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Review

Advancing local energy transitions: A global review of government instruments supporting community energy

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ABSTRACT

The adoption and encouragement of community energy, that is, the incentive to develop renewable energy projects with community participation and ownership, is a key ingredient of energy transition. Government policies and other instruments can pose both barriers and opportunities for community energy development; however, there has been little analysis of the state of research on the range of government tools to facilitate energy transition and the implications of these instruments for community energy. This paper analyses the current scholarly research on government instruments for community energy, focusing on the multiple scales of governance. Our analysis identified 108 articles addressing government instruments and community energy. Research addressing government instruments and community energy has increased substantially in recent years, with most of the emphasis on national or state instruments, situated in the European context, and focused on grid-connected communities. We identified four global categories of government tools designed to support community energy: payment-based, grid access, environmental protection and community planning and capacity. Within these categories, nineteen different government instruments emerged with tools for financial support, feed-in-tariffs, grid services, and fiscal incentives receiving the most attention. Findings emphasize the need for further research on community-focused instruments for renewable energy, the importance of coordination between levels of government to support such instruments, and analysis of the suitability of current instruments for community-appropriate energy solutions in remote and off-grid communities.

1. Introduction

The global energy landscape is changing. Local, decentralised, and community-driven renewable energy projects—community energy [1]—are playing an increasingly important role in a traditionally centralized and fossil-fuel-dominated energy market [2,3]. Meeting international climate targets and transitioning to a low carbon future will require substantial investment in community energy [4,5], but the benefits of community renewable energy projects extend far beyond technological solutions to climate change. Significant societal benefits can also be realized through community energy, from capacity building and community resilience to shaping community social and economic opportunities [6].

Across Europe, the community energy movement has grown in part to enhance energy security whilst generating local revenue streams and community business investment opportunities [7,8,9]. The growing interest in community energy also includes rural and remote regions [10,11]. In northern Canada, for example, over 170 Indigenous communities are not connected to the electrical grid, relying largely on diesel generation or trucked-in liquefied natural gas [12]. In these regions, community energy serves to alleviate energy poverty, creates new social and economic opportunities, and charts a pathway to energy

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sovereignty and achieving reconciliation with Indigenous peoples [13,14,15].

Much of the current literature, and the factors that enable communities to adopt or transition to renewable energy, are framed within the context of transition management and the multi-level perspective [16,17,18,19]. Focused on institutions, norms, innovation space, and governance, the transitions management and multi-level perspective literature provide important insights into the nature of energy system transformations [20]. Scholars recognize that within the context of this transition there is a need to better understand the role of formal institutional arrangements, specifically the formal policies and rules that can pose both barriers and enablers to community energy development [21,22,23].

Literature discussing the importance of government instruments to energy transition is extensive [24,25,26], and scholars have argued that such instruments play an essential role in enabling (or constraining) energy transitions and community energy opportunities [2,24,27]. Researchers have examined the role of government instruments in shaping energy transition – including community energy. For example, Thornley and Cooper [28] explored the relationship between the growth of bioenergy in select European states and the roles of national energy policy, while Roos et al. [29] identified national and local policy as critical factors to bioenergy implementation. However, Aklin and Urpelainen [30] note that government instruments are largely treated "as an explanatory factor of secondary importance" in the socio-technical energy transition. There has been limited research exploring the range of government instruments available to facilitate energy transition and the implications of these instruments for enabling community energy.

This paper explores the current emphasis of scholarly research on government instruments for community energy and identifies key lessons to guide the adoption or advancement of the most appropriate government instruments. We do so based on a systematic review of how the peer-reviewed literature has approached community energy and the government instruments that either constrain or support its development. The premise is that by understanding how current scholarship analyses community energy and the role of government instruments, such as policies and regulations, we will be better positioned to identify critical research gaps and opportunities to improve government instruments for enabling and supporting the long-term viability of community energy.

2. Methods

Seyfang et al. [31] define community energy simply as: "projects where communities (of place or interest) exhibit a high degree of ownership and control, as well as benefit collectively from the outcomes". We extend this definition in our research to include small-scale energy projects with a high degree of local participation and local energy initiatives [32], with a predominant focus on renewable energy sources. Our systematic review [33] used the Scopus database, due to its indexing coverage, advanced search tools, and search design replicability [34], to examine the current state of scholarly research on government instruments for community energy (Fig. 1). We searched for papers that include "energy" in the title, with "community" or "local" as keywords, using the query: [TITLE (energy)) AND ((KEY(community AND energy)) OR (KEY(local AND energy))], and limited the search to journal articles in English. This generated 5,029 results, of which numerous papers were related to technical subject areas including engineering (1,760), computer science (7 6 2), and physics and astronomy (1,034), among others, that do not specifically speak to government instruments. The subject area was thus limited to the Scopus subject areas "energy" and "social sciences" as these were deemed most likely to contain research relevant to this work. We excluded papers in the engineering, mathematics, chemical engineering, materials science, chemistry, physics and astronomy, computer science, arts and humanities, and other related technical and applied science fields, leaving 973 results. No restrictions were placed on the year of publication.

