again, due to the rigid regulatory structure, virtual net metering can create lock-in effects and reduce the community's innovation capacity (Plum, 2020).

To summarize, both North America and Europe have adopted numerous supporting policy instruments for CRE, which broadly fall into three categories: i) feed-in-tariff (FIT); ii) price-based instruments like tax incentives and investment subsidies; and iii) quantity-based instruments such as auctions, quotas, or bidding systems (Schallenberg-Rodriguez, 2017). FITs, a common type of economic supportive policy instrument, have a substantial influence on the growth of prosumers' culture, investment, collective ownership, and participation in CRE projects (Caramizaru &

Uihlein, 2020; Hewitt et al., 2019; REN21, 2017; Suwa & Dreyfus, 2020). A FIT is a price regulation pattern in which energy producers receive a set amount of financial assurance over a set period in exchange for producing renewable energy (Dóci & Gotchev, 2016). This price regulation safeguards the project's financial sustainability, motivating energy investors to invest in the project by contributing to its preliminary capital cost (Dong, 2012; Farrell et al., 2017; Rowlands, 2005). Furthermore, FITs may entice small and medium community-based groups to participate in renewable energy projects, increasing the deployment of renewable energy capacity (Mah et al., 2021). For instance, Ragwitz et al. (2012) found that until 2010 Europe installed approximately 93% and 100% of their entire onshore wind and photovoltaic energy through the FIT policy. Similarly, due to the FIT system, in 2020 Germany produced around 43.4 percent of its total energy from renewable sources and around half of these renewable energy projects are owned and controlled by local community groups (Karakislak, 2023)). Moreover, this policy instrument promotes technological learning through "learning-by-doing" methods in which individuals or actors engage directly with the energy project, develop practical skills and learn from their mistakes (Rowlands, 2005, p. 5).

However, the success of this policy scheme depends on various factors, including the right to access the energy grid, a modest profit from the investment, a regular project review, a long-term agreement, and no cap or limit on the quantity of renewable energy that is developed (Mah et al., 2021; Mirzania et al., 2019; Plum, 2020). Thus, any unbalanced change in the FIT can create a financial burden for the local community, resulting in declining CRE project growth (Caramizaru & Uihlein, 2020; Mah et al., 2021; Haggett et al., 2014). Mirzania et al. (2019) investigated the impact of policy changes in the UK's CRE project and found that changes in the FIT scheme, such as a reduction in the premium rate and the elimination of FIT pre-registration, were disrupting community-led solar projects. In the case of Germany, Caramizaru & Uihlein (2020) also found that after the removal of the FIT scheme in 2015, the number of newly formed renewable energy cooperatives dropped by 25% compared to 2014.

Price-based instruments, including fiscal incentives and investment subsidies, can fix the unit price of renewable energy (Schallenberg-Rodriguez, 2017). Various tax incentives—such as tax credits for renewable energy production and investment, rebates for emission taxes, lower VAT rates, accelerated depreciation schemes, and tax exemptions for green funds—incentivize investors to invest in CRE projects by providing a greater rate of return (IRENA, IEA, and REN21, 2018). These tax or fiscal incentive programs, along with other policy tools, were implemented by Scotland and the United States to deploy CRE projects. However, the biggest challenge with this form of price-based policy tool is that non-taxable organizations cannot benefit from it (Farrell, 2016; IRENA, 2020).

Quantity-based instruments, including auctions, quota systems, and renewable energy certificates, on the other hand, create an obligation for energy users or utilities to use or produce a certain amount of renewable power, allowing the energy market to decide its price (Schallenberg-Rodriguez, 2017). These policy instruments are specially designed to procure energy at the lowest cost as well as promote the inclusion of small and new energy actors through various compliance flexibility measures, including facilitating energy trading and market liquidity. However, these quantity-based instruments create major hindrances; in the bidding system, energy producers are required to fulfill certain requirements, including advance investments, without being assured an agreement. This enhances the fiscal risk for local community energy actors (IRENA, 2019; Plum, 2020; Schallenberg-Rodriguez, 2017).

Different institutional arrangements and actors, including various intermediate organizations and municipalities, contribute to the growth and development of CRE as they assist in connecting different stakeholders like politicians, government officials, and others, leading to the formation of a shared learning and networking platform for CRE (Ruggiero, 2019). Multiple empirical studies show that various tools of administrative bureaucracies—including the environmental impact assessment (EIA) report, essential permits for construction, grid access, and renewable energy production—are often key hindrances to the deployment of small-scale, decentralized renewable energy in rural regions (Community Power, 2014; Fernandez, 2021). In this regard, Plum (2020) found that different umbrella organizations in the UK, Germany, and the Netherlands enable the diffusion of CRE projects by arranging financial assistance, raising awareness, and providing administrative support. Simcock et al. (2016) show that local universities provide various institutional supports, including technical and policy assistance, for the emergence of community bioenergy in Germany. Hall et al. (2016) also demonstrate that local financial institutions facilitate community-led renewable energy transitions in Germany, and to overcome institutional burdens Scotland formed one-stop shops from where the community can easily get required information and advice regarding CRE (IRENA, 2020; OECD, 2020).

3.3.1.1.3 Physical and Technical Factors for CRE

Different physical conditions and technical issues of renewable energy—such as (i) the availability of natural resources, (ii) design, installation, and functioning of renewable energy technology, and (iii) the required knowledge and skill for renewable technology—have been widely mentioned as crucial factors (see figure 3.2) because of their role as enablers and disablers for the deployment of CRE (Creamer, 2015; Furlong, 2020; IRENA, 2020; Seetharaman et al., 2019; UNCATED, 2019). Factors such as the site's topography, accessibility, physical position and infrastructure determine the cost and efficiency of the CRE project. In the design, setup, and functioning of renewable energy, decentralized microgrids and smart technologies (including net-metering and virtual power plants or virtual net-metering) are greatly contributing to the diffusion of CRE through automated and optimized energy systems where the local community can manage and control their energy demand and supply (Connolly et al., 2013; Ford et al., 2019; IRENA, 2020; Lund et al., 2017). Smart energy systems offer better energy security and increase the guarantee of energy supply and reliability, reducing the probability of grid outages and financially expensive system failures (Alamaniotis et al., 2016; Hargreaves et al., 2015; Menniti et al., 2018;). Through local energy demand management and energy system balancing, smart technologies assist in better aligning peaks in energy supply and demand on the grid (Geels et al., 2017). Smart technologies are incorporated into energy systems by acquiring and utilizing various data to help with a wide range of process improvements that can lead to greater efficiency and lower costs (Ford et al., 2019). Enercoop in France, for instance, established "Dr. Watt," a smart energy package including software and online tools to assist consumers in making a self-diagnosis of their specific electricity consumption, as well as help them save energy through an online manual (Sifakis et al., 2019). This intelligent use of system data enables users to make more informed decisions about their energy use (Mathiesen, 2015). However, a lack of technological maturity in smart technology, inaccessibility of standards, high grid connection costs, consumer data privacy and cybersecurity concerns, and energy storage limitations have all been significant barriers to the installation and operation of renewable technologies (Plum, 2020; Rae, 2020; UNCATED, 2019; Zhao et al., 2016).

Most CRE projects are in rural areas, so they need additional energy lines to connect to the main grid. However, only some of these grids are designed to integrate with renewable energy. Consequently, grid integration is a key barrier to reducing the deployment of CRE projects (Seetharaman et al., 2019). Again, most renewable energy technologies are relatively new, and since they are constantly changing, it can be hard to operate and maintain them and hard to find equipment and parts, which drives up the cost of energy production (Bhandari et al., 2015). Lack of essential skills and knowledge, including the installation, management, and maintenance of renewable energy, are also major issues for the diffusion of CRE (Viardot, 2013). The absence of an operation and maintenance culture creates further barriers to implementing CRE projects in rural areas (Streimikiene et al., 2021).

3.3.1.1.4 Ecological and Environmental Factors for CRE

The availability and quality of natural resources greatly impact how CRE is used, including the size and types of CRE projects. Accessible land, airspeed, and wind intensity are key examples of wind power (Talinli et al., 2011). Due to the availability of strong winds, some areas become suitable for wind farms—for example, the presence of high wind speed and wind density in Newfoundland and Labrador. Barrington-Leigh and Ouliaris (2017) mentioned that 25% area of Newfoundland and Labrador has high potential wind area. On the other hand, the Dodecanes islands in Greece could not spread community wind energy because of the seasonal variability of wind in these islands (Khan & Khan, 2019). Access to the required land is a vital factor for the CRE project. For instance, Haggett & Aitken (2015) mention that private land ownership in

Scotland is very restricted; consequently, several CRE initiatives are strongly linked to land reform and communal land ownership in various regions of Scotland.

Conserving biodiversity and reducing carbon emissions are two major enabling issues for CRE. There is abundant literature focusing on the importance of renewable energy for climate mitigation and energy sustainability. A higher degree of environmental consciousness accelerates local support and acceptance of the CRE in rural and small-town areas (Boon & Diepernik, 2014). To achieve these environmental goals, local residents form various energy groups; for instance, a study by Kalkbrenner and Roosen (2016) in rural Germany illustrated how interpersonal cooperation and environmental issues determine residents' involvement with energy cooperatives. Similarly, in the case of Ecopower, Belgium et al. (2017) found that participants in the energy cooperative were very pro-environment oriented compared to the non-participant groups. Instead of the economic impact, the local community sometimes prioritizes environmental needs when forming these energy groups. A study by Soeiro and Dias (2020) shows that localism and environmental problems are more important factors than financial gain for creating CRE projects in rural Europe. Simcock et al. (2016) also said that conserving biodiversity and reducing climate change are important reasons to use CRE. In fact, CRE is often seen as a sign that a country cares about the environment. Water, food, and ecosystem nexuses also promote the development of CRE by detaching the agrifood chain from traditional hydrocarbon energy and decreasing water intensity in the power sector (UNCEE, 2017). Bio Village, a model for rural CRE in Germany, was built at the nexus of energy, food, and the ecosystem (Simcock et al., 2016).

Concerns about the environment and ecology can also hinder the deployment of CRE, particularly when local residents and environmental activist groups find that an existing or planned renewable energy project goes against current strategies and rules for managing resources. The

Crescent Peak Wind Energy Project in Nevada, for instance, has been denied by the government as environmental groups decry the adverse impact of the proposed energy project on public land and wildlife habitats (Susskind et al., 2022).

3.3.1.1.5 Economic and Financial Factors

Economic and Financial factors are the second most cited factor (88 out of 110 studies) for CRE. Economic viability, including access to financial services and capital, is an important enabling and, in many cases, disabling factor for the emergence and development of CRE in rural and small-town areas (Haggett & Aitken, 2015; Warbroek et al., 2019). Different studies, such as Creamer et al. (2018), Gancheva et al. (2018), Hall et al. (2018), and Ines et al. (2020), describe the significance of various grants, subsidies, and funding programs for the deployment of CRE, particularly in the beginning stage when an energy plan starts to be applied. Lack of financial support in the early stages can halt the formation of CRE (Horstingk et al., 2020). Consequently, different European and North American countries adopted various market-based incentives and policies, including FIT, tax incentives, investment subsidies, and one-time grants to help overcome the financial barriers to deploying CRE projects (CREIRENA, IEA, and REN21, 2018, Schallenberg-Rodriguez, 2017). However, these financial policies have some major criticisms, including funding uncertainties due to the prolonged payback time and ending dates of a particular policy (Miller et al., 2018; Viardot, 2013). Several innovative financial mechanisms were used to overcome financial barriers in North America, particularly the United States, such as public capital vehicle financing, carbon bonds, and power purchase agreements (Miller et al., 2018; REN21, 2017; RENA, 2021).

