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Energy democracy, public participation, and support for local energy system change in Canada

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ABSTRACT

In the face of climate change and associated energy system change, there is a growing literature and more general recognition of the 'four Ds' (decarbonization, decentralization, digitalization, and democratization). Yet there has been very little quantitative work that analyzes public perceptions of these changes. Utilizing data from a Canada-wide, nationally representative survey ($n = 941$), this study conducted provincial and regional assessments to spatially explore the public's views of moves toward innovative local energy system change through the development of what we call Local Smart Grids (LSGs). Through descriptive statistics and t-tests, we sought to answer three main questions: i) To what extent does the public support energy democracy via new local energy systems? ii) What does the public desire in terms of participation? and iii) What motivates the public to participate? We find overall support for energy democracy across Canada, yet varied support among provinces and regions. Canadians seem to want to participate in moves toward energy democracy, although we found a strong preference for more passive participatory actions. Additionally, support and a desire to participate is predominantly motivated by environmental factors, including combating climate change, with community and social motivations playing a secondary role, followed by financial motivations. These findings, some of the first of their kind in the realm of energy democracy in Canada, provide useful insights relevant to scholars, policymakers, and practitioners working on LSG implementation as well as others with an interest in socio-technical innovation and energy system change.

1. Introduction

To avoid the worsening impacts of global climate change, average temperature increases need to be limited to 1.5 °C above pre-industrial levels [1]. To do so, and as per the goals of the Paris Agreement,[1] emissions need to reach [2]net zero by 2050 [1]. Achieving these targets will require a complete transformation of the energy sector, as it is currently the source of 73 % of all greenhouse gas emissions [2]. The shift from carbon-intensive fossil fuels to clean and renewable energy is already underway across the globe, and 2022 saw another year of record growth[3] [3]. In Canada, renewable energy has seen significant growth in wind and solar energy generation, while hydropower continues to remain the primary source of electricity generation across much of the country [4].

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[1] The Paris Agreement is a legally binding international treaty on climate change. It was agreed upon by parties in the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations, 2022).

[2] Net zero means emitting no greenhouse gas (GHG) emissions or offsetting emissions to as close to zero as possible (International Energy Agency.

[3] Despite increases in renewable energy in many countries, global energy demand and consumption are growing rapidly in tandem, resulting in carbon dioxide (CO2) emissions nearing record levels globally.

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Yet the steep growth in renewable energy tells only part of the story of achieving a sustainable energy future. To achieve net zero targets and effectively address climate change, it is essential to not only shift the ways in which we generate electricity, but also to 'electrify everything' [2,5] and consider profound changes in the location, governance, and structure of wider energy systems [6,7]. Both shifts can perhaps best be seen through the development of new local energy systems that some [8–10] are calling Local Smart Grids (LSGs). Also known as Smart Local Energy Systems (SLES) in the UK (United Kingdom) in particular [7,11,12], LSGs are emerging energy systems that combine locally-produced renewable electricity, smart technology, and energy storage to electrify previously carbon-intensive activities like home heating and transport [11]. The technical aspects of LSGs are well-documented, however, there is a clear gap in comprehending the socio-political and socio-technical aspects of this energy transition, especially at the local level [12,13].

Speaking to their wider changes in energy systems, LSGs are said to be rooted in the 'four Ds': decarbonization, digitalization, decentralization, and democratization [7]. Perhaps the most impactful of the four [14], as LSG development begins to shift the 'power' of energy systems, there is the potential to democratize energy [15]. While understood differently between sets of policy makers and researchers, the democratization of energy means moves toward achieving participatory energy decision-making, the redistribution of power from corporations to citizens, and greater community ownership and participation in these more local energy systems of the present and future [16]. Simply put, energy democracy can be defined as the enabling of formal participation in energy-related and decision-making processes [17]. It encompasses the concept of prosumerism, which entails community and individual ownership of energy production [17]. Energy democracy empowers more local control - shifting power dynamics toward allowing citizens, communities, and stakeholders to have a greater say and participate in their energy lives [18,19].

As countries like Canada strive for a sustainable and net-zero future, energy democracy-related initiatives may not only contribute to its emissions goal but also provide local, flexible, efficient, secure, and equitable energy systems [20]. Many LSG projects are government funded and led [8], therefore projects may not be defined as 'bottom-up' due to levels of control and participation being possibly predetermined by government and stakeholders. Indeed, the nature of LSG (SLES) development in the UK is showing that projects may be mostly guided by top-down practices that continue to treat citizens as consumers set within a "largely unchanged institutional regime" [21; p. 15]. Yet under a different set of assumptions LSG projects offer a *potential* vehicle toward more citizen participation, and more energy democracy than the status quo [15]. We acknowledge that levels of participation can vary from intensively involved (i.e., being a technology host and buying and selling electricity with other citizens) to being more passively involved, but still participating (i.e., attending a meeting and learning about the project). With regard to the former set of activities, research has shown that projects which stress energy democracy and more citizen autonomy are being shown to offer powerful ways to restructure energy systems through novel frameworks and governance paradigms, and offer successful more viable energy futures [22]. If these systems are to play a role in the future it is essential that all those involved (i.e., governments, planners, and developers) must understand what citizens expect and hope for.

In this study, we address this need by taking a regional and provincial approach to the analysis of quantitative data from a 2022 online survey on Canadians' attitudes and perceptions of LSGs and local energy system change. Our goal was to assess three main considerations around Canadians': i) support for increased energy democracy via new local energy systems; ii) desires and expectations in terms of participation in new local energy systems; and iii) motivations to participate in new local energy systems. Learning more about Canadians' views will not only advance our academic understanding around LSGs, energy democracy, and planning, but will also help inform and advance so-called 'best practices' for widespread, successful, and just local energy transitions. Taking a provincial/regional spatial approach aligns with energy governance structures in Canada, as regulation of electricity is of primarily provincial authority [23]. With recognition of spatial gaps and the need for deliberate democratic mechanisms within energy systems [24], this work provides an important assessment of the spatial difference across Canada [25], while also accounting for authority of energy governance in Canada [23,25]. Our aim is that this work will also be useful for other industrialized countries where public acceptability is linked to success and growth of clean energy development [24].

In the sections that follow, we overview the existing and current literature as well as the context of LSGs and energy democracy. Within this literature review, we also explore participatory planning, the politicization of energy systems, and public perceptions. From there we outline the methodology of this study, consisting of the research context, study design, and data analysis. Subsequently, we present the results obtained from the analysis, before engaging in a discussion that explores the meaning and implications of these results. Finally, we conclude with a summary of our research.

2. Literature review

2.1. Local smart grids

LSGs have several different names and are often referred to as Smart Local Energy Systems (SLES) in the UK [11], Smart Grids in Australia and Canada [26,27], and various other adjacent terms and definitions, often associated with community energy projects [12]. In this study, we chose LSGs, as recognized by the International Community for Local Smart Grids [10] – representing a kind of 'hybrid' between Smart Grids and Smart Local Energy Systems. LSGs have gained traction through development, research, and energy discussions in recent years [28]. As a result of being new both technologically and with regards to actual implementation, with the first publication on the subject dating back to 1995 [29], the literature is constantly evolving as projects are being deployed and researched. While the technical aspects of LSG and energy transitions are well documented, there is a noticeable gap in the socio-political and socio-technical aspects of energy transitions in general, and decentralization more specifically [16,30]. It has only been recently that the social elements of these systems have been assessed [12,13,15,31,32].

In their systematic literature review, Vakulenko et al. [29] found that the majority (52 %) of the 1359 'smart grid' publications reviewed were from the engineering and computer science fields. Early smart grid literature, substantially beginning in 2008, emphasized smart grid technological limitations and constraints. Yet, through significant technological advancements, these elements are no longer seen as major barriers. As a result, there is now increased literature focused on the social elements of smart grids, and the need to examine the entire energy transition system [6,20,29]. Another key takeaway from this emerging social science literature is that a comprehensive understanding of the social dimensions of energy transitions is required to ensure a fair, sustainable, and successful transition [6,15,33].

