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Does polycentrism deliver? A case study of energy community governance in Europe

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ABSTRACT

The European Union's Clean Energy Package (CEP) plans to transform 'passive consumers' into 'active citizens' to support the transition to a carbon-neutral energy system by 2050. By stimulating the growth of renewable energy communities, the CEP works towards the redefinition of renewable energy as an economic commodity to a common good. In this paper, we approach the implementation of the CEP through the notion of polycentricity. Building on previous literature, we identified seven variables for effective polycentric energy governance: equity and co-benefits; inclusivity and local involvement; information, demonstration and innovation; ownership and accountability; organizational multiplicity; experimentation and flexibility; and clear goals set and enforced by a higher-level authority. To compare a variety of polycentric institutional configurations, we analyze Norway, the Netherlands, and Germany. Our findings indicate that, in general, some degree of polycentricity appears to be beneficial for the energy transition. This is the foundation for building local ownership and inclusivity and thus the emphasis is rightly placed there and could be expanded. Secondly, issues of ownership and accountability stand out as key enablers of renewable energy communities and the additional common goods that they bring to the energy system. These communities need to be enabled in financial terms to deploy a sufficient amount of projects, e.g., by giving them access to risk capital in the early development stages. In turn, this requires clear regulations and accountability mechanisms being installed on what precisely falls under the definition of a renewable energy community. Finally, we found that even as polycentricity is a promising approach, it does need to be anchored with a significant role for higher level government in order to function effectively.

1. Introduction

The European Union's (EU) Clean Energy Package (CEP) plans to transform 'passive consumers' into 'active citizens' to support the transition to a carbon-neutral energy system by 2050 [1]. In particular, the EU's Recast Renewable Energy Directive (RED II) recognizes the role of renewable energy communities (RECs) in accelerating the energy transition by mobilizing investments in renewable energy (RE) capacity, stimulating social innovation, providing benefits for local communities, and promoting citizen ownership of the energy transition. In this way, the CEP works towards the redefinition of RE as an economic commodity to a common good [2].

Polycentric governance has been extensively studied by Elinor Ostrom [3,4] as an efficient and effective way to manage common goods such as the maintenance of a stable climate, a key motivator behind the CEP [5]. Yet further research into the circumstances under which polycentric governance is successful regarding climate and energy policy is needed [6,7]. In particular, given the mismatch between EU

Abbreviations: CEP, Clean Energy Package; EU, European Union; NVE, Norwegian Water Resources and Energy Directorate; PBL, Dutch Environmental Assessment Agency; RE, Renewable Energy; REC, Renewable Energy Community; REDII, Recast Renewable Energy Directive; RES, Renewable Energy Strategy; RESA, Renewable Energy Sources Act.

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ambitions and the current role of RECs in the EU, Blasch et al. [8] have called for research into "what institutional contexts enhance the emergence of energy communities and their projects".

The CEP is a promising opportunity for taking up this question since it allows for a comparison of the various ways that states create multiple polycentric sub-systems in connection to the larger polycentric EU. Building on previous research, we identify seven enabling conditions whose presence or absence contributes to the effectiveness of polycentric energy and climate governance systems. To compare a variety of institutional settings, we analyze Norway, the Netherlands, and Germany. For each of these countries, we examine the extent to which the seven enabling conditions have contributed to the current level of RE deployment and the extent to which that deployment has taken the form of RECs. A cross-country comparison of these conditions enables an evaluation of to what extent polycentrism contributes to the RE development goals expected of it. The article concludes with a reflection on what institutional configurations are most helpful to RECs and thus what should be emphasized in future policy measures in countries accounting for the CEP. Since the transposition of RED II is in constant evolution, our analysis does not take into account any regulatory changes implemented after July 2022.