On the other hand, the UK mitigates the financial risk of CRE by partnering with other organizations, including local energy developers and business organizations. Along with this partnership model, the Scottish government formed a renewable energy fund called Community Renewable Energy Schemes (CARE), which provided loans and necessary expert advice for community groups to create and develop their own CRE project. As a result, Scotland established more than 20,000 CRE projects by June 2019, with around 730 MW of installed capacity, and gained the leading position for deploying community renewable energy compared to the rest of the UK. Similarly, in Europe the 'Renewable Energy Cooperatives Mobilizing European Citizens to Invest in Sustainable Energy' (MECISE) program assists small and medium CRE projects with financing during the preliminary phase of the project; they can then sell their ownership to the local community and other investors when the project is up and operating (REScoop, 2018). This is significant as community ownership has been seen as an important economic issue for CRE projects (Haggett & Aitken, 2015; Islam, 2018; Lipp & Bale,2018; Lehtonen & Okkonen, 2019; Munday et al., 2011; REN21, 2017; Seyfang et al., 2013).

In summary, contextual factors are associated with specific context or location-related matters. Considering the most commonly observed contextual factors category among the reviewed publications, it suggested that various politics, policy and institutional factors (particularly the structure of the energy market, acts and regulations, subsidies and financial policies) play the most important role in enabling and disabling for CRE. These factors are shaped by forming, ownership, and participation in decentralized related energy production, consumption and distribution processes both in North America and Western Europe. After the policy-related issues, economic feasibility including access to financial services and capital, stands out as the paramount catalyst for enabling CRE development in rural and small-town areas. Conversely, in numerous instances, it can also act as a significant obstacle to the inception and progress of CRE. On the other hand, among various sociocultural factors, trust stands out as another predominant factor, serving both as a prerequisite and a result of CRE initiatives in both regions. Moreover, the presence of a localism culture, along with small and medium-sized entrepreneurship, combined with a decentralized ownership structure, has facilitated the emergence and implementation of CRE in Western European nations. Likewise, ecological and environmental consciousness accelerates local support and acceptance of the CRE in rural and small-town areas. The study also found physical conditions and technical aspects related to renewable energy have greatly impacted how CRE is used and determine the cost and efficiency of the CRE project.

3.3.1.2 Motivational Factors

CRE in rural areas largely depends on rural communities' motivation and various capacities (Streimikiene et al., 2021). Motivational factors refer to subjective characteristics, including an individual's values, understanding, and perception, which encourage or discourage CRE creation and participation (Ruggiero et al., 2019). Therefore, these factors are always related to human psychology. As previously noted, renewable energy-related activities led by government and other private organizations have often been driven by commercial motivations and have resulted in damaged community trust (Soeiro & Dias, 2020). As for the motivations of community members in the CRE project, these individuals come from various perspectives and backgrounds that influence their perception of CRE, the prevalence of particular motivations depends on the internal structure of the community, external relationships with other communities, and how the community is changing (Verde & Rossetto, 2020). The variation in motivational factors has also been explained from the perspective of institutional arrangements, spatial relationships, and attitudes toward the distribution of institutional innovations (Bauwens, 2016). Consequently, there are multiple motivational factors behind the CRE in rural areas; however, the three most commonly observed are a desire to conserve the natural environment and reduce climate change impact (discussed above), economic regeneration, and increasing social cohesion by accepting renewable energy (Bauwens, 2019; Becker & Kunze, 2014; Hicks & Ison, 2018; Proudlove et al., 2020; Seyfang et al., 2013; Verde & Rossetto, 2020).

3.3.1.2.1 The Pursuit of Economic Regeneration

Motivation for economic regeneration is the second most cited psychological factor for forming and developing CRE, as described by 85 (out of 110) studies. These factors mostly relate to the features of CRE projects. Some CRE initiatives offer a return on investment for their participants and are referred to as green investment (Soeiro & Dias, 2020); as a consequence, rural community members agree to participate in and contribute to the CRE project (Bauwens, 2016). A study by Proudlove et al. (2020) shows that individual desire for economic returns through energy investment is most common among CRE investors. On the other hand, many CRE projects, particularly energy cooperatives, provide energy to their participants, which might benefit them as they pay less for energy than other traditional energy retailers. Moreover, members of these CRE projects are often encouraged to use less energy to sell their extra energy and gain economic benefits (Bauwens, 2016; Hicks & Ison, 2018).

Based on a survey of a UK CRE project, Seyfan et al. (2013) found most respondents in the CRE project joined this project to save on their energy bills. Similarly, Bauwens (2016) found that savings in energy expenses and protection against future power price hikes are key psychological considerations for undertaking CRE initiatives. Local ownership, including benefit sharing and participation in energy decision-making, also encourages individual involvement with CRE projects (Hicks & Ison, 2018; Rogers et al., 2012). Again, many rural areas are "in danger of dying" (Rogers, 2012, p. 245), facing unemployment, low wages, fuel poverty, and declining local business opportunities, so a local CRE project may be seen as stimulating the local community to regenerate and revitalize the rural economy. A study, conducted by DECC (2013), of 25 participants in a UK CRE project conducted reveals that regarding the motives for involvement in the CRE project, the most common responses were economic, including the development of new business opportunities, the eradication of fuel poverty, and cutting down community expenditures. Similarly, to address the psychological reasons for participating in the CRE project, Rahmani et al. (p. 5, 2020) adopted a goal-framing theory and shows that the "gain goal", economic benefit, is the primary driver for the individual to participate in local CRE projects. CRE may enhance various economic prospects, including job development and local entrepreneurship; however, for these projects to attract community members, they must be financially feasible.

3.3.1.2.2 Environmental Concern

Concerns about protecting the environment—from regional pollution and its effects on health to global warming—are important drivers for CRE initiatives, as mentioned by 40 (out of 110) publications. In general, from 1970 to 1980, the antinuclear movement was the major environmental motivation to form CRE projects; however, after 1990, global climate change became a prominent psychological factor in the deployment of CRE both in Europe and North America (Bauwens, 2016; Verde & Rossetto, 2020). Since CRE is a local energy initiative mostly controlled and managed by the local community, it has been pursued as an effective way to deal with and increase awareness regarding various environmental issues (REN21, 2016). After analyzing different CRE projects, Hicks and Ison (2018) identified 22 project motivations where various environmental causes, such as pollution and carbon emission reduction, are the most common motivational factors for developing CRE projects. Using survey data from two Austrian CRE projects, Fleiβ et al. (2017) identified environment protection, such as promoting local environmental projects, providing support for environmental conservation, and decreasing emissions of greenhouse gases. Similarly, other studies such as Becker and Kunze (2014) and Van der Schoor et al. (2016) also feature the desire to influence environmental and energy policies as an important motivating factor for CRE.

Normative beliefs, a person's beliefs about which actions are appropriate or right, can push individuals to prioritize environmental behaviour; for instance, the belief that global warming has to be dealt with and everybody should do something to reduce greenhouse gas emissions leads to participation in CRE projects (Ozaki, 2011). Rogers et al. (p. 242, 2012) show how the responsibility of environmental and community sustainability, called "doing the right thing", persuaded local English people to found CRE projects in England. Numerous studies have revealed that environmental concerns often promote pro-environmental behaviour, resulting in involvement in CRE initiatives (Dóci & Vasileiadou, 2015; Kalk-Brenner & Roosen, 2016). For some, particularly individuals or communities who prefer and seek to maintain a green and sustainable lifestyle, the positive effects on the environment seem can be more significant than the financial gains (Haggett et al., 2013; Radtke, 2014; Soeiro & Dias, 2020).

3.3.1.2.3 Social Cohesion and Community Benefit

Much of the literature on CRE shows that a lack of community participation and community interest is perceived as a key hindrance to CRE initiatives (Furlong, 2020; Goedkoop & Devine-Wright, 2016; Hicks & Ison, 2011; Roberts et al., 2014; REN21, 2017; Slee, 2015; Brisbois, 2019). CRE increases social acceptance among rural community members through ownership and decision-making processes and motivates community members to engage with renewable energy (Furlong, 2020; Hicks & Ison, 2011; Roberts et al., 2014). Most CRE projects are formed within a trusted network, creating a credible promise of public benefits, which contributes to reducing injustice in the distribution of costs and benefits of CRE initiatives (Goedkoop & Devine-Wright, 2016; Schoor & Scholtens, 2015). Warren & McFadyen (2010) conducted a comparative study between CRE and commercially controlled wind energy projects in rural Scotland and demonstrated that although the justifications underpinning views did not change significantly between these two groups, favourable perceptions of local ownership led to lower weights being attributed to worries such as intermittent operation, visual effects, and bird impacts in that region. Similarly, after comparing partially and commercially owned wind energy in Germany, Musall & Kuik (2011) revealed that due to community co-ownership, CRE projects receive more public support and less negative evaluation regarding the shadow flicker, noise pollution, and aesthetic impacts of wind turbines. Different regional and country-specific research shows how a high level of co-ownership, including participation in the planning process and public acceptance of renewable energy, is interconnected. For instance, McLaren-Loring (2007) shows—in a comprehensive study focused on 18 case studies from Wales, England, and Denmark—a strong positive association between substantial community participation, ownership, and project leadership on the one side and community acceptance on the other side.

In summary, regarding the motivational factors' economic regeneration, increasing social cohesion by accepting renewable energy, conserving the natural environment and reducing climate change impact are the most commonly observed factors for CRE (see the summary in table 3.1). The features of CRE projects primarily determine the existence of these factors. While economic revitalization is frequently cited as a leading motivational factor for establishing and advancing CRE, in certain cases, the positive environmental effects appear to be an important issue for CRE. Nonetheless, it is noteworthy that the overall success of CRE initiatives is heavily influenced by the way participants perceive renewable energy.

3.3.1.3 Project-related Factors

Organizational features of renewable energy, referred to as project factors, also have a important role in the likelihood of success for CRE in remote rural areas (Devine-Wright, 2013; Warbroek et al., 2019). The most commonly observed project-related factors are the structure of ownership, the nature of engagement and networking in energy projects, and patterns of leadership (Hentschel et al., 2019; Miller et al., 2016; Munro et al., 2018). Both institutional and energy governance structures determine the influence of these project-related factors (Gupta et al., 2014).

3.3.1.3.1 Engagement and Networking

Local residents are the major drivers for CRE projects in rural areas; consequently, internal social capital, including networking and engagement with the energy project, is essential as it generates a culture of collective action and collaboration within and between communities. Research shows that various forms of networking, including bridging and linking networks, substantially contribute to the formation of trusted social networks through interconnection with different intermediaries and local authority organizations. These organizations in turn assist in knowledge development, facilitating awareness, fostering interpersonal learning and lobbying for the CRE project (Gupta et al., 2014; Munro et al., 2018; Rahmani et al., 2020). For instance, the existing institutional networks and collaboration between the different energy development and rural development programs have rapidly increased the deployment of CRE projects in Scotland, Wales, and Germany (Morris & Pehnt, 2012). Networks and connectivity bring people together, creating a common identity, pride in joint accomplishments, and increased self-worth among those involved (Islam, 2016). It also protects the social and cultural identity and strengthens the relationship between communities and others. On the other hand, a lack of effective social networks can prevent reaching wider community acceptance and expanding CRE activities (Malinen, 2015). Munro et al. (2016) studied a CRE group in southwest England and found that some projects have a low level of networking and connectivity between them and other groups, resulting in a decrease in their ability to negotiate and connect with the broader community and a decline in their opportunities to obtain funding. Similarly, studies like Bauwens and Defourny (2017) and Becker et al. (2017) show that social identity, community ownership, and trust in rural areas have accelerated community members' engagement with CRE projects. Consequently, social networking and participation are prerequisites for CRE to produce beneficial outcomes (Berka & Creamer, 2018; Creamer, 2015).