Recent studies that assess the social aspects of LSGs have been valuable for a variety of reasons, including the fact that stakeholder acceptance of new, contested energy systems relies on how these shifts are perceived in relation to national priorities, social values, and socio-political conditions [2,5]. The adoption and ultimate 'success' of most major energy innovations – like the ones proposed through renewable energy, energy storage, and LSG projects – are driven largely by public support and political backing at various institutional and societal levels [17,34,35]. Mallett et al. [36] assessed the news coverage of LSGs in North America, highlighting that the cultural and political factors in each country are the cause for differences and portrayals across news platforms. While examining the role of environmental framing in the

socio-political acceptance of LSGs, this and other research have shown that in order to foster socio-political acceptance, clear and concise visions of how LSGs can contribute to climate action and what it does for individuals, is necessary [35,36]. The LSGs literature has also assessed social constructs of place in terms of what the 'local' means in LSG projects, highlighting the importance of spatial concepts, local dimensions, and the dynamic nature of boundary-making within local communities [12].

Though still nascent, this literature demonstrates the growing focus on the social and political elements of these LSG transitions. A consensus is that the challenge for a shift in energy systems is not the technical component associated with these systems, it is the level of local and public support and the approach and attitude of policymakers [12,16,35].

2.2. Energy democracy

While encompassing a great diversity of definitions, energy democracy is a concept that looks to bridge the gap among ideas of justice, well-being, and equity through low-carbon energy transitions – transforming the social, economic, and political landscape of host communities via democratic practices [6]. It is a key component of the 4Ds [13,22], and is likely to be the subject of much discourse and a highly contested topic in North American energy policy, politics, and planning processes [16]. Energy democratization is often associated with a transition away from the status quo – large-scale, centralized, fossil fuel-based energy systems. However, for some, the idea is more fundamentally about making sure that local community control and participation is central in new energy projects and systems [22]. In doing so, energy democracy provides the opportunity to reverse energy power imbalances, marginalization, and social and environmental injustices all while supporting the shift toward clean energy [36]. In this paper, we conceptualize energy democracy as the processes and outcomes related to a transition toward participatory decision making and community involvement in energy systems.

If social science research on LSGs is still relatively nascent, literature focused on energy democracy is even more so. There is a growing amount of research addressing energy democracy, with the majority of publications beginning in 2017 and primarily being situated in the UK or European Union [17,37]. The bulk of the literature to date emphasizes the importance of energy democracy as a pillar for the redistribution of economic and political power for energy systems [6,17,22,38]. Here, a key component of energy democracy are the ideas of community participation and energy citizenship (as in Stephens et al. [39]). Wahlund and Palm [17] note that in numerous European countries, there are policy shifts that increasingly encourage pathways toward energy communities. These energy communities, while varying in scope and definitions, offer new roles in energy markets, and roles in the development of citizen-led responses to energy needs and demands, allowing for participatory, and more grassroots community energy initiatives [16,40]. In their ideal form, energy citizenship and energy communities can aid in empowering individuals to engage in broader energy policy, as they push democratic mechanisms with their influence and power to develop new widespread energy policies [17]. In addition to policy and regulatory frameworks, it is crucial to consider the cultural and societal conditions of a region, to ensure successful implementation [35].

The State of Vermont's recent fundamental changes to their energy system is a rare North American example and provides valuable insight into the operationalization of energy democracy [39]. Through active involvement from Vermont citizens, activism aided in the shutting down of the largest central power plant in the state [39]. This work sparked a movement toward energy democracy legislation and policy reform and led to community solar projects where multiple citizens were able to own a single renewable energy unit, collectively run and manage the system, and share the output [19,39]. In doing so, community solar projects in Vermont have helped operationalize energy democracy, placing more authority in the hands of the people, where local residents have a stake and say in their energy future [39]. For example, legislative reform mandated group net metering, full community ownership, and sharing of energy outputs, which have created more legitimate community energy democracy projects. Furthermore, centering the importance of community ownership in the distribution of energy authority, the Stephens et al. [39] study concluded that it is crucial to assess the participation, ownership, and financing structures of new energy initiatives to achieve higher levels of energy democracy.

Throughout this literature, the *type* of energy democracy research being conducted is an important trend as well. Of the 61 articles assessed in a literature review by Wahlund and Palm [17], the vast majority (77 %) utilized qualitative methods. The seven quantitative studies covered a broad range of topics, including the relationship between energy prices and community-led energy system risk as a driver toward consumers' involvement in energy systems, and the role of energy storage and demand response as energy democracy policies [17,41–43]. The lack of quantitative research suggests the need for this research, as survey-based work, and more specifically research on themes of energy democracy and public perceptions, will help inform data driven decision making for policy makers and stakeholders. Additionally, this quantitative work plays a crucial role in establishing generalizability and representativeness for energy democracy research in Canada [44]. These concepts are essential for drawing meaningful conclusions, including applying research findings to the broader Canadian public, as well as provincial and regional contexts.

2.3. Participatory planning

Aligning with the main tenets of energy democracy, allowing for citizens to have greater autonomy and participation in energy systems is shown to allow for more sustainable, equitable, and just communities [17,22,45]. In practice, meaningful participatory planning for LSGs can be a crucial first step to help enable these outcomes [46,47]. True participatory planning allows for and creates transparency, empowered communities, equity, and a better balance of hegemonic powers between the public and government [47]. Current institutionalized public participation in planning can often be seen as tokenistic and a formality [47,48]. Many projects and decision-making processes, while touting participation, fail to reflect public views nor do these views have legitimate influence [49]. Thus, for participatory planning to be equitable and legitimate, public input and participation must be considered and be able to influence outcomes [47,50].

Typologies such as Arnstein's ladder and Davidson's wheel of participation have been developed to understand approaches and indicate the degree in which stakeholders are involved (e.g., limited decentralized decision-making versus limited consultation) [51,52]. Unlike the ladder, Davidson's wheel views participation in a non-hierarchal way, as it can account for varying levels of societal and economic statuses present in an area and allows for the distinguishing of objectives and participation [46]. Davidson's wheel, a valuable framework for analyzing citizen involvement, divides participation into four distinct quadrants; inform, consult, participate, and empower. Each quadrant represents a different level of engagement, ranging from minimal involvement (i.e., inform) to active engagement and independent control (i.e., empower) [46,52]. By assessing participatory planning and energy democracy actions within Davidson's wheel, it becomes possible to establish a standardized spectrum of citizen participation which can offer a valuable tool for future examination of LSG development and energy democracy within Canada and beyond. This framework ensures a more nuanced and inclusive analysis, helpful for promoting effective energy democracy initiatives and fostering community involvement and engagement at varying levels.

Participatory planning does have difficulties, such as the issue of who is at the table and who is not [49]. A comparative analysis by Stober et al. [53] on the quality of participatory processes for 25 renewable

energy projects within Europe found that poor and entirely absent public participation processes were the main factor in unsuccessful development. The study also found that the highest quality and best-ranking participatory planning practices were community-led. With close collaboration between the community and authorities, these projects were able to enable community financial participation (investing money, producing renewable energy and financial return), allowing for more local autonomy.

2.4. Politics and public perceptions

Energy systems and transitions are inherently political. As Brisbois [16] argues, a major reason for the slow deployment of low-carbon energy projects is the resistance by politicians and corporations that have political influence. Such resistance is manifested through regulatory and planning paradigms that enable powerful stakeholders to entrench the existing centralized system [16,36]. There is growing concern that this political influence is not only preventing much-needed energy system change but also eroding principles of [energy] democracy. Indeed, energy companies have been observed eroding democratic principles through practices known as corporate political activity (CPA). These practices include energy corporations sharing voting preferences with stakeholders, executives, and other personnel, with goals to persuade support for certain parties and politicians [54]. This power imbalance results in a transactional relationship, where citizens are seen as customers/consumers [55], with minimal power to impact energy policies and programs [16].