2. Polycentric energy and climate governance

The notion of polycentrism is a useful heuristic to understand the role of RECs in the governance of the energy transition. In general, polycentric governance refers to a situation where different actors regularly arrive at mutually satisfactory and binding decisions by negotiating and deliberating with each other and co-operating in the implementation of these decisions, without any of these actors being able to impose a decision on the others. These negotiations and deliberations do not take place in a 'vacuum', but occur in conjunction with the more traditional state (i.e., the utilization of public authority, backed by coercive power, to take a decision) and market mechanisms (i.e., competition between capitalist producers and suppliers to decide on the distribution of a scarce good). Two characteristics of polycentric governance arrangements stand out [9]. First, polycentric governance has been applied and analyzed predominantly in the context of the management of common goods [4]. Second, it emphasizes solutions that are developed in a largely 'bottom-up' fashion. Bottom-up does not necessarily mean from the lowest to the highest levels in a given hierarchy, but can include the horizontal emergence of an interconnected set of systems that do not reside within a single hierarchy. EU legislation can be seen as 'catalytic' for polycentric governance systems in the sense that it both responds to the existing community energy movement as well as seeks to create conditions that accelerate it as an essential component of the EU energy transition [10].

These two characteristics suggest the importance of an "enabling institutional context" to help RECs form an effective polycentric RE governance system, as suggested by Blasch et al. [8]. This entails comparatively analyzing factors such as national institutional settings as well as barriers and drivers that give rise to different configurations of energy communities [8]. The significance of this level of analysis is underlined by the EU requirements that Member States develop an 'enabling framework' for energy communities while still leaving leeway for how it will be developed and implemented.

There are many different approaches to analyze polycentric governance systems. Early versions were fairly basic ([11]: 831) yet continue to be influential [4]. At the same time, defining polycentric governance has become more complex. Stephan et al. [12] point to 15 approaches developed over the last 50 years. Carlisle and Gruby [6] start with a basic two-part definition of polycentrism as i) multiple overlapping decision-making centers that ii) take each other into account. They break this definition down into the enabling conditions that form each side of this definition and that help produce the functional benefits of polycentric governance. The identification of these enabling conditions is significant for this article since it goes beyond defining a polycentric system to identifying elements that make "robust and functional governance of natural resources more likely" ([6]: 947). The presence of these elements, however, is "no guarantee" of success, since there are "innumerable contextual factors" involved in governance and probably no empirical case fully manifests the characteristics, enabling conditions, and advantages of this theoretical model ([6]: 947).

In light of this, we turn to Sovacool and Martiskainen's work, which overlaps with Carlisle and Gruby's in many ways while developing a more precise set of polycentric variables that "seem predisposed towards more effective climate and energy governance" ([13]: 10). These variables build on earlier work by Sovacool [6] and are ([13]: 10):

- **Organizational multiplicity**: entails multiple stakeholders with overlapping responsibilities across scales and sectors.
- **Experimentation and flexibility**: mechanisms are in place to handle unforeseen events and take an open approach to management.
- **Ownership and accountability**: users bear some costs of governance and are accountable for their actions.
- **Equity and co-benefits**: the equal distribution of benefits and sharing of costs, through the use of public funds or taxes, cost-sharing, national policy targets, and positive externalities.
- **Inclusivity and local involvement**: inclusion of less powerful stakeholders, for example, rural actors and homeowners, instead of just urban actors and commercial firms.
- **Information, demonstration and innovation**: monitoring, information, and feedback mechanisms to facilitate technological learning and innovations in technical performance.

These variables, particularly the first two, encompass the four institutional framework components identified by Moroni and Tricarico [14] for enabling local group self-governance of distributed energy systems. Some advocates of polycentrism have focused on the importance of trust as an enabling condition, perhaps even overriding the importance of enforcement [4,14]. This claim was not as compelling given evidence suggesting the importance of a significant enforcement role for at least one of the actors in the polycentric system, for overcoming the significant barriers that polycentric systems encounter [7,15]. Thus, we add a seventh variable to the above six: **clear goals, translated into targets which are set and enforced by a higher-level authority** to facilitate systemic accountability steering [16,17]. These seven variables can be considered enabling institutional variables for effective polycentric systems governing energy and climate politics. We will use them to evaluate three cases with different degrees of polycentrism that respond to climate change through the promotion of RECs.