3.3.1.3.2 Project Leadership

Leadership is the most cited project-related factor for the emergence and development of CRE in rural and small-town areas (Ruggiero et al., 2014; Rahmani et al., 2020; Seyfang et al., 2014). The role of a leader in a CRE project is to inspire others to participate, establish a social, economic, or environmental vision for the group, and foster collaboration and agreement (Rahmani et al., 2020). Project leaders support CRE projects by providing the resources needed to succeed and assisting in overcoming difficulties and challenges (Hargreaves et al., 2013). Based on 41 structured interviews from different CRE projects in seven European countries, Ruggiero et al. (2014) show that key actors, called local project champions, positively influence the implementation of the CRE project, particularly in the project's initial stage. Project leaders in a CRE initiative have better local knowledge than outsiders and in most cases are politicians, administrative personnel, or energy experts (Rahmani et al., 2020). Their skills and motivation assist in bringing new energy-related knowledge to their community. For instance, after a study on a UK CRE project, Martiskainen (2016) concluded that community leadership frequently employs tacit knowledge like network capacity and identifies local resources and talent for developing community energy projects in small-town areas. Usually, different actors create and operate a CRE project; however, due to strong communication and networking skills, some project leaders have more influence and play a decisive role in the emergency of CRE projects (Ruggiero et al., 2014; Seyfang et al., 2014). Similarly, Middlemiss & Parrish (2010) mentioned leadership as a crucial factor for the success of a CRE project in rural areas. Project leaders contact various organizations, including the government and others, and share their ideas formally and informally with these organizations to create regional economic development. This connection assists ecologically and economically motivated community people to come together with CRE initiatives and helps to attract different funds from and outside of their community. From the Samso CRE in Denmark, Rahmani et al. (2020) show that influential local people in rural regions become the project leaders who coordinate with internal and outsider stakeholders. However, to lead an energy project successfully, a leader should have some personal qualities, called personal capacity, such as passion and enthusiasm, patience and resilience, altruism, and an entrepreneurial mindset (Middlemiss & Parrish, 2010; Rogers et al., 2012).

3.3.1.3.3 Project Ownership Structure

The ability to participate in the ownership structure and have significant control over the energy management process are two of the most frequently cited features of a CRE project; in particular, the ownership opportunity is a major influencing factor for community involvement in CRE initiatives (Campney, 2019; Islam, 2018; McMurtry, 2018; MacArthur, 2016). Previous research identifies various ownership patterns—including energy cooperatives, limited partnerships, community trusts and foundations, housing associations, non-profit customer-owned enterprises, and public-private ownership models—enabling different actors to invest in, expand on, and maintain renewable energy assets (Caramizaru & Uihlein, 2020; Fernandez, 2021). For instance, where the local community wholly owns the CRE project, other stakeholders can be involved with the energy initiative as community participants (Parkhill et al., 2015). Again, in some CRE projects, the local community owns most of the project share, whereas other interested parties might participate in the ownership structure as partners (IRENA, 2020). In the same way, a developer can lead some CRE projects where communities have partial ownership of the project, shared with the energy developer. Due to the cost- and benefit-sharing opportunities, CRE projects offer community members the opportunity to possess a portion of the energy asset with a minimum level of investment (Anna & Daniela, 2010). Furthermore, the opportunities for reinvestment can accelerate the extent of the CRE project. For instance, in the cooperative model, energy producers can consume their own energy, and profits from their energy project are reinvested in the project instead of distributed to the participants. All these ownership patterns have pros and cons, and a community or region can choose a particular ownership model based on their resources. Scotland, for example, mostly uses community trusts and foundation-based ownership models due to a strong sense of place and existing energy and land policies (Haggett & Aitken, 2015). In Canada, there are five different categories of ownership for renewable energy projects namely, cooperative, Indigenous, community investment fund, non-profit organization, and MUSH (Municipalities, Universities, Schools and Hospitals) ownerships (McMurtry, 2018). On the other hand, because of the tradition of cooperative culture and the anti-nuclear movement, most German CRE projects are cooperative-based (Caramizaru & Uihlein, 2020). Cooperative ownership is also very common in other countries where community-based projects are well-developed. However, limited access to financial services for upfront CRE investment and the lack of funding can hinder community-based ownership (MacArthur, 2016, 2017; Wyse, 2018).

In brief, considering various project-related factors, including ownership structure, features of involvement and networking in energy initiatives and types of leadership are the critical factors for CRE (see the table 7). The opportunity for ownership within the energy project significantly influences community engagement in CRE initiatives. However, participation and networking, for instance, social capital, are also very important because they create a culture of collective effort and cooperation within and outside the community. Once again, the role of a leader within the CRE project is to motivate others to initiate an energy endeavour, establish a shared vision encompassing social, economic, or environmental aspects, and foster collaboration and consensus.

These project leaders provide the necessary resources to ensure the success of the CRE project and offer support in surmounting challenges and obstacles.

Table 7: A Synthesis of the Role of Various Factors in CRE

Major Factors	Sub-factors	Key synthesis with examples of studies
Contextual Factors	Sociocultural Factors	1. Among sociocultural factors, trust stands out as the predominant factor, serving both as a prerequisite and a result of CRE initiatives (Berka & Creamer, 2018; Koirala et al., 2018). 2. Education, awareness, and knowledge strongly impact the community's inclination to engage in CRE projects, particularly in cases of lack of knowledge (Ruggiero et al., 2021). 3. The local culture, together with small and medium-sized entrepreneurship, has enabled diverse community members to organize themselves and aspire to drive various forms of social, economic, or other regenerative efforts for their community (Fernandez, 2021). 4. The origination of CRE is strongly connected with various social movements, including environmental campaigns for climate change, anti-nuclear movements, and protests against large-scale centralized renewable energy projects, as these movements create pressure to adopt various regulations and initiatives in favour of CRE (Caramizaru & Uihlein, 2020).
	Politics, Policy and Institutional Factors	1. These factors determine what types of financial benefits, knowledge, and skills are allocated for a CRE project and how a CRE enterprise enters the existing energy market (Plum, 2020; IRENA, 2020). 2. FITs, the most common type of economic supportive policy instrument, have a substantial influence on the growth of prosumers' culture, investment, collective ownership, and participation in CRE projects (Hewitt et al., 2019; Suwa & Dreyfus, 2020).

		3. Sudden changes in these regulations can reduce the performance and growth of CRE projects (REN21, 2017).
	Physical and Technical Issues	(i) The accessibility of natural resources, (ii) the design, installation, and operation of renewable energy technology, and (iii) the necessary expertise and skills for utilizing renewable technology, have greatly impacted how CRE is used and determine the cost and efficiency of the CRE project (Furlong, 2020; Seetharaman et al., 2019).
	Ecological and Environmental Issues	Conserving biodiversity and reducing carbon emissions assist in increasing local support and acceptance of the CRE in rural and small-town areas (Simcock et al., 2016).
	Economic and Financial Factors	Economic feasibility, including access to financial services and capital, stands out as the paramount catalyst for enabling CRE development, particularly in the beginning stage when an energy plan starts to be applied (Schallenberg-Rodriguez, 2017).
Motivational Factors	Pursuit of Economic Regeneration	Economic regeneration is the most cited psychological factor where CRE projects are seen as stimulating the local community to regenerate and revitalize the rural economy (Warbroek et al., 2019).
	Environmental Concern	Various normative environmental behaviour, including concerns about protecting the environment—from regional pollution and its effects on health to global warming—are significant drivers for CRE initiatives (Kalkbrenner & Roosen, 2016).
	Social Cohesion and Community Benefit	CRE projects are formed within a trusted network, creating a credible promise of public benefits which contributes to reducing injustice in the distribution of costs and benefits of CRE initiatives (Furlong, 2020).

	Engagement and Networking	Networking and engagement generate a culture of collective action and collaboration within and between communities. This networking and connectivity, in turn, assist in knowledge development, facilitating awareness, fostering interpersonal learning and lobbying for the CRE project (Munro et al., 2018).
Project-related Factors	Project Leadership	The role of a leader in a CRE project is to inspire others to participate, establish a social, economic, or environmental vision for the group, and foster collaboration and agreement (Rahmani et al., 2020).
	Project Ownership Structure	Ownership opportunities are a major influencing factor for community involvement in CRE initiatives. It enables different actors to invest in, expand on, and maintain renewable energy assets (Campney, 2019; Fernandez, 2021).

3.3.2 Comparison of CRE Factors in Western Europe and North America

Due to climate and economic pressures and to ensure a sustainable energy transition, Europe and North America have adopted various forms of CRE projects; however, there are significant differences between the patterns of CRE projects in these two regions as the various factors discussed above differ within these regions. Four key areas where these regions differ are highlighted below: energy project size, fossil fuel availability, cooperative culture, and energy policy (see Table 8).

3.3.2.1 Energy Project Size in Europe and North America

Western European countries have been focusing on more decentralized and community-oriented energy initiatives, creating renewable energy projects and ensuring local inhabitant participation, including ownership and control (Caramizaru & Uihlein, 2020; Schreuer & Weismeier-Sammer, 2010; Soeiro & Dias, 2020). Subsequently, they address the importance of small and medium-scale renewable energy projects and have reformed their energy policy so that many stakeholders can participate in energy initiatives instead of a few energy actors (Fernandez, 2021). For instance, Germany deployed solar, wind, and bioenergy through the cooperative energy model. They liberalized their energy market in 1998 and, until 2005, did not need to form any public utility commissions or regulatory bodies. Besides the reformation of energy policy, to overcome the financial barrier for decentralized renewable energy, the EU has formed the REScoop MECISE funding project and invested around €110 million in various renewable energy initiatives (RESCOOP MECISE, 2020). A recent study by Cohen & Pons-Seres de Brauwer (2020) shows that the EU promotes small- and medium-scale renewable energy projects through citizen-led financing to meet climate targets. The EU also uses another decentralized energy initiative for rural communities: "smart villages" strategies which assist with overcoming various challenges faced by rural communities and explore new prospects generated by technological and non-technological innovations (ENRD. 2022, p. 3).

On the other hand, the North American energy sector is often made up of monopolies and favours large energy corporations (Penland, 2021). For instance, US citizens were collectively paid around $360 billion for purchasing their electricity in 2016; however, larger investor-owned utilities benefited the most from this revenue (Farrell, 2020). Again, throughout the 1990s, various regions of the United States attempted to deregulate their energy sector; however, they were unsuccessful. While 43 out of 50 US states applied net metering, this relies on the nature of the utility organization, and only a limited numbers of consumers can net-meter. As well, it is difficult for consumers to switch utilities (Morris, 2013). Therefore, community ownership of, or "citizen holdings" in, renewable energy is infrequent in the USA (Brummer, 2018, p.8). Western Europe, particularly Germany, tries to support and protect its small- and medium-scale energy initiatives from large energy corporations, whereas American energy organizations emphasize consumer choice instead of considering the consumer as an energy citizen (Morris, 2013).