While recent years have brought an increase in the number of so-called 'local' or 'community' actors in energy markets, the majority of 'newer' energy actors remain commercial renewable energy producers. Yet as Schweiger et al. [45] note, recent studies showcase the participation of local citizens is vital for LSG success. This includes work from Kabeyi and Olanrewaju [33] which shows that to have an energy transition that is equitable, sustainable, and just, local communities must play a role. Unlike current trends in centralized and many decentralized energy contexts, LSGs and their potential for democratization are typically focused on the community being the main beneficiary [16,37].

While there is currently insufficient published research focusing on public perceptions of LSGs in Canada, there is some work on perceptions of LSGs and specific technologies relating to LSG such as renewable energy and energy storage – both in Canada and abroad. One of the most relevant exceptions to this absence of public perception LSG research can be found in a 2012 paper looking at consumer preferences of smart grid development in Hong Kong [56]. However, the authors write that the survey was developed and presented in a way as to study public opinion of individual components of a smart grid, and not overall energy system change as we do here. Another related paper is from Abdmouleh et al. [57], where their focus went beyond LSGs to include smart meters, energy efficiency, renewable energy, and the environment. The sample was also not nationally representative, surveying only employees at Qatar University. Other published studies include survey research from Canada, but only focused on smart meter acceptance [35] and survey research from Portugal [58] in which the sample was small and unrepresentative. Survey analysis from Jones et al. [25] displayed positive attitude toward energy storage technologies (ESTs) in both Canada and the UK, although preferences for specific technology options varied highlighting the importance of environmental worldviews as a predictor of attitudes and support. What ties many of these survey-based studies together is that while recognizing that little is known about public attitudes toward smart grid projects, authors stress that public acceptability is crucial to political backing and overall success.

The literature relating to both LSG and energy democracy highlights that technological shifts alone will not ensure a low-carbon, sustainable, just future, and that political change is equally important [16,37,59]. It is thus imperative to recognize this politicization of energy as an opportunity for democratization – viewing the prospect of energy democracy as a driver for faster decarbonization, energy security and access, and overall societal well-being [22]. Examining public perceptions of LSGs and energy democracy offers understanding of the public's willingness to participate, as these projects require and benefit from more active citizen engagement [12].

3. Methodology

3.1. Research context and questions

In 2018, Natural Resources Canada's (NRC) $100 million *Smart Grid Program* began supporting a range of 21 LSG projects across the country [27]. As LSGs are new to energy landscapes across the world – and even more so in Canada – there has been little contribution from researchers who have yet to focus on LSGs and themes of energy democracy, planning, and public perceptions [29]. With increased federal investment and research, and longer-term industry-led adoption across Canada in the coming years, it is imperative to better understand these dynamics. Doing so will not only contribute to federal emission goals but also aim to provide local, flexible, efficient, secure, equitable, and 'successful' energy systems [7]. In this study, our method and data analysis were determined by our main research questions, hence we lived by Elliott's "let the question determine the methods" [60].

With this urgency in mind, this research aims to initiate an exploration of energy democracy and LSGs in Canada. Our focus is on the perceptions present across both Canada as a whole and the regions and provinces that make up the country, with the aim of enhancing our collective understanding of the complexity of energy democracy, public perceptions, and levels of support for energy democracy in order to help inform best practices for development. Building from our review of the literature and the major objectives described above, our team developed three research questions that frame this study:

1. To what extent do Canadians support increased energy democracy via new local energy systems?
2. What do Canadians want and expect in terms of participation in new local energy systems?
3. What motivates Canadians to participate in new local energy systems?

We developed these questions to complement each other and anticipate that this research provides insight into the potential for energy democratization through LSGs. Additionally, the research assesses citizens' differences via theoretical support of projects and the tangible actions they are likely to engage in. Doing so will help highlight key differences, if any, present between provinces and regions and allow for a tailored approach to provincial energy planning.

3.2. Study design and dataset

This research project was performed as part of the larger AMTD Global Talent Fellowship and EnergyREV programs at the University of Waterloo and University of Exeter, respectively. In both cases, a primary goal was to assess public perceptions of moves toward smart and local energy systems. In the study presented here, the design was quantitative, using data from a Spring 2022 nationally representative online survey in Canada ($n = 941$).[4] Our quantitative approach utilized a rigid structure of mostly close-ended questions. A quantitative approach was chosen for this study as we sought a contextualized understanding of trends in each Canadian province/region that would allow for greater generalizability, drawing of inferences, and the mapping of population level trends [44,61]. Additionally, survey work and numeric depictions of public

[4] The United Kingdom (UK) nationally representative survey was collected in 2021.

opinion are said to enable policy makers to evaluate and gauge the public's reaction to policy initiatives and projects [62] – a goal of this overall program of research. In this context, the implementation of surveys and a quantified representation of Canadians' perceptions and attitudes proves useful for generalizability [44], as LSGs gain traction through federal funding and growing research. Offering data that is nationally representative will also help inform businesses, stakeholders, and governments on the current Canadian landscape regarding energy democracy.

This survey sought to collect and better understand the opinions of a sample of Canadians to better understand their perceptions of energy democracy, participatory planning, and LSG development. Because the concepts of local energy system change, LSG development, and energy democracy are new, the survey included introductory information (see Fig. 1 below) that helped to describe the kinds of changes anticipated in the coming years. To aid in comprehension, the survey was also framed around the wider 'four Ds' of energy system change (decarbonization, decentralization, democratization, and digitalization). While the focus here is mostly on questions of democratization, we include a full copy of the survey in Appendix A to help the reader understand the full context of our work. Studies centered around all 'four Ds' can be found in our upcoming work.

The survey was made up of 52 ordinal (Likert-scale) and nominal questions and was adapted based on a similar one that our team developed in the UK, with the most significant changes being related to country-specific terminology, units, and demographic categories. We collected data from all 10 Canadian provinces, and the survey data is representative of the 2021 Canadian population along gender (48.4 % male, 50.8 % female, 0.9 % non-binary), language (75.5 % English, 24.5 % French), age (average age range of 35–44, proportion of persons aged 65 and over (23 %)), income (13.6 % of households making between $60,000 to $79,000), and province (36.6 % of survey respondents from Ontario) [63]. Due to cost and other practical considerations, we did not sample residents of the three territories of Yukon, the Northwest Territories, and Nunavut, which together make up 0.3 % of the Canadian population [63]. Moreover, 24.5% ($n = 231$) of the dataset was collected in French — 202 of those (87.4 %) respondents were from Quebec. A translation professional was hired to translate English to French before data was collected. Ethics approval was granted by the Office of Research Ethics at the University of Waterloo.

3.3. Data treatment and analysis

Our dataset was cleaned, transformed, and analyzed using a variety of statistical procedures within SPSS (Version 28). SPSS is widely adopted within the social sciences [64] and offers a wide range of analysis functions that are best suited for analyzing survey data [65], making it an appropriate application for this data analysis.

Data cleaning and transformation included treating incomplete or 'don't know' responses as missing, and in some cases, the grouping of responses by region to provide a more robust analysis. There were enough responses from Ontario ($n = 344$), Quebec ($n = 229$), and British Columbia ($n = 124$) – Canada's three largest provinces – and thus remained as independent provinces. The smaller provinces of Prince Edward Island, Newfoundland and Labrador, New Brunswick, and Nova Scotia were grouped together to represent Atlantic Canada (AC; $n = 70$), while Alberta, Saskatchewan, and Manitoba were grouped together to represent the Canadian Prairies (CP; $n = 174$). A map of Canada displaying each province and region can be seen in Fig. 2. In line with our three major research questions, analysis centered around three key variables from the survey data:

i) To what extent would you support or oppose a change to more local control of energy systems in Canada? (RQ#1)
ii) If a new local energy system was being developed in your local area, which of the following actions might you consider doing? (RQ#2)
iii) What are your main motivations behind the action(s) identified in the previous question? (RQ#3).