Titles were then scanned to exclude papers not related to community or local energy projects. For example, the research string still yielded papers related to such topics as the food-energy nexus [35] and building design [36]. The title scan resulted in 409 papers, for which the abstracts were reviewed, and over 200 articles excluded as not relevant or disconnected from the topic of this research – for example, those related to stakeholder involvement in, or public acceptance of, large-scale energy construction projects [37,38]. This process yielded 239 papers, which were then coded according to thematic categories emerging from the repetition of concepts in the literature [40]. Examples include funding, policies, regulations, community capacity and acceptance, intermediary support, and institutional structures. Each category's content was then analyzed to identify papers addressing specific *government instruments* that impact or influence the development of community energy. We identified 108 peer-reviewed articles addressing one or more government instruments, which include 19 different types of instruments. Those instruments were then grouped into four 'global categories' based on the various functions they serve [40] (Fig. 2).

Considering the importance of multi-level governance for the advancement of community energy [19], the final selection of articles was also classified according to the respective level(s) of government at which the specific instruments were examined or applied, specifically: i) *supranational to national* and ii) *regional to local*. It is also possible that an instrument may be addressed in research at both levels. For example, if an article examined an instrument used or promoted by the European Union or Canada to support community energy development, this

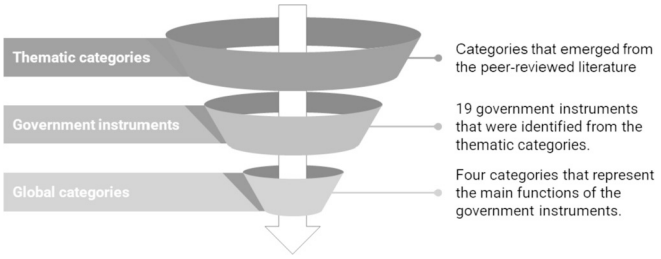

Fig. 2. Scheme used to review the selected papers and categorize government instruments based on Attride-Stirling [40].

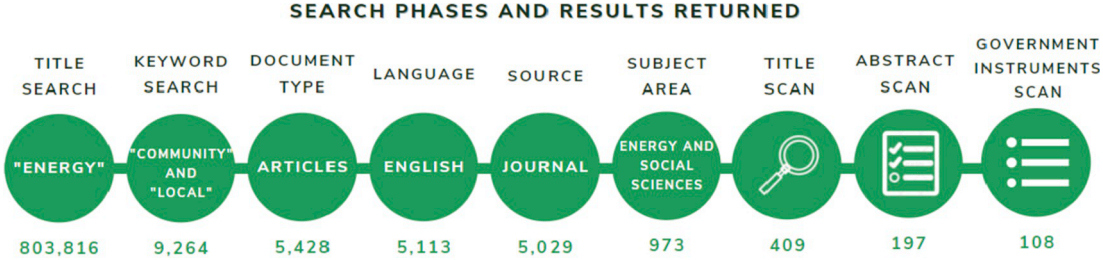

Fig. 1. Process used to identify instruments of government and community energy literature.

instrument was classified as supranational to national; however, in other papers, the efficacy of that same instrument may have been examined or applied in the context of a provincial/regional government or even at the municipal level, and thus classified as regional to local.

The methodology has limitations due to the broad spectrum of definitions of and approaches to "community" energy [41]. The analysis considered projects developed by communities to be small-scale projects that provided benefits locally. Thus, large-scale projects developed by groups that have offered benefits to specific regions, or small-scale projects that have not offered benefits to the local population were excluded from this analysis. A further limitation is that there is literature addressing government instruments that are not captured in Scopus, even though Scopus is a fairly comprehensive database – specifically books, book chapters, technical reports, and various grey literature. There are limitations to any review method [33] where judgment is used in the scanning and categorization of research. However, the use of systematic literature searches as described above are common in scholarly research when used to establish the state of knowledge in a particular field of research [e.g., 42,43], including energy research [e.g., 44,45].

3. Results

A total of 108 articles were identified based on the review and coding process. The earliest two papers that addressed community energy and government instruments [46,47] were published in 2001 (Fig. 3). The number of papers published on the topic increased significantly post-2012, and since then, the number of articles has grown exponentially, with over 60% of articles published within the last 5 years.

Based on the case studies or jurisdictions discussed in each article, most papers addressing government instruments (~80%) do so in the European context. The second most addressed region is North America, at nearly 9%. Most papers are also focused on government instruments in the context of grid-connected communities. Despite a growing literature on the importance of community energy to address energy insecurity in remote or off-grid areas [8,48], we identified only six articles focused on government instruments in these contexts. There is an emerging interest in community energy security in Arctic communities, in particular, emphasizing the importance of locally-based energy solutions [e.g., 13,49,50], but we identified only two articles addressing the merits of government instruments for community energy in Arctic regions [14,15].

Four global categories were identified based on the functions of the 19 different government instruments (Fig. 4). These categories are (1) payment-based instruments, which provide money directly (e.g., grants and funding programs) or indirectly (e.g., tax exceptions or feed-in tariffs) to community energy projects; (2) grid access instruments, which facilitate or create alternatives for communities to access the grid and control the buying and selling of energy; (3) environmental protection instruments, which aim to protect the environment through clean energy generation goals, emissions targets, and incentives for energy savings; and (4) planning and capacity instruments, which encourage community energy planning and capacity generation to advance community energy initiatives. However, not all instruments are exclusive to a single category. For example, financial supports, which are categorized as payment-based instruments, can also be used to develop local capacity and, therefore, can also be effective tools for community planning and capacity-building. Energy storage instruments can be included in the environmental protection category, in view of laws or regulations addressing the environmental risks that batteries might pose. However, communities can also use the grid as an alternative to batteries, so this instrument can also be a tool for grid access.