3.3.2.2 Availability of Fossil Fuels and Deployment of CRE

Dependence on the energy system and the availability of natural resources affect the emergence and deployment of CRE (Horstink et al., 2020). Ruggiero et al. (2014) show that due to the energy necessities in European rural regions such as Scotland and Norway, have created CRE projects. High import dependence on fossil fuels promotes the formation and deployment of CRE initiatives (Plam, 2020), whereas the availability of cheap energy sources is a key hindrance to the development of CRE projects (Kooij et al., 2018; Plam, 2020). European energy, including crude oil, natural gas, and solid fossil fuels, is highly dependent on imports. For instance, imports met around 58% of Europe's energy demand in 2020, and most of this energy came from Russia, followed by the USA (Wettengel, 2023). Therefore, the risk of energy supply disruptions and rising energy prices in Europe have compelled European countries to deploy diverse renewable energy generation. The Russian military attack in Ukraine has immensely interrupted EU access to a reasonable, flexible, and self-sufficient energy system, accelerating the EU energy transition (Dzebo, 2022).

On the other hand, North America has the world's largest oil reserves, for instance, Canada is the world's fourth-largest oil reserve, extracting around 4.7 million barrels of crude oil every day in 2021. Of these extracted oils, 99% were exported to the USA (CAPP, 2023). Moreover, Canada ranked as the world's sixth-biggest natural gas producer in 2020 (Canada Energy Regulatory, 2023). Similarly, the USA generated around 14.5% of the total crude oil supply of the globe in 2021, mostly produced in just five states: Texas, North Dakota, California, Alaska, and Oklahoma (EIA, 2023). Several new technologies, including hydraulic fracturing and horizontal drilling, have led to a boom in petroleum products, resulting in the USA surpassing Saudi Arabia and Russia in 2018 to become the world's leading oil and gas producer (DeSilver, 2020). The availability of these hydrocarbons, the supply and distribution infrastructure of fossil fuels, and economic concern in Canada and the USA greatly influence policy regarding the transition to renewable energy in North America (Van de Graaf et al., 2016). As a result, renewable energy deployment is increasing; however, fossil fuels are still North America's primary energy source (DeSilver, 2020).

3.3.2.3 Rural Cultural Identities and the Emergence of CRE

Strong cultural ties influence collective action; for instance, a strong tradition of community-based activities, including social enterprises, has accelerated the formation of CRE projects in rural Germany, Belgium, Scotland, and Austria (Caramizaru & Uihlein, 2020; Simcock et al., 2016). The early 20th-century cooperative movement in Germany motivated local residents to form various cooperatives, which later transformed into the renewable energy cooperative (Flieger & Klemisch, 2008). Likewise, various farmer cooperatives evolved into Austria's district biomass heating system (Schreuer & Weismeier-Sammer, 2010). In Europe, a strong relationship appears between the substantial level of cooperative activity and significant levels of farmer ownership in rural wind energy projects (Toke et al., 2008). Subsequently, today, around 3,400 renewable energy cooperatives are operating across Europe, most in Western Europe (COOPERATIVES, 2021). Again, studies show that other social movements, like the anti-nuclear movement or alternative energy campaign, are important factors for deploying CRE in rural Europe (Breukers & Wolsink, 2007; Toke et al., 2008). For instance, many large-scale protests against nuclear power were undertaken in the Netherlands in the late 1970s. Similarly, local action groups in Germany created the citizens' initiative movement in the 1970s to promote local concerns, often environmental causes; later, these movements turned into the anti-nuclear campaign (Toke et al., 2008). Consequently, in 1975, around 28,000 anti-nuclear activists seized Wyhl's nuclear power plant site in Germany and stopped the construction of the project (Appunn, 2021). These anti-nuclear protests significantly inspired later interest in alternative energy and the formation of the German Green Party in 1980. In the same way, several large-scale protests happened in the UK against nuclear energy (Wierling et al., 2018).

On the other hand, renewable energy cooperatives are relatively new in North America; for instance, Canada's renewable energy cooperative sector is just beginning to develop, with only 52 operating, and most of these are in Ontario (Pigeon et al., 2022). The lack of a cooperative culture, which includes a lack of public awareness and willingness to use renewable energy sources and participate in the sector, as well as a lack of support from the traditional cooperative sector, are major barriers to the deployment of renewable energy cooperatives in Canada (Pigeon et al., 2022; TREC, 2016). Moreover, instead of pulling out of nuclear power activities, Canada is still funding small modular nuclear reactor (SMNR) projects (Green Party of Canada, 2022; Simakov, 2022). Compared to Canada, the USA has a significant cooperative culture, for instance, there are around

900 electric cooperatives in the USA, which provide various energy-related services and work as innovation hubs, including broadband services, smart meters, energy storage, and carbon capture. However, these energy cooperatives use different energy mixes, such as renewable and non-renewable sources, rather than a sole renewable energy source like Europe (NRECA, 2022).

3.3.2.4 Integrated Energy Policy and the Development of CRE

Renewable energy (RE) policies have become key strategies to address the growth of RE and mitigate the impact of climate change. Europe and North America first introduced RE policy and implemented various RE-supportive programs during the 1990s (Baldwin, 2019). However, there are some policy differences between these two settings. For instance, Europe has a more integrated energy policy associated with environmental conservation, sustainability, and climate change approaches compared to North America (Barrington-Leigh & Ouliaris, 2017; Fernandez, 2021). The EU has applied various policies not only to achieve a sustainable future but also to ensure energy democracy, including project ownership, energy management, and control. Instead of a technocratic path, EU countries have adopted a more bottom-up strategy through the RES Directive 2009/28/EC policy from 2009 (Klessmann et al., 2011; Ydersbond & Korsnes, 2016). Subsequently, all the member nations of the EU have formed their own policies, including FIT, FIP (Feed-in-Premium), tenders, quota requirements, and various additional supportive policy schemes such as investment and financing grants, fiscal measures as mandated under the RES Directive (Saidur et al., 2010; Bauwens, 2016). As a result, until 2000, most countries in the EU had only one major energy policy instrument or supportive mechanism for renewable energy, but after 2009, every EU member state has on average, three or more energy policy schemes (Kitzing et al., 2012; Ragwitz, 2012). Regional energy partnerships between two or more EU member states represent an additional energy policy tool in Europe. For example, a cross-border policy scheme exists between Sweden and Norway for generating energy from different renewable sources (Kitzing et al., 2012). In 2019, the EU updated their RES Directive based on the Paris Agreement and included eight new laws called the Clean Energy for Europeans Package, which mentioned how consumers could effectively manage and control their energy initiatives through market efficiency and strengthened their rights regarding their own renewable energy production and investment. Energy citizen—i.e., active consumers of renewable energy production and consumption based on geographic proximity—and collective forms of energy initiatives with heterogeneous stakeholders are the two fundamental elements of this new regulation, which are promoted to increase the level of renewable energy acceptance and attract investment for renewable energy in rural areas (Hoicka et al., 2018). This "new green deal" also focuses on equal access to innovative funding schemes for energy cooperatives and local residents (Hockenos, 2021, p. 67).

On the other hand, in the USA, shared renewable energy policy such as community solar legislation is not enacted in all states, and only 22 states have adopted this policy; even so, this policy does not provide enough rights for the renewable energy community to participate in energy initiatives (EPA, 2023). Consequently, participants are prohibited from making any claims about the usage of renewable energy. The Institute of Local Self-Reliance, which is evaluating various state renewable policies based on energy democracy, shows that in 2023, among the 50 states in the USA, 13 states were unsuccessful, 14 were mediocre, and 15 states were above average in advancing their renewable energy initiatives through existing energy policies (Fischer, 2023). Similarly, Canada build its energy infrastructure on a province-by-province basis to accommodate its unique history and governance structure (McMurtry, 2018), which may have hindered the energy transition to community-owned alternative energy and favoured private economic interests and centralized government control. Most of the energy legislation is devolved to the level of the provinces, and it is challenging to match energy demand with renewable energy distribution and supply (Barrington-Leigh & Ouliaris, 2016). Lack of integrated policy and fragmented energy governance creates friction at the local, Indigenous, provincial, or federal levels, making it difficult to build energy democracy on a large scale (MacArthur et al., 2020). Moreover, long-term, centralized, elite-dominated energy institutions and corporate-led energy systems (and the policies that support them) consider local actors to be energy customers rather than energy citizens (Barrington-Leigh & Ouliaris, 2017). Furthermore, some energy policies like FIT and COMFIT (Community Feed-in Tariff) have already been eliminated, resulting in the deployment of CRE becoming slow in Canada (Hoicka et al., 2021).

Table 8: Comparison of CRE Factors in WE and NA (Source: Author)

Key Difference Issues	Western Europe (WE)	North America (NA)
Energy Project Size	WE countries have been focusing on more decentralized and community-oriented energy initiatives like smart village strategies, and renewable energy cooperatives (Caramizaru & Uihlein, 2020; Soeiro & Dias, 2020).	The NA energy sector is often made up of monopolies, favours large energy corporations, and emphasizes consumer choice (consumer-provider relationship based on existing market framework) instead of considering the consumer as an energy citizen (Brummer, 2018; Farrell, 2020).
Fossil Fuel Availability	There is high import dependence on fossil fuels promotes the formation and deployment of CRE initiatives	NA has the world's largest oil reserves, and crude oil supply systems greatly influence policy regarding the

	in WE (Horstink et al., 2020; Plam, 2020).	transition to renewable energy (CAPP, 2023; DeSilver, 2020).
Cooperative Culture	A strong tradition of community-based activities like social enterprises and various social movements, including the anti-nuclear movement or alternative/ green energy movement, promote the CRE initiative in WE (Simcock et al., 2016; Wierling et al., 2018).	Renewable energy cooperatives are relatively new in NA, and most of the energy cooperatives use different energy mixes, such as renewable and non-renewable sources, rather than a sole renewable energy source like Europe (Pigeon et al., 2022; NRECA, 2022).
Energy Policy	WE has a more integrated energy policy associated with environmental conservation, sustainability, and climate change approaches, such as the "RES Directive 2009/28/EC" and "Clean Energy for Europeans Package" (Baldwin, 2019; Ydersbond & Korsnes, 2016).	Lack of integrated policy and fragmented energy governance creates friction at the local, Indigenous, provincial, and federal levels, making it difficult to build energy democracy on a large scale in NA (Barrington-Leigh & Ouliaris, 2016; EPA, 2023).

3.4 Discussion

CRE refers to decentralized and democratic energy initiatives. They are formed and developed through various factors, but there are manifold issues that can create different hindrances to CRE activities as well. A large number of studies have described different enabling and disabling factors for CRE; however, context, motivation, and project-related issues are considered most important to explain the determinant factors of CRE (Verde & Rossetto, 2020; Hicks & Ison, 2018). Based on the framework of these three factors, this study sought to illustrate how these factors affect the growth and maturity of CRE in rural Western Europe and North

America and why some rural CRE programs have been successful in reaching desired community outcomes while others have not. This review found that all three factors are important for the rural CRE and have an interconnected, multi-cyclical relationship among themselves; for instance, contextual factors can influence various motivational factors and vice versa. Again, the success or failure of different project-related factors can motivate other energy groups to support CRE initiatives in rural and small-town areas. After reviewing the nature of CRE initiatives in the EU, Verde & Rossetto (2020) found a similar result; however, they did not compare the North American context. Other research, Hicks & Ison (2018) for instance, has illustrated CRE's rise and evolving structure based on contextual and motivational factors without considering project-related variables. Thus, this study is unique in examining all three major factor categories while comparing rural CRE within EU and North America.