Data analysis consisted of descriptive statistics (frequencies and cross-tabulations), and t-tests. Descriptive statistics were performed to summarize, understand, and present the data, allowing for a clear overview and the answering of a few fundamental questions. This descriptive analysis was performed on the three main variables listed above, including highlighting the percentage frequencies of each subsample (i.e. province/region) in terms of the extent of support, and types of actions individuals would perform (see Tables 1–5 and Fig. 3). Three actions relevant to participatory planning and energy democracy were then analyzed regarding individuals' motivations for selecting said action, which included a provincial/regional cross-tabulation (see Tables 3–5 and Fig. 4).

T-tests were performed for the question of support for energy democracy (RQ#1), to identify potential differences between provinces/regions and the rest of Canada (see Table 1). T-tests were also performed to assess mean differences [66] in local energy system actions (RQ#2). Cross-tabulations were used in tandem with bivariate t-tests (see Table 1), and singularly for nominal data (see Table 2–4), as these questions had no numerical hierarchy.

4. Results

Findings are shared across the three subsections below. Section 4.1 relates to RQ#1, assessing overall support for energy democracy, Section 4.2 addresses the RQ#2, assessing the actions Canadians would perform in LSGs, and Section 4.3 focuses on RQ#3, looking at what motivations are present for Canadians' partaking in specific local energy actions.

4.1. Energy democracy

Table 1 presents the t-tests and cross-tabulations that assessed support for our question of energy democracy (RQ#1). The independent sample t-test compared the mean of each province/region versus the rest of Canada, to determine if there are statistically significant differences. The cross-tabulations show the relationship between support for our energy democracy variable ($n = 880$) across provinces/regions and Canada as a whole, showcasing the percentage frequency at each level. Overall support (level one (strongly support) plus level two (tend to support) on the Likert-scale) for energy democracy across Canada was moderately high (68.4 %), while provinces/regions varied from 62.8 % to 76.6 %. AC was the most supportive province/region at 76.6 %, BC was a close second (75.5 %), followed by ON (68.6 %), QC (66.2 %), and CP with the least support (62.8 %). Of the Likert-scale responses (i.e., 1–5), of the five t-tests, only one was statistically significant: British Columbia (1.99) versus the rest of Canada (2.13; $p = 0.045$). Despite the lack of statistical significance among the four other tests, Eastern (AC; 1.98) and Western (BC; 1.99) coastal provinces, showed much stronger support for energy democracy relative to the Canadian average (2.13). Ontario's mean was equal to the national average (2.13), while responses from QC (2.17) and CP (2.23; $p = 0.054$) showed less support – yet still in the 'tend to support' range. These lower levels of support were driven by much more frequent feelings of indifference in QC and especially CP (i.e., 'no feelings either way').

Introduction

Welcome to a survey being conducted by Chad Walker and Ian Rowlands of the University of Waterloo. They are members of a research team based out of the School of Environment, Resources and Sustainability. This survey research is funded through the University of Waterloo and an AMTD Global Talent Fellowship.

For this survey, we would like to explore your opinions on emerging energy systems in Canada. We value your time and hope you will enjoy taking part!

We expect the survey will take about 15-20 minutes. It is conducted according to the Tri-Council Policy Statement and has ethics approval from the University of Waterloo.

The questions ask about your views on energy in Canada. There are no right or wrong answers; all views are important to us, so please answer all questions as best you can.

Introduction to Local Energy

Throughout the survey, you will see the words 'Local' and 'local area'.

Please take these words to mean whatever best fits your own understanding of 'local' and 'local area'. This might be the city, town, or village that you live in.

Currently, Canada has an energy system where electricity is mostly generated in large power stations located far away from where most people live. Electrical grids deliver this electricity to where it is used. The natural gas and oil that we use to meet some energy demand (e.g., heat buildings) comes partly from Western Canada but also from the United States. Finally, the gasoline and diesel that we use to fuel our vehicles is often imported from other Canadian provinces and sometimes other much more distant countries.

Local Energy would involve a change to this system. Electricity and heat would mostly be generated using renewable energy (i.e. solar or wind) in the same city, town or village that you live in. Cars would be powered by locally generated electricity, and their electric batteries would be used in ways that make the local grid work best, for example storing electricity when renewable energy is abundant (e.g., on a sunny day), and releasing it into the local grid when it might be scarce (e.g. when dark at night). Energy would be managed by local organisations, for example electricity would be sold to you by local people and businesses.

Fig. 1. Text of the introductory information provided in the survey.

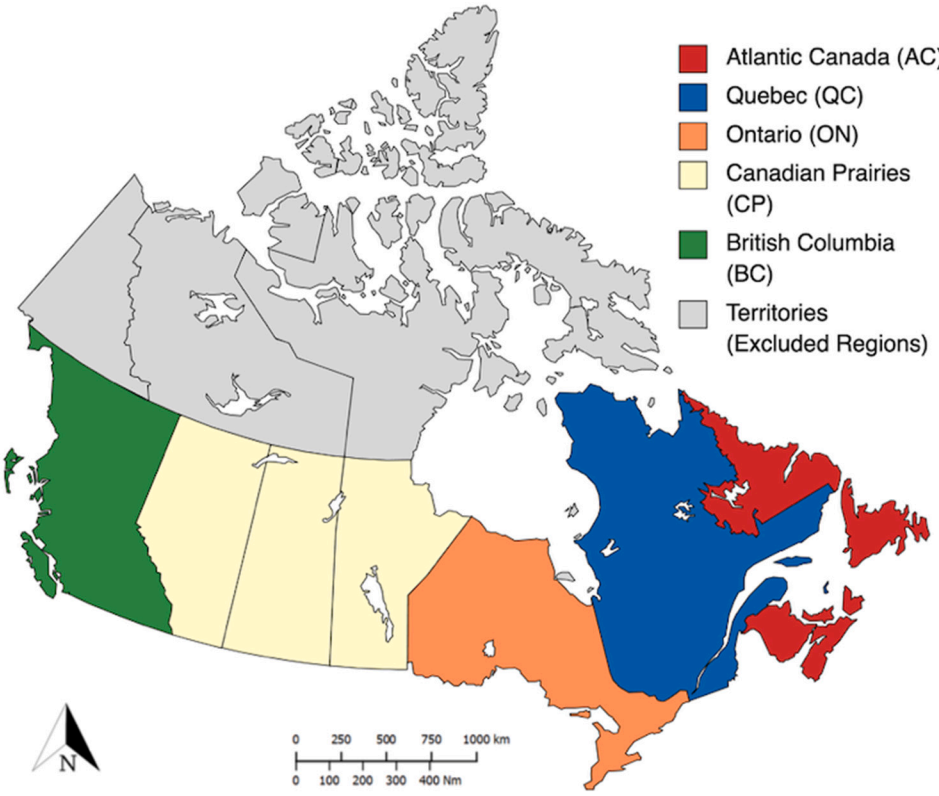

Fig. 2. Map of Canada, showing the five provinces/regions considered for this study and the excluded territories.

Table 1
Support for energy democratization in Canadian provinces and regions.

Survey Question		Support[a] / Oppose					Mean[b]	*P* Value[c]	Std. Deviation[d]	Number of Responses
		1	2	3	4	5				
To what extent would you support or oppose a change to more local control of energy systems in Canada?	ON	27.1	41.5	25	4.6	1.8	2.13	0.477	0.925	328
	QC	24.3	41.9	27.6	5.2	1	2.17	0.239	0.889	210
	BC	31.6	43.9	19.3	4.4	0.9	1.99	0.045*	0.877	114
	AC	32.8	43.8	18.8	1.6	3.1	1.98	0.099	0.934	64
	CP	24.4	38.4	29.3	5.5	2.4	2.23	0.054	0.909	164
	Canada	26.9	41.5	25.2	4.7	1.7	2.13		0.920	880

[a] 1 – strongly support; 2 – tend to support; 3 – no feelings either way; 4 – tend to oppose; 5 – strongly oppose. Values shown are percentages of each province/region subsample.
[b] Mean score for the subsample.
[c] Equal Variances assumed, significance of difference of regional test versus Canada means test, *P-Value $p < 0.05$;**$p < 0.01$.
[d] Standard Deviation.