3. Method and case selection

This article employs a qualitative, comparative analysis of three case studies that meets recent challenges raised for energy social science with regard to research question design, theoretical novelty, and comparative analysis [18,19]. The data analyzed is drawn from the literature as well as the results of investigations carried out through the COME RES project.[1] We included both policy oriented as well as academic literature. Hence, the reviewed literature body consists of policy documents, legislative and regulatory texts, research and policy reports, white papers, and scientific articles (referenced in each of the country sections under Section 4). Electronic databases and search engines (primarily Web of Science, Google Search, Scopus, and ScienceDirect) were utilized to conduct the document search. Additional literature was identified via

[1] COME RES (https://come-res.eu/) is a Horizon2020 project that aims to facilitate the diffusion of RECs in nine EU countries and to support the implementation of an enabling framework.

snowballing techniques, such as reference chasing and tracking citations.

To examine the effects of the different variables identified in the previous section on the development of RECs, we compare both system-wide outcomes so far in the three countries as well as data from stakeholder interviews or workshops within them regarding barriers and drivers to RE development.[2] This article comparatively examines Germany, the Netherlands, and Norway. In selecting our cases, we applied three criteria.

First, all the cases take the ambitions of RED II into consideration.[3] This criterion serves multiple functions. First, it serves as a baseline since considering RED II makes all of the countries part of the same polycentric system, even as the various ways in which it is transposed and interacts with local conditions within each country allow for diversity between cases. Second, it allows us to evaluate how the RED II measures have been or will be adapted to those existing RE regimes in the ongoing transposition process. According to REScoop.eu's transposition tracker at the time of writing (i.e., July 2022), the Netherlands has so far made "average progress," Norway's transposition is still in development, and due to recent legislative changes Germany's transposition is regarded as a good example [20]. Finally, this baseline enables us to suggest key components to incorporate as well as critical areas for attention in the transposition process and future national development of RE regimes.

Second, the cases selected need to have varying degrees of polycentrism between them. While numerous variables can be used to 'measure' the degree of polycentrism of a particular governance system, "it is [the] lack of a single ultimate authority that distinguishes polycentric governance" ([12]: 4). Thus, the degree to which a system moved away from centralized decision making – as a 'proxy' for the degree of polycentrism – was key for our case selection. Norway represents a case where the state apparatus plays a dominant role in its RE sector. Norway's electricity production is, besides being almost fully renewable, for 90 % owned by public authorities, distributed between national, regional, and municipal ownership [21]. Germany represents a case of moderate decentralization, since the federal system provides a strong structural role of the German states in policy making, which extends to shaping energy policy, thus complementing other public and market actors [22]. Finally, by delegating the responsibility for the development of climate action plans to thirty independent energy regions, the Netherlands exhibits a high degree of decentralized decision making ([23]: 97–8). These energy regions do not overlap with existing districts, are not a legally recognized entities, have no formal authority, and so have to negotiate with local governments. Thus, the Netherlands adds an additional quasi-governmental level to the normal milieu of national, provincial, and local governance.

Third, the cases must have already achieved the goals pursued by RED II to some degree. In cases that have already realized this to some degree, it is possible to analyze whether these goals have been generated by a form of polycentric governance. All the countries included are meeting their RE targets so far. While Germany has historically had a high share of individual and collective citizen ownership of RE—which is now declining [24]—it is worth knowing to what extent this has been facilitated by polycentric governance. Norway too has sought to benefit citizens, though with significant involvement of the state, characterized by extensive public ownership of hydropower at the local, regional, and national levels. The expansion of wind power, however, has so far involved more foreign ownership. Nonetheless, renewed plans for onshore wind and increasing demand for PV and decentralized systems might signify a move towards more polycentrism. In the Netherlands, the large number of small cooperatives has yet to translate into a high percentage ownership of RE infrastructure. Though it is the most decentralized of the three models, suggesting a high degree of polycentrism, the question is whether an even higher degree of polycentrism will help spur the transition to a RE system.

4. Results

In this section, we describe the results of our analysis using the 7 enabling conditions identified in Section 2 for each of the three countries (Germany, the Netherlands, Norway).

4.1. Germany

4.1.1. Clear goals, translated into targets which are set and enforced by a higher-level authority

In Germany, the Federal Climate Protection Act and the Renewable Energy Sources Act (RESA) form the foundation for RE development. The former aims at reducing GHG emissions by 65 % in 2030 and by at least 88 % in 2040 (compared to 1990). The RESA provides the key legal basis for the ongoing energy transition in the electricity sector. By 2030, the federal government aims for an 80 % RE share in gross electricity consumption.