Contextual factors—such as sociocultural, ecological and environmental, political and institutional, economic and financial, and technical and physical issues—are mainly related to geographic location. In line with the other studies—i.e., Fernandez (2021), Hicks & Ison (2018), and Simcock et al. (2016)—this study also found that different sociocultural factors, namely the level of education and wealth and the culture of social innovation (including energy cooperatives, social movement and civic engagement, societal norms and trust, and community identity) substantially influence CRE formation and deployment in the rural region. Among these sociocultural factors, trust is the most influential factor and is both a precondition and an outcome of successful CRE initiatives. Different studies show that strong social capital, including various social and environmental norms, place-based attachment, knowledge and skill, can increase the level of trust (Berka & Creamer, 2018; Koirala et al., 2018), and that the success of particular CRE initiatives highly depends on the various levels of trust among energy practitioners and others

(Dizaji et al., 2020; Walker et al., 2010). Compared to the EU and USA, the study found that trust is a more critical issue for Canada. For example, several studies show that a lack of trust because of procedural and distributional justice is the key hindrance to the development of community wind energy in rural Canada (Comeau et al., 2022; Krupa et al., 2015; Shaw et al., 2015).

A culture of localism, small- and medium-sized entrepreneurship, and the distributed nature of ownership are also important factors for CRE in rural regions. Traditional social enterprise and rural cooperative cultures inspired German and Danish residents to form more CRE projects (Fernandez, 2021; Hewitt et al., 2019). On the other hand, the UK does not have a social enterprise culture like other EU countries; however, strong rural community-based activities and collective voluntarism were vital supporting factors for the birth and development of CRE initiatives in the UK (Community Share, 2015; Simcock et al., 2016). Likewise, a census of renewable energy cooperatives in Canada shows that a pool of volunteers was the most vital driver for the deployment of renewable energy cooperatives in Canada (Pigeon et al., 2022).

Similarly, various social movements significantly contributed to the emergence and growth of CRE both in rural North America and Western Europe, and these are linked to environmental considerations. Environmental campaigns for climate change and the anti-nuclear movement in the EU, particularly in Germany, are cited as having a significant role in the deployment of CRE (Ruggiero et al., 2019; Simcock et al., 2016; Stephens, 2019). This review also found that demonstrations against large-scale centralized renewable energy were significant drivers for CRE initiatives in rural USA and in the UK (Wiseman, 2020; Parag et al., 2013).

Policy, political culture, and institutional issues are the most cited factors shaping CRE, where studies mainly mention the importance of a CRE policy framework that is adequately supportive, robust, and stable. Literature shows that energy market structure, energy legislation and regulation, subsidies and financial stimulation, as well as various institutional arrangements, have a decisive role in enabling and disabling CRE initiatives in rural areas. For instance, in a deregulated energy market system, the energy price is determined based on the demand-supply approach, and those who meet the minimum requirements may produce and distribute energy.

However, small- and medium-scale community-oriented energy producers are deflated due to the lack of a long-term price guarantee (PEMBINA Institute, 2010). Again, in monopolized energy structures, in the USA or Canada for instance, only a few actors manage and control the entire energy production and distribution process, creating a barrier to the development of CRE in rural areas, considering stakeholders to be energy consumers rather than energy citizens, resulting in the slow growth of CRE (Barrington-Leigh & Ouliaris, 2017; MacArthur et al., 2020). On the other hand, decentralized liberalized energy systems, such as in Germany, the UK, and Denmark, promote more deployment of CRE by providing financial independence for local energy groups and creating opportunities for more active participation of various actors, including local government and communities (Plum, 2020; Suwa & Dreyfus, 2018).

Several policy schemes and regulations contribute to the deployment of CRE; however, a sudden change in these regulations can reduce the performance and growth of CRE projects (REN21, 2017). This finding is in line with the result of Wagner et al. (2021), who show how a swift change in German cooperative law and the application of auction policy led to a quick decline in the number of new CRE projects. The literature review also found that both North America and Western Europe have implemented various supporting policy mechanisms, including feed-in-tariffs (FIT), price-based instruments such as tax incentives and investment subsidies, and quantity-based instruments, namely auctions and quotas. Among these supportive policy mechanisms, FIT is the most common and significantly contributes to the birth and growth of renewable investment, community ownership, and involvement in CRE projects (Caramizaru & Uihlein, 2020; Hewitt et al., 2019; REN21, 2017). However, the performance of FIT highly depends on access rights to the energy grid, the rate of profit from the investment, and the length of the agreement, and any uneven modification to the feed-in tariff might put an economic burden on the local community (Haggett et al., 2014; Mah et al., 2021). Many Western European countries have adopted the FIT program; however, North America introduced this policy instrument only recently. For instance, in Canada, only Ontario and Nova Scotia have adopted this program (Walker & Baxter, 2017). Similarly, other quantity-based supporting policy instruments, such as auction and quota systems, are more available in Western Europe than in North America. Both in the case of rural Western Europe and North America, a large number of studies mention different institutional barriers such as unnecessary bureaucratic hurdles regarding power plant construction, grid access, and renewable energy production; however, some countries successfully overcame these problems through various umbrella organizations and a one-stop innovation hub (Hall et al., 2016; OECD, 2020).

Economic aspects, including job creation, revenue earnings, and the frequent lack of financial assistance, are among the most discussed topics in CRE literature. This review found that various economic developments through CRE are highly related to place, policy, and other social aspects of the community, which is consistent with the findings of Verde & Rossetto (2020). Access to financing and financial services for the rural community, particularly at the initial stage of the energy project, is crucial for CRE projects (Haggett & Aitken, 2015; Pigeon, 2022; RENA, 2021; Warbroek, et al., 2019). Both North America and Western Europe applied various mechanisms to reduce barriers to accessing financial support. While the EU adopted a central fund and related other financial services like 'Renewable Energy Cooperatives Mobilizing European

Citizens to Invest in Sustainable Energy' (MECISE) for its member states (Fernandez, 2021; Verde & Rossetto, 2020), North America introduced carbon bonds and power purchase agreements for rising initial energy project cost (Miller et al., 2018; Pigeon, 2022; RENA, 2021).

Physical and technical factors, including topography, the presence of natural resources, the maturity and modularity of different renewable technologies, and the necessary knowledge and skills, are dominant factors for CRE (Creamer, 2015; Furlong, 2020; IRENA, 2020). Most physical factors are uncontrollable; consequently, these factors determine CRE initiatives' size, functions, and deployment (Seetharaman et al., 2019; UNCATED, 2019). For example, compared to the EU, Canada has a much larger energy landscape; however, most of Canada's energy resources are in remote areas or far from large population centers, resulting in an uneven distribution of energy needs and energy production. As a result, despite Canada having more renewable energy resources, the expansion of CRE projects in Canada has lagged compared to the EU. Similarly, large numbers of studies based on North America and the EU demonstrated that lack of technological maturity, high grid connection costs, and energy storage limitations are key hindrances to deploying CRE projects in rural areas (Plum, 2020; Rae, 2020; Zhao et al., 2016; UNCATED, 2019)

Generally, community members come from different backgrounds, with different statutory objectives, from economic aspirations to environmental protection, which motivate them to engage in CRE projects. Though participants in CRE have multiple motivations represented across the research analyzed, environmental motives (including net-zero emissions), natural conservation, and reducing pollution seem to be the most prevalent in both North America and Western Europe (Haggett et al., 2013; Radtke, 2014; Soeiro & Dias, 2020). Similarly, economic gains, including the reduction of energy costs, becoming energy self-sufficient, and the growth of the local economy, are another primary psychological factor for the emergence of the CRE project in rural areas (Bauwens, 2016; Rogers et al., 2012; Rahmani et al., 2020; Seyfan et al., 2013). Moreover, the literature also demonstrated that North America, particularly Canada, has a distinct type of CRE project—Indigenous Community Renewable Energy—compared to Western Europe, primarily pursuing political and economic self-determination, land reclamation, and environmental rights (Hoicka, 2021; Viswanathan, 2021). These factors increase the acceptance level, another significant issue for the birth and growth of CRE initiatives (Furlong, 2020; Goedkoop & Devine-Wright, 2016; Hicks & Ison, 2011).

The study found that project-oriented factors such as network and engagement, leadership, and ownership structure predominate in CRE initiatives in rural regions. In the same way as trust, networks and engagement are also considered a prerequisite and consequence of CRE in North America and Western Europe. Similarly, a project leader from the rural community can play the role of a middle actor to connect the local community and various outsider actors. Another frequently cited unique feature of CRE projects is the opportunity to participate in the ownership structure. From the review literature, the study found various forms of ownership models in North America and Western Europe; for instance, the cooperative model of ownership is available in Germany because of the tradition of grassroots innovation culture (Caramizaru & Uihlein, 2020), while in the UK, energy community trust and foundation-based ownership are the most common due to the placement attachment and existing energy and land policies (Haggett & Aitken, 2015). On the other hand, Canada has five types of ownership in renewable energy projects (McMurtry, 2018), however, municipal ownership is the most typical among these five models (Hoicka & MacArthur, 2018; MacArthur, 2016).

In summary, this review shows different contextual, motivational and project-related factors particularly policy, the culture of localism and trust, access to natural resources, and economic regeneration including ownership structure are the most important issues for CRE in rural regions of both Western Europe and North America. Western Europe successfully deployed the CRE project through these factors, whereas North America encountered challenges in achieving similar outcomes due to these factors.

3.5 Conclusion and Recommendations for Future Research

This study addresses two important research questions: what factors affect the growth and maturity of CRE in Western Europe and North America, and why some CRE programs have successfully reached desired community outcomes while others have not. The study found that various contextual, motivational, and project-related factors are responsible for enabling and disabling CRE in both settings. It is difficult to conclude that any particular factor is responsible for the change in CRE as these factors are interconnected and have a multi-cyclical relationship. However, contextual factors, particularly policy, financial issues, available natural resources, and technology dominate CRE literature. Socio-cultural issues such as trust as well as networking and engagement are both prerequisites and consequences of CRE, making CRE initiatives a social phenomenon. Motivation regarding various environmental needs and economic desires contributes to contextual and project-related factors. A CRE project's success highly depends on these factors. However, cultural ties and trust, enabling and stable policy, and economic and ownership structure can potentially be leading the best practices of CRE, while technological maturity, lack of initial investment opportunities, the inadequacy of early participation and involvement of local residents in energy planning create barriers for CRE projects. With significant differences in the presence or absence and nature of these factors, the emergence and growth of CRE have varied in North

America and Western Europe. With stronger CRE development in Western Europe, there is much to be learned from the European experience by North American institutions, taking into consideration contextual differences. For example, based on successes in Western Europe, the study proposes some important strategies for North American jurisdictions, such as i) adopting an integrated policy similar to the "RES Directive 2009/28/EC", ii) promoting cooperative and social entrepreneurship culture by establishing more renewable energy cooperatives, iii) increasing social movement and community involvement regarding energy transition, and iv) similar to the initiative 'Renewable Energy Cooperatives Mobilizing European Citizens to Invest in Sustainable Energy' (MECISE) in Europe, North America can set up a central funding opportunity to ensure all initial financing opportunities solely for small and medium CRE projects.