Results indicate a diversity of instruments that can either support or hinder community energy (Table 1). Four instruments were addressed in ten or more articles: the role of financial support instruments (i.e., funding programs, grants, loans) was addressed in 37% of articles, followed by feed-in tariffs (32%), grid services (12%), and fiscal incentives (i.e., tax breaks, 11%). These four instruments are addressed not only in papers exploring community energy in Europe and North America, but also in countries such as Australia, New Zealand, Japan, South Korea, and South Africa. These four instruments also appear to offer at least some support for off-grid regions; of the eight instruments identified in the six articles that *did* address off-grid regions, two are financial supports and two are grid services instruments. Of course, our findings represent the extent to which these instruments are addressed in research, which does not necessarily reflect how common the instrument is found in practice.

Financial support instruments, feed-in tariffs (FITs), grid services and

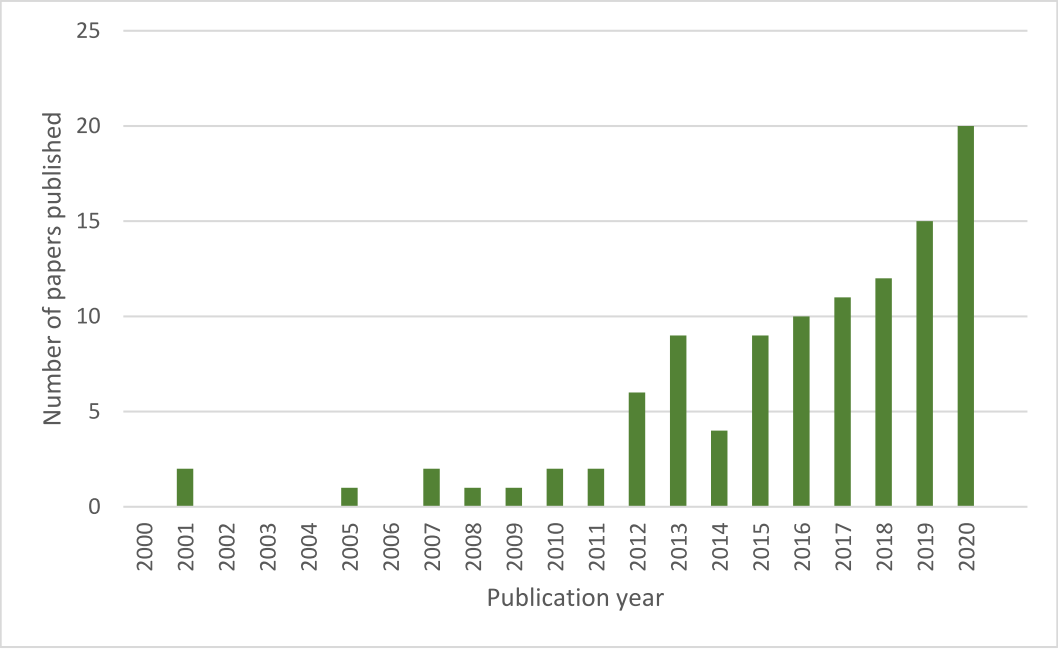

Fig. 3. Number of papers published annually (2000–2020) addressing at least one government instrument in relation to community energy.

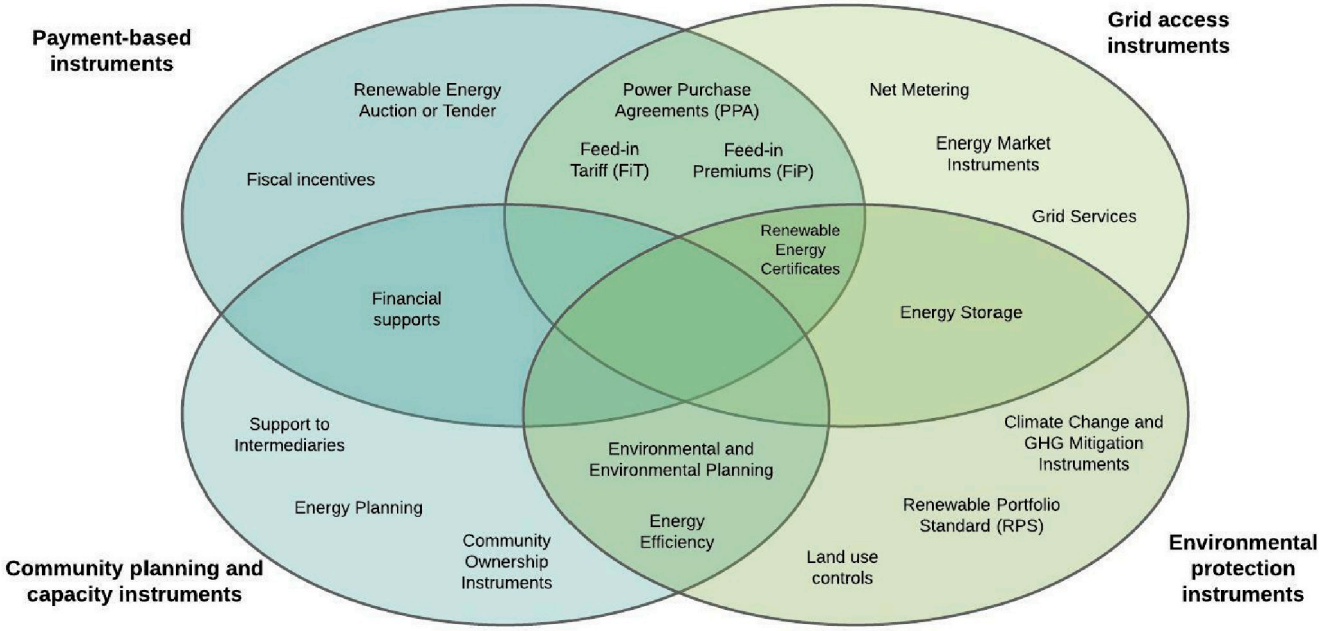

Fig. 4. Distribution of government instruments across four global categories – payment-based, grid access, environmental protection, and community planning and capacity.