The energy transition in the electricity sector has been fostered by national targets, certain privileges for RE projects under the Building Code, attractive feed-in tariffs and premiums, guaranteed grid connection, priority dispatch, and bottom-up approaches. The transition from a price-based support scheme to competitive bidding and auctions in 2017 combined with increasing complexity of permitting and slow designation of wind energy suitable and priority zones led to a slowdown in RE development. Although many scholars agree that the auction model represents a barrier for actor diversity in general and community energy in particular [25,26], the Federal Minister for Economic Affairs and Climate Action is not prepared to fundamentally change the auction model. With the recent amendments of the RESA adopted in July 2022, the current federal government increased the quantitative targets set out in the RESA and exempted projects of citizens' energy companies in the field of wind energy ($\leq$18 MW) and PV ($\leq$6 MW) from the obligation to participate in auctions. This will likely help to reduce the risks and administrative efforts for such projects.

In order to advance the expansion of onshore wind power, the federal parliament passed the Wind on Land Act in 2022. Its main objective is to increase the share of land dedicated for wind power plants to 2 % by 2032. In order to achieve the expansion targets of the RESA considering various conditions in each German state and fairness among them, the accompanying Wind Area Needs Act establishes binding land-use targets for the 16 federal states. It is up to the states to translate these targets into their spatial planning, guided by a set of uniform rules issued by the federal government. If a state, however, does not achieve its land-use target, its minimum distance rules for wind energy plants will be suspended and investors would be allowed to build new turbines in areas previously unavailable due to the state's distance rules.

In sum, the German approach has been characterized as an 'influential top-down mechanism', although the federal states enjoy a certain leeway to experiment within the given legal framework [27]. In Germany's federalist system, the federal government has broad authority for legislation in the energy sector. However, the federal states exert significant influence on the legislative process via the Federal Council. Many federal states have implemented individual climate and energy

[2] See data relevant to particular countries under the 'stakeholder desks' tab at https://come-res.eu/.

[3] Norway is not an EU Member, but EU directives included in the EEA agreement apply to Norway also, however the timing of implementation is slower. That Norway is not an EU member makes it significant from a polycentric perspective as it has no direct formal relation to RED II, but both indirect formal and informal relations to European renewable energy governance. Formally but indirectly, Norway is negotiating the implications of RED II through its membership in the European Economic Area (EEA). Informally, Norway partakes in the polycentric governance of European renewable energy both through market structures and political signals as well as feedbacks between REC movements domestically and in the rest of Europe.

targets, strategies, and legislation. Often these are not adequately coordinated with the federal policy targets [28,29]. The current system exhibits a lack of multi-level integration, spatial coordination, and system optimization [27]. Recently however, the federal government took a number of measures to improve vertical policy coordination [17,30].

4.1.2. Organizational multiplicity

The federal government bears responsibility for the overall market design, the main support schemes for RE and the definition of rights and duties of market actors including energy communities. Spatial planning and designation of suitable zones for RE projects, however, are typically performed by subnational institutions. The state governments can also design complementary support measures to facilitate the development of RECs. R&D activities including regulatory sandboxes are typically developed by national and sub-national policy and administrative actors.

Additionally, municipalities can play multiple roles in the energy sector as policy makers, planners, owners and operators of land and infrastructure, enablers and facilitators. Further, municipalities may act as initiators of or shareholders in energy communities and may purchase the energy produced by such entities. In their role as owners of land and property, municipalities may provide suitable sites for RE facilities operated by energy communities. They may provide start up financing or information. Finally, they can help to build trust in and provide legitimacy to RECs [31].

Municipal multi-utility companies, with their decentralized structures, are particularly important actors. Germany has a tradition of municipal ownership in the energy sector and still today, numerous municipalities have their own multi-utility companies (*Stadtwerke*) providing various services such as electricity and heat generation, distribution and supply, district heating/cooling, gas supply, and public transport. Furthermore, Germany has a long tradition of energy cooperatives [32]. Only a few survived, but modern energy cooperatives experienced a strong growth mainly because of the conducive policy framework and low risk investment environment [30]. Additional actors with organizational responsibilities are RE associations and other umbrella organizations, e.g. the German Renewable Energy Federation, the Federal Wind Energy Association, and their respective regional representations, the German Cooperative and Raiffeisen Confederation, or the Citizens' Energy Alliance [33]. Such associations participate intensively in policy formulation processes via legislative proposals, assessments, deliberations, and expert hearings. They function as intermediaries between community energy initiatives and governments at all levels. They fulfil an important role by creating networks, hence providing a possibility for learning between community energy initiatives, and platforms for sharing best practices [34].