The findings of this study are based on a review of secondary sources. To gain more insights about these influencing factors, further primary and applied research, particularly in Canada, is recommended. To provide just one example, many studies mentioned the role of the FIT; however, this policy has already been eliminated by dominant energy-producer countries like Germany and Canada. Further exploration of why and how the reportedly successful energy policy tool was ultimately seen as burdensome for particular societies would be valuable. In addition, further comparative studies between European and North American countries need to be conducted to identify best practices and potential policy improvements for encouraging CRE. Again, it is also essential to explore the role of various innovative financing mechanisms and investment models for CRE projects based on crowdfunding, green bonds, and public-private partnerships and analyze their effectiveness in driving project growth. Furthermore, there is a necessity for research studies that investigate the potential for collaboration between different sectors, including the agriculture, housing and transportation nexus, to create integrated sustainable development projects that incorporate CRE components. Finally, as renewable energy projects continue to expand, determining capacity and support for CRE might be built in contexts such as Canada, where CRE is not widespread despite its observed benefits for community and environmental sustainability in the midst of the current climate crisis.

CHAPTER 4: CONCLUSION

4.1 Introduction

Rural landscapes provide an important source of raw materials, food, energy products, and other environmental services for rural and urban residents, along with other socio-cultural and economic contributions that rural communities make to society at large. However, various unfavourable conditions, including extreme weather events, global pandemics, changes in population dynamics, and other socio-economic changes adversely affect rural community resilience. Among these pressures are, on the one hand, pressure for carbon emission reductions to mitigate climate change (while also adapting to the consequences of climate change) and, on the other hand, to achieve energy security to meet household and industry needs. In this situation, renewable energy is deemed a great solution. However, previous studies show that renewable energy (RE) projects have often failed to contribute to rural sustainability or create benefits for rural communities, largely because they are part of large-scale centralized energy-producing systems that are mostly focused on the economic benefits of energy generation instead of energy democracy, social and environmental justice, and equity. The findings of this study suggest that, consequently, it is essential to switch from centralized renewable energy to collective, locally driven energy ownership and management practices, otherwise known as community renewable energy (CRE), to enhance rural sustainability.

Different studies describe CRE based on various characteristics and related outcomes, including multiple types of organizational forms and legal structures, socio-technological innovation, economic growth, environmental and psychological well-being. Subsequently, there is no universal definition of CRE, and many studies describe CRE as a problematic concept.

Chapter 1 of this dissertation discussed various definitions, along with relevant key terms, details of the study's methods and methodology, and the features of the extracted literature. Chapter 2 explored the role of CRE in rural resilience, including diversity, networks and connectivity, equalization, and adaptability. Despite evidence of several potential benefits of CRE, CRE projects have not always succeeded due to a number of factors, as discussed in Chapter 3. Previous studies have covered many different factors; however, this thesis fills a gap by providing a comprehensive study related to all identified determinant factors for CRE, including: i) contextual factors: socio-cultural; political, policy & institutional; physical & technical; ecological & environmental; and economic & financial, ii) motivational factors like economic regeneration, environmental concern, and social acceptance, and iii) project-related factors such as engagement and networking, project leadership, and project ownership structure. This research sought to fill additional gaps in the existing literature described in Chapter 1 by exploring the linkages between CRE and rural resilience and exploring the role of various factors generating various opportunities and barriers for CRE projects in Western Europe and North America.

4.2 Methods of the Study

The study followed a systematic literature review method through a four-step data collection and selection process: identification of data sources, screening, eligibility, and inclusion. In the data source identification step, the author performed a literature search using three academic databases—Scopus, Science Direct, and Sociological Abstract—as well as various gray literature sources like Google Scholar, ProQuest (thesis and dissertations), and a web search on different prominent energy organizations. After identifying these various data sources, key terms were selected for data screening based on the principal themes and subthemes of the study. The data eligibility phase started with examining titles, abstracts, and full texts of 427 publications based on inclusion and exclusion criteria, including (i) document properties exclusion criteria like unavailable full text, published before 1997, or not written in English and (ii) content exclusion criteria like non-European and non-North American countries, only partial relevance (e.g. urban renewable energy projects, global renewable energy deployment, hybrid renewable/non-renewable energy projects), non-academic sources (e.g. editorials, letters, and meeting reports), entirely irrelevant subjects (e.g. hydrocarbon energy like oil, gas, and coal), and engineering and physical science documents.

After completing this four-step method, 188 publications were selected for categorizing and analysis. Analysis of these publications shows that after the Paris Agreement and EU renewable energy directive, the number of studies on CRE has increased since 2015. From 2015 to 2020, existing publications focus on different CRE projects across the UK, Germany, Netherlands, and the USA, primarily describing the features and motivations of CRE, but also various benefits and values of energy communities. This study also found that the CRE projects in North America and Western Europe differ significantly, although contributions have been made to rural resilience through CRE in both regions.

4.3 CRE and Rural Resilience (Answering Research Question #1)

The study attempted to explore how community renewable energy projects (CRE) have impacted rural resilience in North America and Western Europe. To address this research question the study first identified CRE as an umbrella concept and drew a comprehensive definition of CRE based on three key features: decarbonized, decentralized, and democratized energy (Chapter 1). Decarbonized energy is defined as a structural shift in energy production, use, and supply based on efficient, clean, and non-conventional energy sources. Decentralized renewable energy refers to a small-scale localized distributed energy system, having a higher degree of local autonomy, acceptance, and endowments than large-scale, centralized systems and where the local community can take on major roles and responsibilities in the social and economic consequences of energy production and consumption. Democratized energy means there is energy sovereignty, participatory governance, and civic involvement and ownership in the energy system. The efficacy of CRE primarily relies on, and can also contribute to, various social capitals, including trust, connectivity, shared norms, and community goals, together with energy policies and available decarbonized resources and technologies (factors discussed further below).

Secondly, regarding the role of CRE in rural resilience, this study defined rural resilience based on four characteristics, namely diversity, networks and connectivity, equalization, and adaptability, and examined the contributions of CRE to each of these. This review found that CRE mostly contributes to rural diversity, followed by networks and connectivity, equalization, and adaptability. Key contributions of CRE to each of these areas are presented in Chapter 2 and summarized below.

i) Diversity:

Diversity is the major outcome of CRE initiatives**.** CRE enhances diversity in rural communities in multiple ways, including economic diversity and regional development, and energy diversity, particularly when compared to other renewable energy initiatives. Greater employment growth and income opportunities for the local community can result from CRE compared to commercial, non-locally owned energy projects. These projects have also accelerated different economic activities, including social entrepreneurship and local innovation, and supplemented incomes by developing a localized value-added chain in rural areas. In addition, the Distributed Energy Resources (DER) system in CRE supports a diverse range of energy services like frequency management, voltage and load control, recovery of the energy system, and improved power quality, which helps to reduce energy costs and ensure a reliable power supply for the local community (Menniti et al., 2018).

ii) Networks & Connectivity:

CRE business models bring new actors into the energy sector, increasing the diversity and collaboration opportunities for the local community and their renewable energy initiatives, but also in the energy supply overall. This economic and energy diversity can enhance networks and connectivity in rural communities by increasing trust and social acceptance of renewable energy technologies, enriching both external and internal networking, and improving information exchange (Berka & Creamer, 2018). Through the creation of a platform for the involvement of all stakeholders and engaging them with knowledge sharing and networking opportunities CRE generates and increases various bonding, bridging and linking networks between energy participants and others. It promotes sustainability of the energy initiative and the community by acquiring relevant information and ensuring resource access. These enhanced networks and connectivity further encourage positive perceptions of renewable energy technology and the forming of trusted social networks (Rahmani et al., 2020).

iii) Equalization:

Equalization is the third significant consequence of CRE for rural resilience. CRE contributes to both procedural and distributional justice as a consequence of implementing multiple engagement methods to ensure local participation in the energy decision-making process.

CRE implies the “consult-consider-modify-proceed” process instead of the “decide-announce-defend” model, accelerating local acceptance, transparency, trust, and participation in the CRE project, which also tend to contribute to reducing conflict (Walker & Baxter, 2017, p.7). However, discrepancies in culture, economic situation, lack of agency, share prices, and the average welfare of citizens can create barriers to energy procedural justice.

Distributional justice in CRE initiatives occurs through different forms of community ownership, resulting in inclusivity, community empowerment, and fulfilling of local needs. CRE adopts various patterns of community ownership, most commonly cooperatives, enabling citizens to collectively own and manage energy projects, often following the democratic principle of "one member, one vote" (Mundaca et al., 2018, p 105). These ownership models can build capacity for communities to generate revenue. Greater revenues in turn result in economic empowerment, including financial sustainability and leverage, asset control and security, and influence. However, access to benefits, non-membership, geographical location, different socio-demographic conditions, and policy instability can create distributional injustice in a CRE project.

iv) Adaptability:

Finally, CRE promotes adaptability in rural contexts by facilitating renewable energy transition, increasing sustainable attitudes and climate change awareness, and creating various leadership, training, and development opportunities. Due to the adoption of smart technology including smart meters, energy monitors, software, and wearable technology, adoption and transition to renewable energy has been increased in many communities with CRE (Alamaniotis et al., 2016). Smart systems open opportunities for energy export, further bolstering financial performance and improving the feasibility of decentralized energy generation, as well as facilitating trading platforms that provide a route to the market (Menniti et al., 2018). However, a lack of technological maturity, energy storage problems, unfair access, and technological and regulatory obligations with connection to the existing grid infrastructure are key hindrances to the adoption of smart technology in CRE.

CRE also assists in improving awareness and promotion of sustainable lifestyles, including saving energy, participating in energy management, and encouraging or compelling others to change their energy-consuming behaviour. These projects trigger social learning among CRE project members by encouraging or enforcing certain behavioural rules, leading to lifestyle changes and more sustainable energy use. Through self-organization and social learning processes, CRE creates a trusted source of information for its members to increase awareness and knowledge, including knowledge of engineering, regulatory policies, business frameworks, and various infrastructures and facilities. This has accelerated the creation and deployment of different skills and personal capacities, ultimately increasing local residents' ability to survive in a challenging and uncertain environment and encouraging them to form local think-tanks to assist in adapting to new local challenges (Ayers et al., 2014).

In summary, considering the role of CRE in rural resilience (1st research question), this study found that CRE positively impacts several aspects of resilience in rural regions, including diversity, networks and connectivity, equalization, and adaptability. However, diversity is recognized as the major contribution of CRE, as it accelerates a wide range of economic prospects and other innovative approaches for rural communities while diversifying energy supply. The literature reviewed in this study also suggested that formation of diverse social networks and interpersonal relationships, both within and beyond local communities, through CRE helps to foster local acceptance and reduce local and regional conflicts while enhancing equalization. This has, in turn, facilitated rural revitalization, bolstered ecological stewardship, and stimulated socioeconomic and cultural development in rural areas. The interplay of these factors supports the transformative impact of CRE on empowering rural communities and supporting, even driving, progress towards sustainability in rural regions.