fiscal incentives were mainly discussed in the supra-national to, primarily, national context – an observation applicable to most all instruments (Table 1). The exceptions were power purchase agreements (PPAs), energy efficiency programs, and, interestingly, instruments related to climate change, which tended to be discussed more at the regional (i.e., regional or provincial government) to local (i.e., community or municipality) level in terms of implications for community energy development. Articles addressing PPAs focused on agreements between communities and regional energy utilities, or between utilities and local consumers [47,51]. In terms of energy efficiency programs, the emphasis on local instruments primarily concerned municipal energy efficiency – specifically residential and commercial buildings [52,53]. Climate instruments, such as incentives to reduce emissions through community energy transition, tended to be addressed in the context of regional to local governments' climate change policies and mitigation plans [e.g., 54,55].

Feed-in premiums (FIPs), renewable portfolio standards (RPS), and energy storage instruments are the least mentioned across the sample of papers reviewed. All of these instruments were discussed in terms of community energy initiatives in Europe, and all were situated at the supranational (i.e., European Union) to national level. FIPs were often identified as a risky instrument from a community energy perspective, in that the need to sell the energy generated in the wholesale market is seen as a complex arrangement for many communities [9,56]. In Denmark, for example, the adoption of FIPs generated a wave of community energy projects dissolving and a decline in the entry of new players in the community energy market [9,56]. In Germany, however, FIPs were identified as one of the drivers of growth in community energy [57] – but largely because small producers were not required to sell the generated energy on the wholesale market. Despite the popularity of RPS in countries such as the United States [58,59], the papers captured in this review that discussed the relationship between RPS and community energy were mainly focused on Europe. In those papers, RPS were largely identified as a tool that provides support to other government instruments, such as FITs and climate change legislation, to support community energy [60]. Nevertheless, Burton and Hubacek [61] argue that RPS tend to favour large-scale projects.

Despite the crucial role of storage in enabling the energy transition [48], energy storage instruments were mentioned in only one article. The Energy Storage report published by the International Energy Agency [62] indicates that energy storage development depends on much more than technology – it requires supporting storage policies and regulations. Baldinelli et al. [63], for example, report that the lack of energy storage instruments can pose major barriers to the deployment of community energy projects. The authors present the case of the municipality of Perugia, Italy, which proposed to build a photovoltaic and energy storage system but because of the absence of legislation to regulate the installation of energy storage systems, the project was discontinued.

In the sections that follow, the four key instruments identified most frequently in recent scholarship are further explored to examine the state of scholarship and merits relative to community energy. Collectively, these four instruments comprise over 50% of the instruments discussed in the scholarly literature regarding community energy. The relative strengths and limitations of these instruments for supporting community energy, and key lessons learned from research application, are synthesized in Table 2.

3.1. *Financial supports*

Financial supports are the most frequently discussed instrument in the literature on community energy. These include financial supports from supranational or national governments, such as the programs offered by the government of Denmark for the development of wind turbines [56], to smaller-scale financial supports provided by regional and local governments [32,65]. The literature often referred to specific funding opportunities for community energy project economic feasibility studies [e.g., 7,47,72,73]; funding land purchases for renewables project development [66]; and funding to promote renewable energy and energy conservation awareness [64,74].

Several authors discuss the importance of loans provided by governments or state-owned banks as essential financial instruments to support community energy [e.g., 56,75]. Nolden [76], for example, identifies loans provided by German state-owned banks as among the country's most important financial instruments supporting community energy. The emphasis on such loans offered by government entities is based on the premise that they can be offered to communities and local energy developers at subsidised interest rates [68]. The Local Energy

Table 1
Government instruments identified from the sample of literature, indicating number and % of papers identifying the instrument and level of focus of governance or implementation.