4.1.3. Experimentation and flexibility

Federal states have leeway to aid the development of RE, and many have played a pioneering role in promoting the use of RE and community energy initiatives [31,35] and acted as "laboratories for experimentation" [27]. Schleswig-Holstein is a chief example for the development of novel forms of RE infrastructure and took a pioneering role regarding the development of citizens' wind farms. In 2018, the state government of Schleswig-Holstein established a 'Citizens' Energy Fund' to provide start-up and risk capital in the initial phase of collective RE and energy efficiency projects. This fund helps citizen energy projects in the planning and start-up phase and to reduce financial risks. The fund also helps to mitigate difficulties faced by local initiatives for financially viable projects due to the uncertainties of the auction model. Inspired by the example of Schleswig-Holstein, in 2022, the federal government decided to set up a similar scheme providing start-up funding for citizen energy companies in the field of wind energy.

The federal system in Germany provides many opportunities to develop social and institutional innovations for energy transition at the municipal level [28,36]. Constitutionally guaranteed municipal self-government can be regarded as the basis for an active local energy policy [37].

4.1.4. Ownership and accountability

Decentralized actors, such as citizens, SMEs, and municipalities, contributed significantly to the local implementation of the energy transition [38]. From 2006 to 2021, energy cooperatives invested an estimated 3.3 billion Euros in the implementation of RE projects [39]. This is reflected in the ownership structures: solar PV (48 % owned by private citizens), onshore wind (40.6 %) and biogas (73.9 % owned by farmers) are RE technologies with a particularly high share of citizen involvement (all 2019) [24]. In 2016, around 1700 community energy initiatives existed [40], some of which likely fulfil the RED II criteria for RECs regarding ownership, proximity, socio-ecological motives and inclusivity.

In order to preserve the diversity of actors under the auction system, in 2017, the federal government introduced certain privileges for citizens' energy companies in the area of wind energy. Due to cases of misuse by traditional market players, some privileges have been abolished, while others such as a preferential pricing rule have been kept [41]. To qualify, citizens' energy companies had to fulfil certain eligibility criteria: at least ten natural persons have to be voting members or voting shareholders and at least 51 % of the voting rights must be held by natural persons that lived for at least one year in the concerned district before the bid was submitted. The new federal government recently decided to increase those thresholds to minimum 50 natural persons and to a minimum of 75 % of voting rights (starting from 2023). The spatial orientation is targeted towards decentralization and empowerment of local actors. On the one hand, the high threshold is a means to avoid misuse by other market actors, on the other, it makes it difficult at least for some community-owned initiatives to qualify as "citizen energy company".

The introduction of the auction model revealed another type of risk and accountability. Planning of a RE project requires considerable upfront costs that have to be covered regardless of the outcome of the auction which results in an investment risk for citizen initiatives. Initiatives such as the 'Citizens' Energy Fund' initiated by the regional Ministry of Energy Transition and implemented by the Investment Bank of Schleswig-Holstein play an important role to mitigate these risks and represent a good incentive for energy projects led by citizens. However, the risks are actually relatively low as auctions for onshore wind and ground-mounted PV are often undersubscribed [42]. More importantly, from 2023, wind and solar projects that fulfil the 'de minimis' rules laid down in the European Guidelines on State Aid for Climate, Environmental Protection and Energy 2022 (2022/C 80/01) have been exempted from participating in the auctions (cf. supra).

Accountability depends on the type of legal entity. Many local energy projects are implemented by registered energy cooperatives [43]. Larger projects, such as wind power plants, are usually implemented by limited partnerships with a private limited company as a general partner. This form of organization allows larger projects, but is ambiguous regarding the power that participants can actually exert [44]. Usually, in this model, voting rights are dependent on the number of shares.