4.4 Contributing Factors of CRE in North America and Western Europe (Answering Research Question #2)

The second key objective of this study was to describe the determinant factors in the presence and success of CRE and compare these factors in both North America and Western Europe. Subsequently, as described in Chapter 3, this study examined these factors within three key categories, including i) contextual factors: socio-cultural, ecological and environmental, political and institutional, economic and financial, technical and physical; ii) motivational factors like economic regeneration, environmental concern, and acceptance of renewable energy; iii) project-related factors such as engagement and networking, project leadership, and ownership structure.

i) Contextual Factors:

Based on the most frequently noted factor category in the publications reviewed, it is evident that political, policy and institutional factors such as the structure of the energy market, energy actors, various pieces of legislation and regulations, subsidies and financial policy, administrative processes, requirements for project management and acquiring essential permits play critical roles in both enabling and disabling CRE in North America and Western Europe. Literature shows monopolized energy structures in the USA and Canada, where only a few actors manage and control the entire energy production and distribution process, creating a barrier to the development of CRE (Farrell, 2020). On the other hand, decentralized and liberalized energy systems in Germany, the UK, and Denmark promote more deployment of CRE by providing financial independence for local energy groups and generating more opportunities for the active participation of various actors, including local government and communities (Soeiro & Dias, 2020).

Both North America and Western Europe have implemented various supporting policy mechanisms which broadly fall into three large categories: i) feed-in-tariff (FIT); ii) price-based instruments like tax incentives and investment subsidies; and iii) quantity-based instruments such as auctions, quotas, or bidding systems. FIT is the most common and significantly contributes to the birth and growth of renewable investment, community ownership, and involvement in CRE projects. Compared to the Western European countries, North America introduced this policy instrument recently (Pigeon et al., 2022). However, studies also illustrate that a sudden change in this policy mechanism could reduce the performance and growth of CRE projects. Along with FIT, the USA has enacted various tax incentive programs. Similarly, other quantity-based supporting policy instruments, such as auction and quota systems, are more available in Western Europe than North America. Both regions applied various mechanisms to reduce barriers to accessing financial support. While the EU adopted a central fund and other financial services like 'Renewable Energy Cooperatives Mobilizing European Citizens to Invest in Sustainable Energy' (MECISE) for its member states, jurisdictions in North America, on the other hand, introduced carbon bonds and power purchase agreements to assist in rising initial energy project costs. The study also found various administrative processes, including environmental impact assessment (EIA), required permits (e.g. construction), requirements for grid access, and permits for renewable energy production are key hindrances to deploying small-scale renewable in both settings (Lehtonen & Okkonen, 2019).

This study shows that different sociocultural factors, namely the level of education and wealth and the culture of social innovation, including energy cooperatives, social movement and civic engagement, societal norms and trust, and community identity, play a significant role in the formation and deployment of CRE. However, among these various sociocultural factors, trust is the most influential. Trust is both a precondition and outcome of CRE initiatives (Dizaji et al., 2020). Compared to the EU and the USA, where self-interest is a major barrier, a lack of trust due to a history of procedural and distributional injustice is the key hindrance to deploying community wind energy in Canada (Comeau et al., 2022). Research shows that various types of pre-existing networks, including bridging and linking networks, have substantially contributed to forming trusted CRE-related social networks through interconnection with different intermediaries and local authority organizations, which assists in knowledge development, facilitating awareness, fostering interpersonal learning, and lobbying for CRE projects.

A culture of localism, small- and medium-sized entrepreneurship, and distributed ownership are also significant issues for CRE. For instance, strong traditions of cooperative culture in Germany and Denmark have assisted in the birth and deployment of CRE in these countries. In the UK and Canada, strong community-based activities and collective voluntarism are vital supporting factors for the CRE initiatives. Similarly, various social movements significantly contributed to the emergence and growth of CRE both in North America and Western Europe.

Environmental campaigns related to climate change and the anti-nuclear movement in the EU, particularly in Germany, had a significant role in the deployment of CRE. Along with these movements, the study found that demonstrations against large-scale centralized renewable energy were significant drivers for CRE initiatives in the USA and the UK (Wiseman, 2020; Parag et al., 2013).

Physical conditions and technical issues of renewable energy, such as (i) availability of natural resources, (ii) design, installation, and functioning of renewable energy technology, and (iii) required knowledge and skills for renewable technology, have also been widely mentioned as crucial enablers and disablers for the deployment of CRE. For example, compared to the EU, Canada has a much larger energy landscape; however, most of Canada's energy resources are in remote areas far from large population centers, resulting in an uneven distribution of energy needs and energy production. As a result, despite Canada having more renewable energy resources, the expansion of CRE projects in Canada has lagged compared to the EU. Similarly, many studies demonstrated that lack of technological maturity, high grid connection costs, and energy storage limitations are key hindrances to deploying CRE projects in North America.

Economic viability, including financial capital and access to various financial services, is the most important enabling and/or disabling factor for the emergence and development of CRE. Several innovative financial mechanisms were used to overcome this financial barrier for renewable energy in North America, particularly the United States, such as public capital vehicle financing, carbon bonds, and power purchase agreements (Lehtonen & Okkonen, 2019)

On the other hand, the UK mitigates the financial barriers and risks by partnering with other organizations, including local energy developers and business organizations. Similarly, the 'Renewable Energy Cooperatives Mobilizing European Citizens to Invest in Sustainable Energy'

(MECISE) program greatly minimizes various financial barriers to developing CRE projects in European countries (REScoop, 2018)

ii) Motivational Factors:

There are multiple motivational factors behind CRE; however, the three most commonly observed are conserving the natural environment and reducing climate change impact, economic regeneration, and increasing social cohesion by accepting renewable energy. The presence of these factors mostly relies on the features of CRE projects. Economic revitalization is the most-cited motivational factor for forming and developing CRE. Concerns about protecting the environment—from regional pollution, and its effects on health, to global warming—are also significant drivers for CRE initiatives. In some cases, the positive impact on the environment seems to be more significant than the financial gains, particularly for individuals or communities who prefer and seek to maintain a green and sustainable lifestyle. However, the success of CRE projects highly depends on the participants' perception of renewable energy. Much of the literature on CRE shows that the lack of community participation and community interest is perceived as a key hindrance to CRE initiatives, while CRE projects formed within a trusted network, creating a credible premise of public benefits and reducing injustice regarding the distribution of costs and benefits of energy initiatives, are more successful.

iii) Project-related Factors:

Various project-related factors, including ownership structure, the nature of engagement and networking in energy projects, and leadership patterns also influence the creation and success of CRE projects. Engagement and networking are essential as they generate a culture of collective action and collaboration within the community and between communities and other stakeholders. The role of a leader in a CRE project is to inspire others to create an energy project; establish a social, economic, or environmental vision for the group; and foster collaboration and agreement. The project's leaders support the energy project by providing the resources needed to succeed in the CRE project and assisting in overcoming difficulties and challenges.

Ownership opportunity in the energy project is, however, the most influencing factor for community involvement in CRE initiatives. The research mentioned various ownership patterns, including energy cooperatives, limited partnerships, community trusts and foundations, housing associations, non-profit customer-owned enterprises, and public-private ownership models enabling different actors to invest in, expand on, and maintain renewable energy assets. In Western Europe, for instance, the cooperative ownership model is available in Germany because of the tradition of grassroots innovation culture, while in the UK, energy community trusts and foundation-based ownership are the most common due to place attachments and existing energy and land policies. On the other hand, Canada has five types of ownership in renewable energy projects, namely cooperative, Indigenous, community investment fund, non-profit organizations, and MUSH (Municipalities, Universities, Schools and Hospitals) ownership. Municipal ownership is the most typical kind of CRE ownership across these five models. However, municipal ownership of RE assets is restricted by law in some Canadian jurisdictions, such as Newfoundland and Labrador (Patel & Parkins, 2023)

iv) Similarities and differences of various factors in Western Europe and North America:

This study revealed four key differences between North America and Western Europe that have influenced the nature and growth of CRE in these contexts. Firstly, European policymakers at multiple scales prefer small- and medium-scale energy more than those in North America. Western Europe has been focusing on more decentralized and community-oriented energy initiatives, creating renewable energy projects and ensuring local inhabitant participation, including ownership and control of the energy project. Subsequently, they have highlighted the importance of small- and medium-scale renewable energy projects and reformed their energy policy so that many stakeholders can participate in energy initiatives instead of a few energy actors. On the other hand, the North American energy sector relies on monopolies and favours large energy corporations. Therefore, community ownership or citizen holdings in renewable energy is infrequent in the USA and Canada (Penland, 2021). As discussed in Chapter 3, Western Europe, particularly Germany, tries to protect its small- and medium-scale energy initiatives from large energy corporations. In contrast, American energy organizations emphasize consumer choice instead of considering consumers to be energy citizens.

Secondly, high import dependence on fossil fuels promotes the formation and deployment of CRE initiatives, whereas the availability of cheap energy sources is a key hindrance to the development of CRE projects. The availability of hydrocarbons and the supply and distribution of fossil fuels in Canada and the USA greatly influence policy regarding the transition to renewable energy in North America. Though renewable energy deployment is increasing, fossil fuels remain

North America's primary energy source. European energy, on the other hand, is highly dependent on imports. Consequently, the risk of energy supply disruptions and rising energy prices in Europe have compelled Europe to deploy diverse renewable energy generation.

Thirdly, a strong tradition of community-based activities like social enterprises and various social movements such as the anti-nuclear movement, as well as the growing demand for alternative energy has accelerated the formation of CRE projects in Western Europe. Authors such as Curtin et al. (2017) and Brummer (2018) have argued that due to the strong cooperative culture and integrated policy framework, Western European countries have prioritized decentralized renewable energy. On the other hand, renewable energy cooperatives are relatively new in North America. The lack of a cooperative culture and support from the traditional cooperative sector are important barriers to deploying renewable energy cooperatives in Canada (Leonhardt et al, 2022). Compared to Canada, the USA has more cooperatives. However, many US energy cooperatives use different energy mixes, such as renewable and non-renewable sources, rather than solely renewable energy like in Europe.

Fourthly, Europe and North America first introduced RE policy and implemented various RE-support programs during the 1990s. However, Europe has a more integrated energy policy associated with environmental conservation, sustainability, and climate change approaches compared to North America (Canada and the US). The EU has applied various policies not only to achieve a sustainable future but also to ensure energy democracy, including project ownership, energy management, and control. Instead of a technocratic path, EU countries have adopted a more bottom-up strategy through the "RES Directive 2009/28/EC" policy from 2009 (Fernandez, 2021). Besides this, all member nations of the EU have formed their own policies. As a result, whereas until 2000, most countries in the European Union had only one major energy policy instrument or supportive mechanism for renewable energy, after 2009, every EU member state had three or more policy schemes on average. On the other hand, in the USA, shared renewable energy policy, such as community solar legislation, has not been enacted in all states. Similarly, in Canada fragmented energy governance and the lack of integrated policy creates friction at the local, Indigenous, provincial, or federal levels, making it challenging to build energy democracy on a large scale. Moreover, long-term centralized, elite-dominated energy institutions and corporate actor-led energy policies consider local actors as energy customers rather than energy citizens (McMurtry, 2018).

In summary, regarding the determinant factors of CRE (second research question), the review shows different contextual, motivational and project-related factors particularly policy, culture of localism and trust, access to natural resources, and economic regeneration, including ownership structure are the most important issues for CRE in rural regions of both Western Europe and North America. Western Europe successfully deployed the CRE project through these factors, whereas North America encountered challenges in achieving similar outcomes due to these factors.