4.2. Individual actions in new local energy systems

To answer RQ#2, we performed a percentage frequency analysis to discover what actions Canadians would consider if a new local energy system were being developed in their local area[5] (see Fig. 3 below). The actions were ordered in the manner in which they were presented to respondents, from least involved to most involved; 'learn more about the project' is classified as the least involved, whereas 'investing my own money in a part of the system' is most involved, with the latter requiring time, effort, and a financial commitment. Respondents were able to select all that apply. There is a clear preference for less involved actions with 'learn more about the project' at 58.7 %, being the most selected. The more involved actions 'leasing an electric car' (17.6 %) and 'investing my own money…' (12 %) were the least selected.

Using a provincial/regional lens, Table 2 outlines the place-based differences of each action, using t-tests comparing each province/region mean against the rest of Canada. Of the 40 tests run, we see a total of nine significant differences, with the most prominent being seen through the actions of 'trying to influence or shape the project' (two differences), 'buying and selling electricity' (two differences), and 'investing my own money…' (two differences). In most cases, provincial/regional means aligned with the Canadian mean (i.e., within approximately 0.03-0.04), yet outliers can be seen for each action. QC was a common outlier, typically showing lower levels of interest in each action. This includes 'investing my own money…' (0.07 or 7 %), which had high statistical significance differences ($p = 0.007$). AC had a much stronger preference (0.26 or 26 %) for 'leasing an electric car' ($p = 0.033$).

4.3. Motivating factors for local action

Building off the previous survey question, and to help address RQ#3, respondents were then asked 'of the actions you selected, what are your main motivations behind choosing [said actions]?'. Respondents were able to select all motivations that apply. These results in Fig. 4 highlight a balanced response, yet environmental motivations were most prevalent. The top motivations were: 'to help the environment' (48.9 %) and 'to reduce local air pollution' (40.5 %). The relative lack of individualized and more involved actions as shown in Fig. 3, is also reflected here, with the most frequent motivations centered around bettering the environment, supporting the project's success, and strengthening the community. The individualized financial motivation 'to gain a personal financial gain on investment' was the second least selected response (25.4 %). The lowest selected motivation was the motivation 'to enable the community to gain a financial return.' This goes against the strengthening the community trend seen in the high selection frequencies of community-oriented motivators, yet it does support the trend of financial motivation being least selected and least important in this context.

We then chose to conduct provincial/regional analyses of this set of motivations in relation to three key participatory planning actions (see Tables 3–5). Table 3 presents a cross-tabulation of six motivations[6] respondents chose (RQ#3) when selecting the action 'learning more about the project' (RQ#2) ($n = 552$). Across the national sample and aligning with more general trends seen in Fig. 4, there is a strong preference toward environmental elements. Of the respondents who chose 'to learn more about the project,' 60.9 % were motivated to help the environment, and 52.7 % were motivated by '[reducing] …local air pollution'. At a national level, the Canadians who wanted 'to learn more about the project' were least motivated by gaining a 'personal financial return' (31.7 %). Respondents from QC, BC, and AC were especially motivated by environmental elements, whereas ON and CP saw greater relative motivation in 'taking part in a local initiative' and 'help[ing] strengthen the community.'

Table 4 shows analysis centered on what Canadians were motivated by when selecting the action 'trying to influence or shape the project with my views' ($n = 204$). Like the trends in Table 3 and Fig. 4, Table 4 reveals a preference for environmental motivations, yet community-centered motivations are more common for influencing the project compared to Table 3. Nationally, 47.5 % of respondents were motivated by 'strengthening the community' and 41.2 % were motivated by 'taking part in a local initiative,' 11.1 % and 8.8 % higher respectively than those same motivations related to 'learning more about the project' in Table 3. Provincially/regionally, respondents from AC and BC were highly motivated by environmental elements (also seen in Table 3). Respondents from ON were highly motivated by supporting the project in being successful (48.8 %) relative to the national percentage frequency of 41.7 %. Table 4 presents a similar trend, showing a general lack of financial motivation. Yet again, QC was an outlier, where responses showed high levels of motivation by financial elements (42.1 %; 12.2 % higher than the Canadian average) for this action of 'trying to influence and shape the project.'

Lastly, for the action of 'buying and selling electricity with other local people' (Table 5; $n = 236$), Canadians were strongly motivated 'to support the project in being successful', a 9.6 % and 8.3 % increase compared to the actions in Tables 3 and 4. Nationally, we see a much lower frequency of the motivation 'to take part in a local initiative' (38.1 %) compared to all other motivations, and a relatively high

[5] The following actions within the survey data were omitted in Fig. 3; 'none of the above' ($n = 150$) (15.9 %), and 'other' ($n = 7$) (0.7 %), this was due to the relevancy and scope of the research.

[6] The motivations of: 'because others I know may have invested as well', 'to enable the community to gain a financial return', and 'other' were omitted due to lack of relevance, redundancy, and low response rates.

Table 2
Actions Canadians would consider doing if a local energy system was being developed in your local area.

Actions	Province/ Region	Mean[a]	P value[b]	Std. Deviation[c]	Number of Responses
Learning more about the project (e.g., by going to meetings or reading a website)	ON	0.58	0.457	0.494	344
	QC	0.55	0.099	0.499	229
	BC	0.65	0.078	0.480	124
	AC	0.63	0.230	0.487	70
	CP	0.58	0.428	0.495	174
	Canada	0.59			941
Recommending the project to my friends or family	ON	0.24	0.181	0.427	344
	QC	0.21	0.301	0.408	229
	BC	0.24	0.285	0.430	124
	AC	0.24	0.332	0.432	70
	CP	0.18	0.900	0.389	174
	Canada	0.22			941
Trying to influence or shape the project with my views	ON	0.25	0.030*	0.434	344
	QC	0.17	0.016*	0.373	229
	BC	0.24	0.233	0.430	124
	AC	0.16	0.104	0.367	70
	CP	0.22	0.397	0.418	174
	Canada	0.22			941
Using a battery to help manage the local grid network	ON	0.3	0.023*	0.460	344
	QC	0.24	0.168	0.428	229
	BC	0.24	0.270	0.430	124
	AC	0.26	0.442	0.440	70
	CP	0.24	0.221	0.429	174
	Canada	0.26			941
Offering to be a technology host (e.g., solar panels on roof, battery in home, smart meter, electric heating)	ON	0.28	0.185	0.452	344
	QC	0.22	0.038*	0.417	229
	BC	0.31	0.149	0.463	124
	AC	0.23	0.221	0.423	70
	CP	0.28	0.325	0.451	174
	Canada	0.27			941
Buying and selling electricity with other local people	ON	0.28	0.047*	0.451	344
	QC	0.17	0.001**	0.381	229
	BC	0.27	0.260	0.448	124
	AC	0.3	0.162	0.462	70
	CP	0.25	0.472	0.436	174
	Canada	0.25			941
Leasing an electric car for use when I need it	ON	0.18	0.408	0.385	344
	QC	0.17	0.390	0.377	229
	BC	0.17	0.413	0.377	124
	AC	0.26	0.033*	0.440	70
	CP	0.15	0.151	0.358	174
	Canada	0.18			941
Investing my own money in a part of the system	ON	0.13	0.165*	0.341	344
	QC	0.07	0.007**	0.263	229
	BC	0.13	0.371	0.337	124
	AC	0.17	0.085	0.380	70
	CP	0.13	0.388	0.333	174
	Canada	0.12			941

[a] Mean score for the subsample, (1 = yes, 0 = no) shown as decimal of percentage.
[b] Equal variances assumed, significance of difference of regional test versus Canada means test, P-Value *$p < 0.05$;**$p < 0.01$
[c] Standard deviation.

frequency of the motivation 'to help strengthen the community' (48.7 %). While environmental motivations remain the top selection across all actions, there is a notable increase for 'to gain a personal financial return on investment' (44.5 %) for this action of 'buying and selling electricity', a 12.8 % and 14.6 % increase compared to Tables 3 and 4. Regionally, QC is highly motivated by financial elements (50 %), yet is noticeably lower than the Canadian mean in 'supporting the project in being successful' (10 % lower) and 'strengthening the community' (13.7 % lower).