4.1.5. Equity and co-benefits

Pursuant to RED II, the primary purpose of a REC is providing environmental, economic or social community benefits, rather than gaining financial profits. The directive, however, does not define these benefits and the amended RESA did not further specify this either. In recent years however, several federal states among which are Mecklenburg, Western Pomerania, Thuringia and Schleswig Holstein and the federal government adopted policies and measures requiring or facilitating active and/or passive financial participation of local communities in RE projects. Financial returns used to play an important role for many community energy initiatives, including cooperatives [45]. Numerous studies illustrate that the financial involvement of locals can enhance

acceptability of RE projects [46–49]. Local involvement represents a significant factor in both RESA and proposed amendments, thus ensuring the sense of locality. As most members of RECs are local or regional actors, a common interest of developing and improving everyday life can be assumed. Furthermore, to ensure actor diversity and local acceptance as well as to reduce bureaucracy, RE projects implemented by citizens' energy companies below certain capacity thresholds (cf. supra) will be exempted from auctions in the future. However, as participation in a REC is voluntary and financial contribution is a condition for membership, there is no possibility to take part in deliberations about benefits for citizens outside of the energy community. This is a challenge, especially for vulnerable households. Whereas the general income level in Germany is comparatively high, there are distinct regional differences.

4.1.6. Inclusivity and local involvement

Both municipal utilities and energy cooperatives are locally oriented and the number of cooperative arrangements between those actors is growing. Energy cooperatives can be partners of municipal utilities in the construction of RE plants or participate as shareholders in municipal utilities. They can participate in the financing, building and management of the plants. Municipal utilities support energy cooperatives in energy projects, provide know-how for local energy projects or roofs and other suitable areas from the municipal environment.

Collective initiatives such as jointly acting renewable self-consumers and RECs enhance inclusiveness, social cohesion and sustainability. In Germany, RECs are in principle open to all citizens, including vulnerable groups and low-income households. To achieve this inclusivity, many cooperatives lowered entrance barriers, by requesting minimum investments of around 100–500 Euros. Although this amount is rather low, such amounts of capital can still pose a barrier to some households. There are no federal measures to enable all citizens regardless of their background to participate, nonetheless there might be local efforts to tackle this challenge.

4.1.7. Information, demonstration and innovation

Ministries at federal and state level, national and regional energy agencies, regions, districts and municipalities play a key role in supporting the development of community driven initiatives through advice, guidance, capacity building, institutional innovations, networking and financial support [50]. The regional government of Rhineland-Palatinate supports a regional network of energy cooperatives. Also, the now disbanded Energy Agency of North Rhine Westphalia provided important impulses with its dedicated platform promoting citizen energy systems and providing start-up advice for cooperatives as well as fostering training events for organizations and group-specific concepts [51].

Further actors promoting the provision of information and exchange of good practices are national and regional associations, community energy associations, and associations of energy cooperatives such as 'Citizen Energy Thuringia'. Such associations organize seminars, workshops, and informational events to help citizens actively participate in the energy transition. Those initiatives usually represent bottom-up approaches and are not financed or specifically promoted by the national or state government.

Innovations and demonstrations are often implemented in a bottom-up manner. For instance, the cooperative electricity supplier EWS Schönau provides an excellent example that attracted international attention [33]. EWS Schönau is a multi-utility cooperative and was the first of its kind in Germany to take over the electricity grid as well as electricity supply to the local community. Later, EWS began to supply customers with green electricity on a nationwide scale. Recently, EWS started pilot projects in the field of energy sharing and initiated a community virtual power plant. Such initiatives can gain momentum but rely on the local circumstances as well as the legal leeway to implement innovations.

4.2. The Netherlands

4.2.1. Clear goals, translated into targets which are set and enforced by a higher-level authority

The priorities of the Dutch climate and energy policy up to 2030 are described in the Climate Agreement of 2019, the result of deliberations and negotiations involving over a hundred representatives of lower administrations, industry, and interest groups, under the guidance of the Dutch Social and Economic Council [52]. This agreement contains a package of measures, adopted by consensus, aimed at achieving a 49 % reduction in GHG emissions by 2030 compared to the 1990 level, and reaching 35 TWh of renewable electricity production on land by 2030, of which 50 % should be owned by local actors. The latter policy goal, however, expresses a non-binding policy intention with unclear consequences should the goal not be met in 2030.