Categories	Government instruments	Definition	# of papers mentioning instrument	%[1]	Supranational to National	Regional to Local
Payment-based instruments	Financial Supports	Financial contributions offered by governments to support community energy, either directly or indirectly, including funding programs, grants, and loans.	40	37.0%	29	13
	Feed-in Tariff (FiT)	Agreements that offer fixed payments for renewable energy generation over an established period.	35	32.4%	30	6
	Fiscal Incentives	Benefits offered by government in the form of tax deductions, exceptions, or exclusions for energy development.	12	11.1%	9	3
	Renewable Energy Certificates (REC)	Certificates that attest the generation of a minimum amount of renewables-based electricity, offered to renewable energy generators who trade the electricity generated on the energy market.	9	8.3%	9	0
	Renewable Energy Auction or Tender	An instrument of sourcing and acquiring renewable energy through competitive bids, whereby the interested parties who offer the lowest price are selected.	8	7.4%	8	2
	Feed-in Premiums (FiP)	Agreements that offer payments for renewable energy generation based on the wholesale electricity price.	3	2.8%	3	0
Grid access instruments	Grid Services	Includes all instruments that control the access to a grid system, including laws and regulations that control energy connection, transmission, and distribution.	13	12.0%	11	2
	Energy Market Instruments	Control the ability to sell generated power in the energy market, such as energy market legislations and regulations.	9	8.3%	8	1
	Power Purchase Agreements (PPA)	Energy contracts between those who generate and those who will purchase the generated electricity.	7	6.5%	3	4
	Net Metering	Agreement in which consumers who generate energy can receive credits on their electricity bills for the excess of electricity generated.	6	5.6%	4	2
	Energy Storage	Laws and regulations that control the storage of energy produced and the types of energy storage available.	1	0.9%	1	0
Environmental protection instruments	Climate Change and GHG Mitigation Instruments	Laws, regulations, and policies that establish GHG reduction targets and aim to control the effects of climate change and improve air quality.	7	6.5%	3	5
	Land Use Controls	Land and spatial planning legislation, regulation and policies used to control land use in a specific area.	6	5.6%	4	3
	Environment and Environmental Planning	Laws, regulations, policies, and strategies that aim to protect the environment and identify and manage possible environmental impacts generated by renewable energy projects.	6	5.6%	5	1
	Energy Efficiency	Laws, regulations, and policies created to reduce energy use and promote energy conservation.	4	3.7%	1	3
	Renewable Portfolio Standard (RPS)	A policy that establishes a minimum of total energy production that must come from renewable sources.	3	2.8%	3	0
Planning and capacity instruments	Community Ownership Instruments	Regulations, legislations, and policies that guarantee or encourage full ownership or shared ownership of renewable energy projects for communities.	8	7.4%	7	1
	Energy Planning	Legislation, regulations, and policies created to guide the development of a region's energy system.	5	4.6%	5	0
	Support to Intermediaries	Legislative, regulatory, and policy tools that aim to support organizations that assist with the planning and implementation processes of community energy projects.	4	3.7%	4	0
	TOTAL				155	49

[1] Total does not add to 100% as the same article can cite more than one government instrument.

Communities project in Germany [77], for example, indicates that the loans offered by KfW Bank, a German state-owned bank, to support community renewable energy projects include a low 1% interest rate.

Much of the discussion on financial supports, however, is focused on grants or one-time, non-repayable funds as important financial instruments for communities to pursue local energy initiatives [31,78]. Government grants were often identified as providing essential support for local communities facing major energy obstacles, like energy poverty and remoteness – including, for example, grant programs to address fuel poverty in England [79], and state support for the development of renewable energy technologies (e.g., wind, solar, geothermal, hydrothermal, biomass, in-stream hydropower) in remote Alaskan communities [14]. Grants to support initial community energy project feasibility studies were identified as especially important. Roesler [80] reports that even the most basic feasibility studies for community energy projects in Germany can cost on average about 10,000€. In remote regions, these costs are even higher [73], and communities rarely have the resources to cover these upfront costs of community energy development [8,55]. However, the intermittent and one-time nature of many grant programs is identified as an enduring constraint to the longer-term success of community energy initiatives [64].

Regardless of the type of financial support, a clear message in the literature is that the costs of energy development are often far greater than what most communities can afford [76], and the lack of government financial support poses a major barrier to the pursuit and success of community energy [14,57,82]. Cebotari [83], Honvári & Kukorelli [10], and Parag et al. [81], for example, point to examples where in absence of government funding several community energy projects would not have

Table 2
Key strengths and limitations of government instruments for community energy, including key lessons from research, as identified in the literature.

Instruments	Reported strengths	Reported limitations	Lessons and observations	Examples
Financial supports	Supports capacity development at the local level. Covers up-front investment, such as feasibility studies and construction, to jump-start projects, especially in energy poverty communities. Opportunity for low-interest loans for local energy initiatives. Accessible support for remote and off-grid communities.	Increases community external financial dependency for kick-starting new projects. Unannounced or unexpected change in external funding can slow or stop community energy projects. Inequitable distribution and availability to communities. Typical one-time nature can constrain the long-term viability of projects or increase dependency on other forms of funding.	Successful examples of community energy emphasize the importance of coordination between levels of government for financial supports to be most effective – and non-conflicting with other instruments. A mixed funding model that includes a minimum level of investment from communities can increase community buy-in and long-term viability of community energy projects. One-time funding models can constrain longer-term project success, especially in energy-poor communities. Over-compensation generated by communities receiving funds from two different government sources may result in the cancellation of some funding programs. Loans offered by state-owned banks or government entities are important sources of funding for communities, when low-interest loans are possible.	[64,65,66]
Feed-in Tariff (FiT)	Can generate income for communities. Surplus revenue generated through FIT can be used to create training programs to improve community capacity. By guaranteeing stable income, FIT creates an investment security scenario for projects allowing banks to offer loans with better interest rates. The investment security scenario helps attract private investors. An alternative to community dependency on grants, which are usually one-time funding and are not always available.	Often a complex application process, favouring larger players. Upfront investment, with no availability of capital for the planning process. Electricity rates offered sometimes insufficient for communities and do not consider additional costs of grid connection. Highly vulnerable to political and policy changes. Even with long-term contracts, project viability at end of contract term can be uncertain.	Communities benefit most when FIT has specific provisions for community energy or when FIT programs are developed only for community energy projects. Simplified applications process and extended periods for receiving applications usually benefit communities aiming to apply for FIT programs. Electricity rates should be guaranteed for communities regardless of the application period - in cases where rates change according to the period in which the application is made. FIT eligibility criteria must include provisions for off-grid communities. Availability of upfront funding to cover initial project expenses, such as project planning and programs applications, is recommended for communities to have access to FIT. When offering FIT rates to community energy projects, the higher expenses with grid connection and distribution should be considered in the established rates. When profits from FIT are shared or reinvested in the community, overall community support for renewable energy projects can increase.	[56,67,68]
Grid Services	Effective grid instruments can ensure that communities have access to affordable grid tariffs.	Grid regulations imposed by higher levels of government can conflict with local regulations. High grid connection and distribution rates can make smaller community energy projects unfeasible. Grid regulations and connection requirements are often unfavourable for small or remote communities and favour large players	Coordination between all levels of government is essential to avoid regulatory conflicts. Grid connection and distribution fees can challenge community energy projects; some authors suggest that excluding distribution and connection fees may support the development of community energy projects.	[62,69,70]
Fiscal incentives	Tax relief and tax exemptions can 'free-up' resources for communities. Establishes an investment security scenario to help communities secure low-interest rate loans. Fiscal incentives can result in long-term funding for communities when programs are stable.	Some tax relief programs are focused on private organizations and end up not always benefiting communities seeking to develop energy projects. Guidelines and requirements are often unstable or change or discontinue without sufficient notice. Changes in guidelines or program availability can slow down the development of community energy projects or cause project termination.	There is no single type of fiscal incentive that is best for community energy projects. Community eligibility criteria and guidelines must be designed considering the multiple forms of community energy (e.g. cooperatives, municipalities, indigenous trusts and cooperatives, etc.).	[52,56,71]