Table 3
What are Canadians' main motivations behind the action: 'Learning more about project (e.g., by going to meetings or reading a website)' if a new local energy system is being developed in their local area?

	Motivations						
Province/ Region	To support project in being successful[a]	To take part in local initiative	To help strengthen community	To gain a personal financial return on investment	To help the environment (e.g., climate change)	To reduce the problem of local air pollution	Number of respondents[c]
Canada (total)	40.4	32.4	36.4	31.7	60.9	52.7	
ON	42.8	32.8	40.8	30.8	57.7	54.2	201
QC	38.7	30.2	26.2	35.7	64.3	53.2	126
BC	40	31.3	37.5	27.5	68.8	57.5	80
AC	45.5	25	38.6	38.6	65.9	50	44
CP	34.7	38.6	38.6	28.7	54.5	46.5	101
Total responses[b]							552

[a] Values shown are percentages of each province/region subsample.
[b] Total number (n) of total respondents that selected action of 'Learning more about project (e.g., by going to meetings or reading a website)'.
[c] Number (n) of respondents of each province/region subsample for specified action.

Table 4
What are Canadians' main motivations behind the action: 'Trying to influence or shape the project with my views' if a new local energy system is being developed in their local area?

Province/ Region	Motivations						
	To support project in being successful [a]	To take part in local initiative	To help strengthen community	To gain a personal financial return on investment	To help the environment (e.g., climate change)	To reduce the problem of local air pollution	Number of respondents [c]
Canada (total)	41.7	41.2	47.5	29.9	57.4	51.5	
ON	48.8	37.2	53.5	25.6	58.8	54.6	86
QC	28.9	55.3	39.5	42.1	65	57.5	38
BC	36.7	43.4	40	30	73.5	61.8	30
AC	36.4	27.3	63.6	18.2	76.2	61.9	11
CP	43.6	38.5	43.6	30.8	59.1	36.4	39
Total responses [b]							204

[a] Values shown are percentages of each province/region subsample.
[b] Total number (n) of total respondents that selected action of 'Trying to influence or shape the project with my views'.
[c] Number (n) of respondents of each province/region subsample for specified action.

Table 5
What are Canadians' main motivations behind the action: 'Buying and selling electricity with other local people' if a new local energy system is being developed in their local area?

Province/ Region	Motivations						
	To support project in being successful [a]	To take part in local initiative	To help strengthen community	To gain a personal financial return on investment	To help the environment (e.g., climate change)	To reduce the problem of local air pollution	Number of respondents [c]
Canada (total)	50	38.1	48.7	44.5	63.6	53.4	
ON	54.6	36.1	49.5	45.4	58.8	54.6	97
QC	40	40	35	50	65	57.5	40
BC	47.1	47.1	55.9	41.2	73.5	61.8	34
AC	57.1	28.6	57.1	47.6	76.2	61.9	21
CP	47.7	38.6	50	38.6	59.1	36.4	44
Total responses [b]							236

[a] values shown are percentages of each province/region subsample.
[b] Total number (n) of total respondents that selected action of 'Buying and selling electricity with other local people'.
[c] Number (n) of respondents of each province/region subsample for specified action.

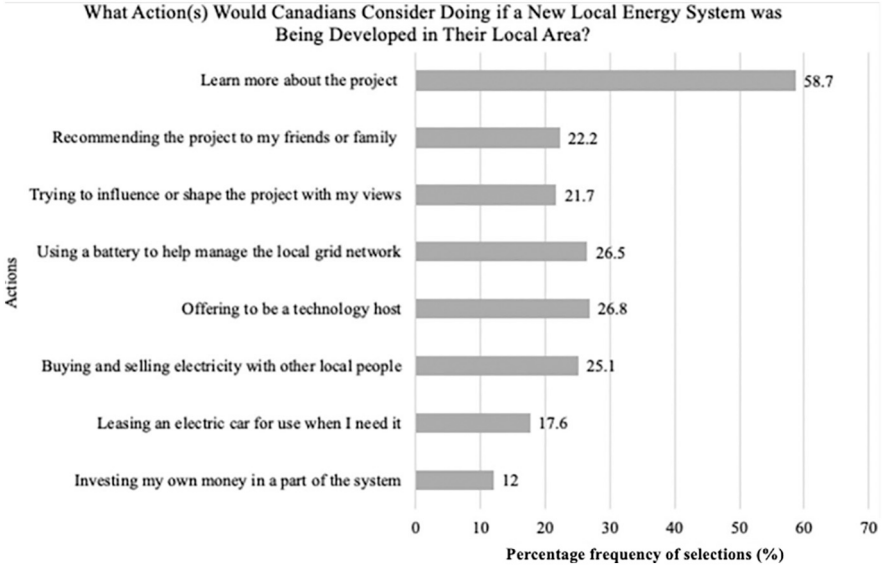

Fig. 3. What action(s) would Canadians consider doing if a new local energy system was being developed in their local area?

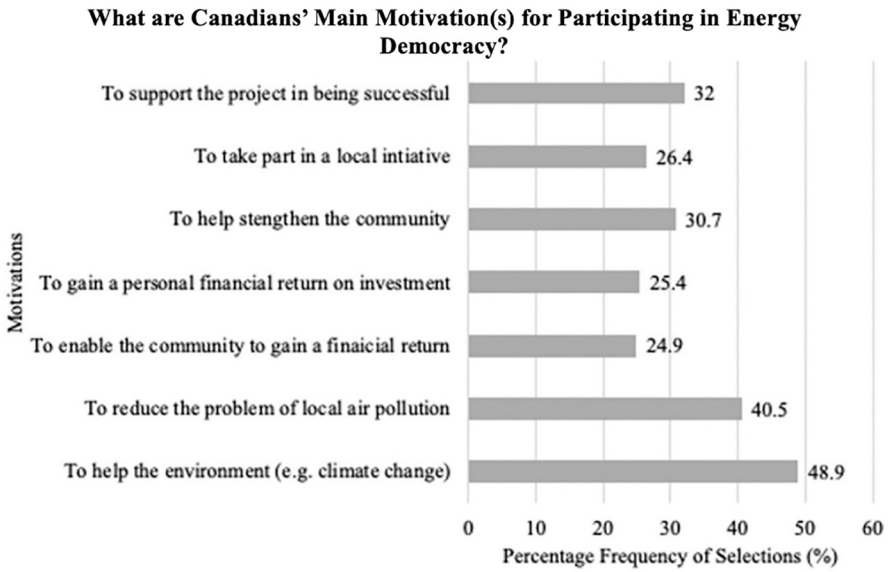

Fig. 4. What are Canadians' main motivation(s) for participating in energy democracy?

5. Discussion

To mitigate and avoid the worsening impacts of climate change, the rapid decarbonization of energy systems is essential [2]. Yet, along with the decarbonization of energy systems, recent research following the development of LSG, SLES, and similar projects suggests a broader shift in energy systems that extends to include three more of the 'four Ds'. That is, beyond decarbonization, LSGs are bringing about or emphasizing trends of decentralization, digitalization, and democratization [13]. According to Peters et al. [35], the primary obstacle to successful LSG development no longer lies in the technical aspects of these systems, but in the level of public support and corresponding policies of decision-makers [16,22]. Through the development of LSGs, energy systems are becoming increasingly complex, and this complexity creates new forms of uncertainty for decision-makers at all levels of government [13,67]. Understanding public perceptions is a key first step in creating policies and programs that are more likely to gain support and more generally for the holistically successful creation of new energy landscapes.