The Climate Agreement also stipulates the creation of 30 energy regions, each of which is obliged to work out a 'Regional Energy Strategy' (RES). Targets to be met by these RESs are not imposed by the central government, as the RES regions have relative autonomy to decide on regional transition goals, with the understanding that each region should take on an unspecified fair share of the national effort. The 30 RES regions are, however, coordinated and facilitated at the state level by the 'National Program Regional Energy Strategies', including the establishment of 'learning communities' or setting up an expert pool. Furthermore, scientific assessment and feedback on the RESs in the draft stage is provided by the Dutch Environmental Assessment Agency (PBL). Should the PBL establish that the sum of the efforts offered up by the different regions does not add up to at least 35 TWh renewable electricity production, then the RES regions will be invited to step up their efforts, though this was not needed in the first round of RES development where the calculated sum of the regional plans resulted in a total of 52,5 TWh [53]. Coercion by the central government is possible when needed (e.g. by authorizing the construction of wind or solar parks against the will of lower administrative levels) but is considered to be a measure of last resort [54].

4.2.2. Organizational multiplicity

The formulation of a RES generally depends on achieving a balance between four different factors. Firstly, a fixed amount of electricity generation from wind and solar power, and a fixed amount of GHG reduction must be reached by 2030. Secondly, these RE projects have to be fit into spatial plans. Thirdly, the projects (and the RES as a whole) have to muster social, administrative and political support. And fourthly, RE has to be fed into local electricity networks, which often are faced with capacity problems. Securing these four demands entails the strong involvement of regional and local governments (including water boards), and network operators. The involvement of the business community, social partners and civil society varies between the RES regions [54].

4.2.3. Experimentation and flexibility

The RES approach can be seen as an 'experimental' response to the poor outcomes of the centralized top-down planning of wind energy implementation adopted in the Netherlands since the 1990s, despite positive early cooperative experiences in wind energy e.g. in the province of Zeeland. Due to the fact that the central government ignored local needs and gave little voice to municipal authorities and local communities in the siting of wind turbines, the top-down approach led to poor social acceptance, public disapproval or even civil unrest [55,56]. In line with recommendations from an emerging literature on the subject, the regional level was chosen as the right scale for linking the energy transition challenge with other challenges in the physical environment, and thus balancing the various interests [57–60]. The Dutch RES regions as defined in the 2019 Climate Agreement constitute an institutional novelty because the regions are not a formal constitutional tier of government in the Netherlands and have no legal status or

power to implement the decisions taken within the framework of the RES [61]. The RES program is therefore based on a kind of 'mandatory voluntary cooperation' [54]. This 'voluntary' component does give the RES regions considerable room for flexibility in defining and pursuing an energy transition strategy, concerning the number and type of stakeholders to involve in decision-making (e.g. grid operators, businesses, civil society), and the sectoral scope covered (e.g. the built environment, the industrial sector, mobility and transport, agriculture, and the energy system) [62]. Flexibility notwithstanding, most RES regions follow a fairly technocratic approach based on a top-down spatial assessment of suitable locations to build wind and solar parks, possible heat sources, or suitable rooftops for the installation of PV systems [54].

4.2.4. Ownership and accountability

By the end of 2021, the Netherlands counted a total of 667 energy cooperatives. The number of local energy cooperatives is not growing much anymore, but the activity of the existing cooperatives is broadening and deepening. For instance, about 75 % of them are working integrally on the energy transition within a specific locality by combining activities in solar, wind, heat, and/or energy saving. In 2021, Dutch cooperatives owned a total of 217 MW in solar generation capacity (out of a total of 14 GW, or 1.6 %), and 296 MW of onshore wind generation (out of a total of 5800 MW, or 5.1 %) [63].