succeeded without government funding. Hicks and Ison [8] note that the *lack* of government funding in Australia, specifically in the form of grants, has made community energy projects largely unfeasible. The lack of funding programs supporting training and capacity building is also identified as a challenge to community energy projects [84], but financial instruments to support energy education and training have received relatively less attention in the literature. Several scholars suggest that a mixed funding model, whereby financial support from government is complemented by modest local community contributions, can address financial barriers to community energy and also promote a stronger sense of ownership and responsibility and more community-wide engagement in local energy projects [78,85].

3.2. Feed-in tariffs

Feed-in tariffs (FITs) are the second most common instrument

discussed in the literature regarding community energy, addressed in approximately 31% of articles. Thirty articles mentioned FITs in the supranational to national [e.g., 56,86], and six in the context of regional or local governments [e.g., 68,87,88]. We observed ten articles identifying FITs as an important driver for community energy development [e.g., 67,89,90] , including multiple community energy projects in Denmark, Germany, Scotland, and Switzerland [56,66,91,92]. However, Nolden [76] argues that FITs alone do not guarantee community energy project success, identifying that upfront investments, uncertainties of planning outcomes, and grid connection costs are some of FIT's primary constraints to community energy.

Generating income locally, a primary feature of FITs [78,93], is often identified as the main reason for communities to engage in community energy projects [64]. Bere et al. [94], for example, report that in a poor community in Wales the income from FITs was used to pay for child-care programs to support single working mothers. In England, the local revenue generated from FITs was used to pay team members of "low carbon community groups" who previously worked as volunteers [80]. The revenue generated from FIT is also considered an avenue to help reduce fuel poverty in communities [95], and to create an environment of investment security for communities, banks, and private investors [56]. For example, for communities seeking loans from private or state banks to cover the initial expenses of community energy projects, having a FIT long-term energy purchase agreement allows banks to provide loans at a lower rate of interest [8,66]. However, other researchers have cautioned that FITs do not bring the same benefits to regions where community energy development is focused on off-grid communities. In Indonesia, for example, Guerreiro & Botetzagias [84] report that FITs are not considered an essential, national instrument for the success of community energy projects because the benefits of such programs do not accrue to the rural and remote communities where community energy is most needed.

3.3. Grid services

Grid service instruments, those instruments concerning access to a grid system and the laws and regulations that control energy connection, transmission, and distribution, were discussed in 13 articles. The focus was predominately on instruments established at the supranational or national level [e.g., 63,86], but often with implications for community energy establishment and growth and the local level [96]. The literature identifies grid connection restrictions and costs as among the major challenges to current grid services laws or regulations [96,97] – especially for remote and rural areas seeking community energy development or expansion opportunities [98]. Madriz-Vargas et al. [69], for example, report that Panama's current regulations do not allow extensions to the grid for distant, rural communities.

Where extensions and connections are permitted or supported, several researchers note the high costs paid by communities to use the grid as a major impediment to community energy [99,100]. In France, community energy projects, locally known as collective self-consumption operations, have to pay specific grid tariffs set by the National Regulatory Authority [101]. These grid tariffs, however, are usually higher than the grid tariffs applied to standard consumers. Under these types of scenarios, Dragan [97] suggests that excluding distribution and connection fees may support the growth and sustainability of community energy projects.

Regulations on the transmission and distribution of energy are also identified obstacles to local community initiatives [66]. In Japan, for example, Hager & Hamagami [102] report that even though some communities are allowed to sell the energy generated, regulations imposed by utilities may prevent the transmission and distribution of that energy. Blanchet [96], however, describes grassroots initiatives in Berlin, Germany, that are seeking to change current regulations to allow more localized citizen participation in electricity grid operations. While authors such as Pinker et al. [66] argue that energy distribution regulations tend to favour large players, these grassroots initiatives are seeking to "re-municipalize" the electricity grid or to create partnerships with the municipalities and other actors [96] to control the electricity grid, promote renewable energy locally, and develop the local economy.