Hence the purpose of the work presented here centered around Canadians' perceptions of LSG development, and in particular, its relation to themes of energy democracy, participatory planning, and local actions. We did so through the analysis of a nationally representative online survey ($n = 941$) conducted in the Spring of 2022. In Canada, there is a growing set of literature on both LSGs and energy democracy [16,20,35,36,68], but not much is yet known about Canadians' support for and perceptions of these changes. We especially do not know how Canadians view this kind of significant energy system change in terms of the democratization of energy. Through a focus on three main questions, we sought to advance our understanding of: i) Canadians' overall support for energy democracy, ii) the roles they want to have in these systems, and iii) their motivations in doing so. Investigating these questions of energy democracy, and with a focus on place-based differences via provincial/regional analysis, we present empirical findings which highlight participatory and motivational differences across Canada. The findings are presented with the goals of helping to inform policy at all three levels of government (federal, provincial, municipal), as well as to add to the growing literature focused on LSGs, energy democracy, and participatory planning.

Consistent with new research on energy democracy, the results here suggest favourable overall support for our conception of energy democracy across Canada. Throughout the overall sample, support for the question of 'to what extent do Canadians support increased energy democracy via new local energy systems' was 68.4 %, whereas 25.2 % had no feelings either way, and 6.4 % opposed. This support for energy democracy is seen alongside a growing awareness of associated issues within current energy systems; both in terms of its source and governance in Canada [16,23]. Support for energy democracy – and indeed the broader support for new energy systems – also aligns well with survey work by Gaede and colleagues [68], highlighting that Canadian respondents generally agreed upon the idea that provincial electricity systems are costly and outdated. Implicit in this disapproval are questions of energy justice, including the disparity between those who experience the impacts of energy systems and those who make decisions about them [50], and the transactional relationship between 'consumers' and producers of energy, which results in a power imbalance and overall societal discontent [16,59]. Additionally, there is growing concern about the lack of democratic principles in current systems, and the control of power from politicians and corporations entrenched in fossil fuel industries [54] – problems that LSG development may help address.

Still, energy policy and the fundamental shifts that are proposed in LSGs will require public support. Hence, we developed our first research question, which sought to inquire about overall support for energy democracy across Canada and its provinces/regions. We did so with an understanding that although Canada is relatively small in terms of population, its people – even those already engaged with innovative local energy systems – are likely not homogenous [see also 69]. When looking at support across Canada, our analysis shows clear, sometimes statistically significant, differences between all provinces/regions. While our research did not investigate the important question of why this might be the case, this may be attributed to the unique societal, spatial, political, and institutional environments of each place [69]. Eastern (Atlantic Canada) (76.6 %) and Western (British Columbia) (75.5 %) coastal provinces have the highest levels of support, whereas Ontario (68.6 %), Quebec (66.2 %) and the Canadian Prairies (62.8 %) exhibit the least support for energy democracy, yet still favourable. This geographic variation in support aligns with similar research by Gaede et al. [68] who assessed public perceptions of ESTs in Canada. They too found positive intentions to accept ESTs across five regions. Atlantic Canada highlighted the greatest support, followed by Ontario, and British Columbia. In line with our results, Quebec and the Canadian Prairies showed the lowest levels of support. Assessing the broader difference in support for energy democracy across Canadian provinces and regions contributes to the spatial understanding [12,68] of energy

democracy and LSGs throughout Canada. Evidence is needed to inform policy decisions on alternative energy provisions, yet there are often gaps in spatial considerations of community and local energy [24,70]. It is important it is to conceive of energy democracy and LSG initiatives as geographical processes, due to the spatial reconfiguration and impacts they have on the social and economic activities specific to places [12].

The geographic differences seen in our study are expected, as climate change and energy systems remain highly contested topics with much political discourse, and which are dependent on the societal and economic factors present in each place [16]. These regional differences are seen in the way media reports on climate change and low-carbon technologies [36,71,72]. In the Canadian Prairies (i.e., Alberta, Saskatchewan, and Manitoba), many people have a deeply established economic dependence on oil and gas development, therefore more support for the status quo, and less support for alternative energy systems might be expected. These lower levels of support are seen, with responses from the CP showcasing the least support relative to other provinces/regions. This difference in support is useful to note in terms of thinking about what impact the effective deployment of LSGs would have in the Canadian Prairies versus, for example, Atlantic Canada. In the CP, it may be helpful to frame LSGs less around environmental benefits, and more around their financial outputs, grid reliability, and other economic benefits.

Within the concept of energy democracy, the participation and involvement of citizens is a fundamental pillar [39], and it is vitally important to look beyond overall support and understand the level of participation citizens are interested in. On a national scale and consistent with the findings on energy democracy (i.e., RQ#1) above, survey respondents showed a positive overall interest across most forms of participation (e.g., 26.5 % of Canadian respondents wanting to participate in these systems by using a battery to help manage the local grid network). Consistent with prior research in the realm of Canadians' support for LSG-adjacent technologies, higher levels of support are associated with stronger positive attitudes, and the perception of these technologies as a solution to energy grid problems [68]. The work from Gaede and colleagues [68] aligns with our results; we see some inclination among Canadians to learn how to participate in these new systems. Overall support for the higher levels of participation needed in locally driven LSG, reaffirms recent literature on the importance of community involvement and participation in the energy system. Poor public involvement and local participation in renewable energy planning consistently results in less successful and sustainable projects [53]. The fact that our data highlights that Canadians want to have more decision making power and control by performing new actions in their energy system, is encouraging.

There is a clear preference (see Fig. 3) for what we see as the initial first step of 'learning more about the project' (58.7 %). This may signal interest but also an unfamiliarity with LSGs and moves toward local energy systems. The data also highlights favourable numbers of Canadians wanting to use a battery (26.5 %), be a 'technology host' (26.8 %), and buy and sell electricity (25.1 %), all of which can underpin this move toward LSGs [12,73]. Taking these results centered on what actions and role Canadians want to have in energy democracy and placing them within Davidson's wheel of participation, we have 58.7 % (learning more about the project) of the participants tested wanting to be situated In the 'inform' quadrant of the wheel, yet, 26.8 % (technology host) of participants tested wanting to be situated in the empower quadrant of the wheel [52], as they have independent and entrusted control of active participation within energy democracy. While there is a clear preference for citizens to simply be informed with regard to energy democracy and LSG projects, there is a noticeable portion of respondents wanting to be actively involved, participating, and empowered in energy democracy. Utilizing Davidson's framework allowed us to assess broader levels of participation through a non-hierarchal, standardized approach. As these new energy systems become more commonplace, other researchers interested in democratic or participatory assessments may find similar value in 'the wheel'. [52].

Related to our provincial/regional analysis on the actions Canadians would consider (i.e., RQ#2), we find varying levels of selection for participatory LSG actions and several instances of significant differences. This place-based analysis provides key insight into the social environments in each province and region and will help shape LSG and energy democracy rollout accordingly. Understanding the motivations centered around community (i.e., taking part in a local initiative) may be especially important to note, as community participation and other social elements of LSG development need to be key considerations in what makes local energy systems successful [33,45].

Along with being those with the highest levels of support of energy democracy, respondents from AC and BC were also more likely to show interest across all eight actions (see Table 2). QC was below the Canadian mean across all eight actions. Therefore, not only does the QC sample show more feelings of indifference in terms of overall support (see Table 1), but they are also less interested in actually participating. On the contrary, the CP sample, while showcasing the least overall support for energy democracy, relative to QC, were often scoring higher frequencies (5 out of 8) of selection for actions. Additionally, CP scored higher than the Canadian mean for two actions, including 'offering to be a technology host' and 'investing my own money in part of the system.' We might take this to mean that while those from the CP may not fully support energy democracy in theory, when asked about tangible actions, this attitude changes – at least in relation to QC's low levels throughout. QC's lack of wanting to participate in energy democracy and LSGs might be linked to stronger feelings of nationalism (nation of Quebec) and provincial sovereignty [74–76], whereby more opposition toward climate initiatives being proposed and funded by the federal government, like LSGs, is likely. Relatedly, QC's lack of support and desire to take part may be due to perceived risks and distrust in government. If so, these findings would align with recent research showing that greater perceived risks lead to less support for LSG-adjacent technologies [68]. Our findings from QC may also reflect results from a recent study from Donald et al. [77], who showed high levels of approval for the province's existing low emission and affordable – yet mostly centralized – hydro-based energy system.