4.5 Recommendations and Further Research for CRE in Canada (Answering Research Question #3)

i) CRE Initiatives in Canada:

Canada has a distinctive energy landscape in terms of the prospect of renewable energy. For instance, it has plentiful land areas with the potential for installing wind and solar energy, as well as vast water areas, including inland and ocean, which could be utilized for both wind and tidal energy. Similarly, the presence of mountains and boreal forests in Canada has given rise to the world's largest hydro and biomass energy prospects (Hicks & Ison, 2018). Conversely, Canada has a low population density, with most people living in the south. Compared to the south, the northern regions are more sparsely populated and experience harsher weather conditions; however, this region has more capability for producing renewable energy (Valiante, 2013). There is no robust and sufficient nationwide transmission infrastructure across Canada (Mortensen, et al, 2017). Consequently, a disparity arising from the mismatch between the geographical distribution of human settlements and the available renewable energy sources leads to an imbalance in energy demand and supply (McMurtry, 2018). This gap presents two key challenges for energy policy (Barrington-Leigh & Ouliaris, 2017). Firstly, energy evaluations at the local, regional, or provincial level are required to determine demand and potential energy availability. Secondly, to evaluate the complete capacity, it is also essential to adopt a comprehensive strategy that considers all energy sources collectively.

Winfield et al. (2021) show that three Canadian provinces (BC, ON, and NB) have adopted local renewable energy and climate change planning initiatives; however, these local energy activities are poorly integrated with regional energy policy and mostly focused on renewing large or centralized power production resources. On the other hand, Wyse (2018) shows that Canadian local energy plans (LEPs) tend to focus on local aspects and their role in energy savings and environmental advantages. However, these LEPs have not been able to assure social benefits like community empowerment, procedural justice, and energy literacy, and a significant number of these plans do not substantially contribute to the formation of CRE due to the lack of policy regarding community ownership. Similarly, McMurtry (2018) mentions four key challenges for local energy initiatives: access to the energy grid, access to financial services, lack of capacity and negative perception of these energy plans. Again, political economy issues have created significant hindrances to the energy transition, including CRE initiatives in Canada (MacArthur, 2017). For instance, lead provinces in adopting renewable energy, like Ontario, New Brunswick, PEI and Nova Scotia, are facing difficulties in fulfilling their energy demand and highly depend on traditional and dirty energy production systems. On the other hand, provinces like Manitoba, Alberta, Newfoundland and Labrador, British Columbia, which possess well-established and lucrative oil and hydro resources, are least interested in energy transition, including community energy policy, because their existing energy system can meet their energy demand sufficiently (Thompson, 2022).

Another challenge is that political leaders have not adequately acknowledged the potential of the CRE sector to contribute to and facilitate the ongoing energy transition and their biases favour extensive and centralized power generation, creating barriers to deploying CRE initiatives in Canada (Leonhardt et al., 2022; Mortensen, et al., 2017). Consequently, McMurtry (2018) identified two challenges for CRE initiatives in Canada: the significant economic influence of corporate and governmental entities, as well as the failure of both the public and policymakers to recognize alternative energy solutions.

Although various obstacles have been recognized, numerous renewable initiatives have succeeded due, at least in part, to enabling policies. Both federal and provincial governments have applied different supportive policies for decentralized renewable energy, for instance, ecoENERGY for Aboriginal and Northern Communities and federal gas tax revenues. The ecoENERGY policy, from 2011-2016, primarily focused on the First Nations communities and provided a maximum of $250,000 for developing renewable energy (MacArthur, 2017). Continuing this policy, the federal government introduced a new policy scheme with $300 million up to 2027 called Clean Energy Initiatives in Indigenous, Rural and Remote Communities, which focuses on renewable energy production and energy efficiency and capacity building initiatives. On the other hand, the Gas Tax Fund supports community energy systems and assists provinces with local infrastructure projects. In addition, The Federation of Canadian Municipalities (FCM) runs a Green Municipal Fund of 1.6 billion, which offers grant funding to support the creation of plans, feasibility studies, and low-interest loans for local pilot renewable projects (Green Municipal Fund, 2023). Different provinces have also adopted various policies, including net metering (Saskatchewan, Newfoundland and Labrador), FIT (Ontario), COMFIT (Nova Scotia), and small-scale generation regulations (Alberta) for deploying decentralized renewable energy (Leonhardt et al., 2022).

ii) Some Recommendations for CRE Initiatives in Canada Based on this Review:

Based on the findings from this research, including the critical role of policy and institutional factors, several recommendations arise to address essential issues for deploying CRE in Canada. These are:

1. The complex jurisdictional landscape, diverse renewable resource endowments, varying priorities and agendas among different Canadian provinces, long-term sustainability vs. short-term politics, the existing energy market structure, and economic considerations are significant challenges for deploying renewable energy in Canada (McMurtry, 2018; MacArthur, 2017). For instance, Canada has mainly transferred responsibility for energy policy to the provinces, and evaluations of possible supply and demand are undertaken at the provincial level. However, regions with a strong potential for renewable energy are not correlated with those with a high demand for energy (Barrington-Leigh & Ouliaris, 2016). Again, land ownership and rights can be

complex issues in rural, remote areas due to the Indigenous territories. Developing renewable energy projects in Indigenous territories requires negotiations with multiple parties, including federal and provincial governments. These challenges underscore the need for careful collaboration among all levels of government, industry, Indigenous communities, and other stakeholders to develop an effective and integrated energy policy framework. This integrated policy should include coordinating efforts across sectors, optimizing resource allocation, harmonizing regulations, and fostering stakeholder collaboration. By adopting a multi-sectoral approach, setting ambitious targets, implementing binding policies, and integrating sustainability into various aspects of governance, Canada can create an integrated policy framework similar to the EU's Green Deal.

2. The study found that policy is the most important issue for CRE. Canadian governments have adopted various supportive policies, including various funding programs, tax savings accounts, loans from credit unions, FIT and net metering policies. However, high loan interest rates for CRE, high grid connection costs, complex and cost-prohibitive securities regulations, unstable net metering programs, bureaucratic processes to get power purchase agreements, and hard eligibility criteria for net metering are constraining engagement in CRE projects (Leonhardt et al., 2022). Consequently, these governments should (within their respective powers and jurisdiction) examine options such as: permit virtual net metering, offer increased flexibility within the regulations governing grid access, enable collaborations between CRE and regional energy distribution utilities, and establish power purchase agreements mandating a particular portion of the energy to come from CRE.

3. The study found that access to the existing grid or potential alternative sources are crucial for CRE in small towns and rural areas. The responsible level(s) of government in Canada should adopt appropriate grid management initiatives, such as giving priority to stand-alone (SA) systems that produce electricity apart from the utility grid, requiring low plant load factors, and always balancing operating power capacity with the demand (Kaundinya et al., 2009). Policy to ensure local communities the ability to sell their excess renewable energy to the national/regional grid, would also be beneficial.

4. The review shows that access to various financial services is one of the key factors that can lead to deploying CRE in rural areas, particularly at the initial stage of CRE initiatives. Many rural communities in Canada are located in remote areas that are impossible or very costly to connect to central grids. Consequently, both provincial and federal governments should invest more in decentralized renewable energy, for instance, providing incentives for residential solar panels, support for community solar gardens or installation of small-scale wind turbines and other microgrid systems; creating funding programs or grants like green bonds, green certificate trading systems, or the "Clean Energy for Rural and Remote Communities Program (CERRC)" program to support entrepreneurs and small businesses regarding renewable energy in rural and remote regions.

5. This study illustrated that centralized energy systems are dominant in Canada; however, different decentralized institutions are essential for the development of CRE. Therefore, governments should facilitate the creation of decentralized institutions like local distribution companies (LDCs) to deploy CRE initiatives in Canada. Renewable energy communities can establish a new central organization like "League of CRE" to cooperate with each other, including

sharing various technical and economic supports, and disseminating the most recent research findings in that field (Leonhardt et al., 2022, p 24). As well, federal and provincial governments should collaborate to establish locally (or regionally)-based one-stop innovation hubs jointly in collaboration with universities, NGOs, Indigenous organizations, local governments, and local communities, providing various technical, social, financial, and policy-related services for deploying CRE in rural Canada.

6. The research illustrated that negative perceptions are one of the important barriers to developing the CRE project in Canada. Investing in educational programs, arranging community conferences, webinars and workshops, community energy fairs, and public art and installations can raise awareness and assist in building capacity within communities about the benefits of CRE, the available technologies, financing options, and project development processes. This can be facilitated by the development of an interactive online platform including social media, mobile Apps, and websites that share data, case studies, and success stories about existing CRE projects to inspire and guide other communities' efforts. These energy initiatives would help build further support for and engagement in CRE.

7. Finally, this review shows that Indigenous renewable energy initiatives can be great economic sovereignty tools and contribute to the reconciliation process. TRC outlined 94 Calls to Action to promote reconciliation between Indigenous and non-Indigenous peoples, including i) urging federal, provincial, and territorial governments to fully adopt and implement the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP); ii) advocating for the establishment of a Royal Proclamation and Covenant of Reconciliation to provide direction for diverse Indigenous land and resource management initiatives; and iii) promoting investment in

Indigenous economic advancement, including natural resource projects that enhance the well-being of Indigenous communities. In Canada, the provision of energy to Indigenous communities is a multi-jurisdictional issue that obliges cooperation between local and regional Indigenous governments and councils, the federal government, and provincial/territorial governments (Barrington-Leigh & Ouliaris, 2016). Therefore, governments should focus on resolving multi-jurisdictional issues that serve as barriers to CRE programs. Moreover, while the federal government recently announced the $15 billion budget for the Canada Growth Fund, the key objective of this fund is more to promote the private sector rather than focusing on social outcomes Beck (2023) and there is typically limited community control over the design and management of projects funded by the Fund, reducing their ability to shape economic development according to their needs and priorities. Such funds should be distributed based on recognition of Indigenous land and resource management rights, insight regarding community needs and capabilities, available resources, and more inclusion of Indigenous communities as essential steps to facilitate the energy transition.

The results of this study are drawn from secondary sources, which show that CRE is having significant positive impacts on rural resilience in North America and Western Europe. However, particularly in some settings, this renewable energy model also has some significant challenges and limitations, including unfair access to membership and benefits, lack of technological maturity, and lack of regulatory obligations regarding connection to the existing grid infrastructure. These are among the major challenges for energy transition and CRE more specifically. Therefore, further research is needed based on both primary and secondary data on these challenges as well as how CRE can best be facilitated in rural regions as part of a global effort toward energy transition. Cooperative culture has accelerated decentralized renewable energy in Europe compared to North America. Consequently, further study is required to determine why North American cooperatives have been unable to contribute further to the development of CRE and how these and other challenges might be overcome.

Finally, CRE has a significant impact on rural resilience, where diversity is the major contribution of CRE, followed by networks and connectivity, equalization, and adaptive capacity. Various contextual, motivational, and project-related factors, particularly policy, the culture of localism and trust, access to natural resources, and economic regeneration, including ownership structure, are the most important factors for CRE in North America and Western Europe identified in this study. While Western Europe has effectively implemented CRE projects through these factors, North America has faced impediments in achieving comparable results due to their influence, suggesting much room for improvement.

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