3.4. Fiscal incentives

Fiscal incentives, such as tax deductions, exceptions, or exclusions for community energy development, are addressed in 12 articles. Such examples include tax relief to communities for investments in renewable energy projects [56]; climate change, environmental protection and carbon taxes [60,101]; and gas taxes that provide funding to improve community energy infrastructure [65]. Nine articles addressed fiscal instruments at the national level – such as state CO_2 tax benefits applied by the Swedish government, which helped develop the country's community energy sector 20 years ago [52]. Three articles addressed fiscal instruments at the regional to local level: Hamman [103], for example, reports how fiscal incentives can be a motivator for communities to engage in the energy transition, identifying tax credits as one reason for a community in France adopting wood-fuelled boilers and solar panels.

Historically, fiscal incentives have been seen as an important factor in the development of community energy projects [52]. For example, fiscal incentives can assist communities in securing private investments. Bauwens et al. [56] report that the Seed Enterprise Investment Scheme (SEIS), a tax relief scheme created by the UK government to stimulate private investments in start-ups, supported community energy projects to offer better investment returns to private investors. Because of this tax scheme, investors seeking to invest in community energy projects were able to receive up to 50% of their investments back. The funds obtained through taxation can also support the development of local energy infrastructure [65,71]. In Canada, for example, the federal Gas Tax Fund is a source of funding intended to provide support to the development of local infrastructure, including community energy systems [65,104].

The eligibility criteria for fiscal incentives, however, do not always favor community energy projects. Magnusson and Palm [52] argue that most tax relief programs are focused on private organizations and end up not always benefiting communities seeking to develop energy projects. In the United States, for example, Brookshire and Kaza [105] report that certain Indigenous communities or organizations may not benefit from tax incentives offered to private organizations because they are classified as government organizations. Frequent changes in tax guidelines are also identified as a challenge to community energy development. In 2009, a new interpretation of the guidelines of a Swedish tax scheme slowed the development of community energy projects. Magnusson and Palm [52] report that the new tax code interpretation made it difficult to run renewable energy cooperatives and reduced overall interest in cooperative start-ups. Literature also identifies examples where the abrupt termination of established tax schemes also adversely affect community energy – including termination of the Climate Change Levy tax exemptions, an exemption to the environmental tax charged on business energy use in UK, requiring communities to start spending an additional £8000 of the annual income generated by local energy projects on taxes [60].

4. Discussion

Governments and the various instruments of government, from GHG reduction targets and energy distribution regulations to fiscal incentives for investment in renewables, play an important role in shaping energy transition and in the establishment and viability of community energy initiatives. Based on a review of the published literature, 19 instruments were identified as the focus of scholarly research and with the potential to impact community energy. These instruments could be broadly classified into four categories based on the functions performed.

Grid access instruments, for example, illustrate that communities do not have grid ownership and depend on effective government

instruments to be able to transmit and distribute locally generated power. Instruments with a primarily financial function highlight the need for effective payment-based tools to jumpstart many community energy projects and the importance of long-term continuity in supporting those tools. Instruments with an environmental protection function not only emphasize climate change and mitigation solutions via energy efficiency, safe storage, and community energy, but also the importance of such matters as land controls and minimizing the adverse impact of community energy projects – especially when such projects are developed on Indigenous peoples' traditional lands.

The collection of community planning and capacity instruments all serve to support local community capacity building (e.g., social and economic capital), yet, in some cases, local capacity building is indirect or secondary. For example, while community ownership instruments may more obviously support local community capacity, other instruments indirectly support a community's capacity to pursue and maintain community energy projects – such as engagement in community energy planning processes or the technical training offered by intermediary organizations. Importantly, the number of instruments that can be grouped into multiple categories demonstrates the multiple functions of some instruments, which suggests the potential for the same instrument to achieve more than one objective and also for multiple instruments to reinforce a common objective. Results indicate the need for further research to better understand which instruments or combinations are most effective in advancing community energy in any given context.

Results also show that the amount of research addressing government instruments for community energy has increased in recent years, but the geographic focus has been concentrated in European contexts and largely focused on grid-connected communities. Most of the instruments addressed in international scholarship are also framed at the supra-national to the national level, but with important implications for the advancement of regional to local community energy projects. The greater focus of scholars on European regions may be because regions such as Germany, Denmark and the UK are pioneers in promoting and developing community energy [106]. This geographical concentration of research may also explain why the focus is predominately on grid-connected communities.

Our analysis also provides several important observations to inform research and policy development on government instruments to support community energy. First, sensitivity to community context is essential to the success of government instruments in enabling community energy. Many of the instruments identified in the literature to support or incentivise energy transition do not necessarily offer the support or opportunities that communities need to pursue local energy projects. For example, RPS are identified as critical to supporting renewable energy development and thus energy transition [107], yet we identified only three papers in our sample that address RPS in the context of supporting community energy [60,61,108]. Ensuring the success of community energy initiatives requires government instruments that are appropriate to the local context of communities. Government instruments with provisions, restrictions, or eligibility criteria that are not sensitive to regional or local community contexts can stifle opportunities for, or limit the attractiveness of, community energy projects. We observed examples of this in the application of auction systems [102,109], financial supports [110], and grid services instruments [93]. Related, instruments intended to support community energy must be sensitive to local capacity to adopt, comply with, or capitalize on such instruments. For instance, the 'first-come, first-served' scenario where FIT rates decline over time is not always conducive to encouraging community energy projects, as communities may not have the capacity to apply quickly enough and secure sustainable energy rates [67,111]. It can also be difficult for smaller communities, with limited capacity, to negotiate fair PPAs [112].