Another important takeaway from this work is that Canadians showed a strong motivation 'to help the environment' in their support of, and participation in, new local energy systems. Canadians' push for climate action (48.9 %) is particularly encouraging and it may signal a growing awareness and acceptance of climate change – in stark contrast to anti-science, and anti-government trends which have resulted in significant segments of 'climate deniers' in North America [72,78]. Relating to the provincial/regional cross-tabulations and percentage frequencies of motivations for choosing one of three participatory planning actions, we saw varied responses (see Tables 3,4,5). As levels of participation increased (i.e., from attending a meeting to buying and selling electricity), we generally saw Canadians' motivations shift to a greater focus on financial benefits, yet environmental factors still led. Contrary to similar research that found a negative relationship between environmental values and widespread support for ESTs [68], our work sees every participatory action being strongly motivated by environmental values. The negative relationship between environmental values and EST support may be linked to the perception of viewing ESTs as a techno-fix to environmental challenges [68], while LSG development is more closely tied to the idea of energy democracy, which can be seen as bringing about broader societal, political, and environmental change.

5.1. Importance

As might be expected from a reading of LSG-related literature in the past 20 years, as well as the more recent growth of energy democracy literature [12,13,29], our work has shown that Canadians support a change toward more local, and locally driven, energy systems. As Canadian governments at all three levels work to support net-zero goals

and associated clean energy projects, we are now at a key moment in time to not only decarbonize but create economically and socially sustainable energy systems. To do so, we know there must be a shift away from large, centralized fossil fuel energy systems toward the '4Ds' of energy system change.

In terms of key takeaways, the study presented here aligns with and contributes to past and growing research on the importance of energy democracy in energy transitions [17,19,22]. The project also adds an initial, yet significant understanding to areas not yet explored – notably Canadians' perceptions and attitudes toward energy democracy in the context of LSG development. We believe our provincial/regional approach will be increasingly important as LSGs are rolled out in Canada, and more programs like Natural Resources Canada's *Smart Grid Program* are implemented. With better knowledge around what Canadians support and want to do in the face of smart and local energy transitions, governments and developers can develop better projects that are based on a more informed understanding of what the people of each province/region expect and desire. Globally, the emphasis on the spatial differences across Canada offers international relevance by providing transferable insights and facilitation of comparative studies in the realm of energy democracy and LSGs.

In the young but burgeoning study of LSG projects and their intersection with themes of energy democracy/justice [6,15,17], qualitative work is far more prevalent. In combination with our unique quantitative approach to understanding public support and expectations, we hope to aid in the successful rollout of LSGs across Canada. While not dismissing the value of impactful qualitative research in this area, quantitative data analysis which assesses public support and attitudes is said to provide a useful step in providing interested policymakers with numerical data that can be used to back and create data-driven decisions [67].

Although the national data across our three main research questions are quite similar, the provincial/regional data analysis shows some nuanced differences which we hope will shape a place-based implementation of LSG projects. From the start, this study aimed to provide valuable insights relevant to scholars, policymakers, and practitioners – as well as others with an interest in socio-technical innovation and energy system change. Although LSGs and energy democracy are complex systems and concepts [13,35], individual citizens, and the social, economic, digital, and physical environments and conditions specific to each community must be integrated into these systems. We hope this work has advanced an understanding of energy democracy, public support, and moves toward LSG development in Canada.

5.2. Limitations and future research

Several limitations of this research can be highlighted, some of which suggest important opportunities for future research. The first is the sample size of the survey ($n = 941$). While large enough to provide us with a confidence level of 95 % (margin of error = 3.5 %) and mostly representative of the 2021 Canadian population, a larger and even more representative sample would provide a greater representation of Canadians and their views on this topic.

Second, while a variety of statistical analyses, including bivariate t-tests were performed, the lack of more complex and advanced statistical significance testing should also be considered a limitation. That said, the testing performed (percent frequencies, cross-tabulations, and t-tests) were specifically chosen to help us answer our three main research questions. Additionally, it is important to note this study represents the preliminary stages of this survey data research. The descriptive analyses shared here establish important foundational knowledge – helping to provide an important snapshot in time of Canadians' views toward the development of new local energy systems. Further research using more advanced statistical testing (i.e., regression analyses) as well as in-depth qualitative research is recommended to assess why there are these provincial and regional differences in support, levels of participation, and differing motivations to uncover more about the unique societal and political environments of each place. Future research in this area may also benefit from a change in fundamental framing of the typologies of participation and/or engagement in local energy system change. For example, and opposed to Arnstein's ladder, Smith et al.'s [21] example of 'levels of inclusive innovation in SLES' may help more accurately describe how different levels of participation (i.e., inclusion) can co-exist within the same local energy project.

Next, there are multiple avenues for future research within this rich dataset. For example, with relation to the survey data and energy democracy, future researchers could develop questions around what groups (municipal, university, business, provincial, and federal governments) should be involved in LSG development, the levels of public trust and distrust of such groups, and/or what groups Canadians are interested in participating with. Exploring survey data on Canadians' trust and distrust of various actors, through a provincial and regional lens – including via survey data here – may offer more insight into QC's lack of wanting to participate in LSGs. A further understanding of the nuances of these relationships may also require in-depth qualitative methods, including interviews with people from across Canada. Additionally, within the survey data, future research assessing the urban and rural differences at a provincial level in public perceptions would further develop a better understanding of the Canadian context. Indeed, in Canada and other similar countries with a significant percentage of rural populations, distinguishing between urban and rural perspectives is crucial given the varying infrastructural needs and landscape changes that are likely to accrue to each set of communities [79]. It is also important to recognize that no specific efforts were made to distribute the survey to Indigenous peoples in Canada. Yet, this allows for future research in the growing field of Indigenous-led renewable energy projects and to examine Indigenous contributions and participation with and in renewable projects as a vehicle to accelerate reconciliation efforts [80, 81]. We also call for future research to focus more squarely on themes of public subsidies, financial incentives, and cost savings associated with local energy system change. Our questions on financial matters were mostly centered around investments and returns, which will not be realistic options for many to even consider.

While not a weakness per se, this study focused on sample data from just one country, Canada. Assessing trends within other national settings, including in the UK where a similar dataset already exists, may provide important comparisons that allow us to better contextualize the Canadian research. Doing so would also help create even more targeted policy, and development strategies for governments at all levels, and promote well-informed participatory planning opportunities for people living in particular places.

6. Conclusion

As decarbonized, decentralized, digitalized, and democratized energy initiatives unfold in Canada – and indeed the world – assessing public support and expectations is crucial. In this study, we investigated Canadians' support for the so-called 'fourth D' (energy democracy), the actions Canadians want to have in LSGs, and what motivates them to participate. With a significant amount of literature on the economic and technological elements of LSGs, this study is one of the first in this field to assess public support and expectations for these new energy systems. Our contribution is made clearer with our implicit focus on energy democracy as a guiding principle, and the context of Canada, where we take a provincial/regional approach to understanding public views.

Our analysis highlights favourable support across Canadian provinces and regions for energy democracy, whilst offering insight into the nuanced differences across provinces and regions. This has led to a better understanding of the roles Canadians may want to have in these initiatives, as well as what motivates them to take part. Our results highlight promising, yet differentiated, motivations to make energy systems cleaner and more local. Finally, we believe that understanding the role Canadians want to have in their energy lives and futures, and

what motivates them to participate in energy democracy, will provide practical knowledge and information for policymakers, governments, and researchers to inform best practices and develop projects that meet and suit the needs and expectations of communities. Doing so will help achieve successful energy systems that benefit Canadians and provide them with sustainable, fair, affordable, and reliable energy systems.

CRediT authorship contribution statement

Joseph Fiander: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Chad Walker:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ian H. Rowlands:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition. **Patrick Devine-Wright:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Conceptualization. **Charlie Wilson:** Writing – review & editing, Validation, Funding acquisition. **Iain Soutar:** Writing – review & editing, Validation. **Rajat Gupta:** Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

A copy of the survey can be found online at https://doi.org/10.1016/j.erss.2024.103526.

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