Second, the success of government instruments in supporting community energy often hinges on coordination and complementarity, both between instruments and between levels of government [83]. Complementarity between payment-based instruments, for example, is reflected in Bauwens et al. [56] who argue that FITs alone are insufficient to guarantee the success of community energy projects. Seyfang et al. [31] and Mirzania et al. [78] also emphasize the importance of a mix of financial supports. Coordination and complementarity between all levels of government is also essential to the development and sustainability of community energy projects. The success of community energy in Scotland, for example, is attributed in part to the coordination between bottom-up and top-down initiatives [113], whereby communities first began to look for better ways to get electricity, and subsequently, the Scottish government started to support community to develop the renewables sector. Yet, multi-layered decision-making authorities and the lack of coordination between them are commonly reported obstacles to the efficacy of government instruments for community energy [98,114], emphasizing the importance of mutually supporting national to local level instruments for supporting community energy [83,115]. The success of government instruments and the long-term viability of community energy projects depends on alignment between different levels of government, each in control of different instruments, from the supra-national to the national, and regional to local [116] and also complementarity between the various functions of government instruments.

Third, there is a need to better understand what government instruments are most appropriate for, and effective in, remote or off-grid communities. The majority of research on government instruments for community energy has focused on grid-connected communities, with relatively fewer papers addressing remote regions – particularly communities that rely heavily on diesel generators [15]. The literature that does exist draws attention to the limitations of existing instruments to remote contexts. Guerreiro & Botetzagias [84], for example, report that off-grid communities in Indonesia are not eligible for the region's FIT program, which further constrains the ability of those communities to secure private financing and external investors for community energy projects. In Panama, Madriz-Vargas et al. [69] report that current regulations do not permit for grid extensions to distant communities. Across Arctic regions, remote, off-grid communities are well poised for community energy transition [14], but the dominant focus has been on national instruments and drivers [117,118] – typically designed to meet emissions reductions targets versus ensure community-appropriate energy solutions [13]. The literature is also sparse in addressing these instruments' merits in Indigenous government contexts, which may be complicated in autonomous territories [49] or where Indigenous self-government agreements are in play, such as in the Canadian Arctic. Much research attention is needed on the effectiveness of current government instruments for supporting community energy in remote, off-grid communities and ensuring energy solutions that are appropriate to the rural and remote community context.

Finally, it is generally acknowledged that the success of local energy initiatives depends in large part on community engagement [2,64]; the same can be argued for the development of effective government instruments to support community energy [113]. Government instruments for community energy are often conceptualized based on centralized, top-down values, treating community energy systems and the instruments for their governance as independent from the social fabric of the communities themselves [13,119]. Urmee and Md [120] argue that if the design and implementation of government instruments for community energy, especially in rural, remote, and off-grid settings, fail to incorporate social values, they are unlikely to be successful. Given past injustices in the distribution of energy risks and benefits [121], especially in rural and marginalized regions, communities need to be part of the design of government instruments for community energy, ensuring greater control over their own energy futures [122,123].

5. Conclusion

Improving local energy security and providing local economic benefits are some of the reasons behind the growth of community energy worldwide [8,108]. Thanks to community energy projects, off-grid communities have the potential to achieve self-sufficiency and more affordable energy rates. The growth in community energy is also a major contributor to energy transition, and it is through energy transition policies and regulations that the community energy sector has been advancing [24,27]. Government instruments used to promote energy transition, such as energy regulations and policies, can pose both opportunities and barriers to community energy development [21,22,23]. The success of government instruments in supporting community energy is thus dependent, in part, on coordination and complementarity between the multiple levels of government and the multiple instruments that exist. However, there is also a need to better understand instruments that are potentially contradictory. There are numerous cases reported emphasizing how instruments developed by local governments to support community energy may conflict with national energy strategies.

Further research is also needed to ensure that instruments intended to support community energy are keeping pace with technological advances and opportunities, specifically research on energy storage instruments. In addition, not all instruments intended to support community energy are likely sustainable in the long-term, both economically and in terms of maintaining on-going government support. We thus suggest the need to identify the underlying factors that challenge the sustainability of government instruments. In other cases, however, certain instruments are widely used or promoted, but research is needed on the effectiveness of those instruments in different contexts and their transferability. For instance, 38 states of the United Stated have an RPS or renewables goal [124], but there is limited analysis in the literature about their role in promoting community energy. Understanding community context is essential to the success of government instruments in enabling community energy, ensuring that instruments are designed to consider the diversity of community technical and social capacities and needs, their access to intermediary organizations and supports, as well as geographic context. This suggests the need for greater engagement of communities in the shaping of the policies and instruments, at all levels, designed to support community energy, including engagement of Indigenous knowledge systems. Finally, our analysis indicates a critical need for research on appropriate government instruments to advance community energy in remote or off-grid communities, ensuring the development and implementation of policies, programs and regulations that ensure community-appropriate energy initiatives and solutions – especially in northern and indigenous community contexts. Addressing the above research needs and understanding the implications of government instruments in these different contexts, requires the additional insight and experience of energy professionals, government officials, local energy champions, and the communities engaged on-the-ground in local energy initiatives.

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.

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