Since the RES region is not a formal level of the Dutch constitutional regime, a regional strategy to transform a RES into official politics is only possible through the official decision-making bodies of the participating decentralized governments (mainly municipalities, and to a lesser extent the provinces and water boards). In other words, the practical implementation of a RES will depend on the decisions taken by the municipalities, who also remain accountable to their constituent citizenry. According to Van Dijk et al. [64] this leads to high transaction costs and process delays since without having all municipalities in an energy region on board, the creation of a RES becomes problematic. Many municipalities will also take a cautious attitude in promoting RE projects on their territory, given the fact that many of these projects encounter resistance from local action groups. In line with a wide body of literature [65,66] pointing out that community ownership of RE projects can be a main driver for local acceptance, many municipalities seek to extend ownership of RE infrastructures to their citizens or local associations. Since most favorable locations have already been taken by private enterprises, and the Dutch national and provincial laws do not allow the imposition of a minimum percentage of citizen ownership of RE projects developed by private project developers, some municipalities seek to impose some measure of ownership in the socio-economic framework conditions for developing RE projects on their territory. Such conditions can range from giving local citizens the opportunity to participate financially in the project, to setting up a local fund financed by the project's profits. As some provinces (e.g. North Brabant) are left with considerable financial assets after selling shares in former provincial energy companies following the liberalization of the energy market in the mid-2000s [67], they can also play an important role in stimulating citizen ownership, for instance by providing the risk capital needed to construct a wind farm, and later on giving citizens the opportunity to buy shares once the wind farm has entered its operational phase.

4.2.5. Equity and co-benefits

The fact that coordination between the different RES regions is based on a voluntary deliberation and negotiation process makes it unlikely that unfair burdens will be imposed upon particular regions. Likewise, at the local level much emphasis is put on sharing the benefits of RE production with local actors, be it in the form of co-ownership or establishing a local fund. However, Hoppe [54] notices that most energy regions favor solar over wind energy for spatial and socio-political reasons. Although this preference is understandable considering the greater social legitimacy of solar power, it has the disadvantage that solar production units are much less efficient than windmills in terms of investment costs and space needed. This means that compared to a 'centralized' approach, the total cost of the RES approach (partly borne by taxpayers in the form of subsidies) will be significantly higher.

4.2.6. Inclusivity and local involvement

Citizen participation and social support for RESs are considered of great importance in the RES program in order to enhance social acceptance, enable informed decision making by using the knowledge and experiences embedded in local networks, and ensure community ownership [68]. To support the energy regions, a collaborative civil society initiative was launched in 2019 under the name 'Participation Coalition', including a number of organizations representing community energy and RE cooperatives in the Netherlands. The Participation Coalition works on formulating, implementing and guarding a participatory approach for the RESs, with a focus on citizen participation in planning processes, integrating RE projects in the local environment, and guaranteeing at least 50 % citizen ownership of local projects. Even though all RES regions have included the latter goal in their strategies, an evaluation of participation in the RES process by the Participation Coalition concluded that only limited numbers of citizens or grassroots organizations had been involved so far [69]. In particular, the Participation Coalition recommends far greater involvement of residents' initiatives, farmers, energy cooperatives, and environmental organizations.

4.2.7. Information, demonstration and innovation

Since RESs will inevitably also imply costs and burdens for different constituencies (e.g. in terms of landscape pollution, lost agricultural land, noise pollution, negative impact on avifauna and wildlife, reduced property values, etc.), transparent information on the risks, costs and benefits of RESs seems to be a crucial ingredient to enable fully-informed participation and deliberation in accordance with principles of good governance. However, according to Hoppe [54] no common rules or guidelines on how to do this are in place. Hoppe [54] furthermore states that according to the 'Green Audit Office', who assessed of some RES documents, costs and risks are hardly mentioned. He concludes that "*the tone used in the draft RES is excessively positive; it gives the impression of an advertising brochure*". Furthermore, each RES region relies on different knowledge providers (often private consultancy firms) and data sources that might be specific to the region, making comparison and learning among the regions difficult to achieve.

Local energy communities are however quite active in adopting technological innovations, as witnessed for instance by the community Virtual Power Plant in Loenen, which attracted international attention [70].

4.3. Norway

4.3.1. Clear goals, translated into targets which are set and enforced by a higher-level authority

Norway's obligations under the Paris Agreement are statutory under the Climate Law. Norway has set an enhanced GHG emission reduction target of 50–55 % in 2030 (compared to 1990). Since Norway is almost completely self-sufficient in renewable electricity supply with 92 % hydropower and about 6.4 % onshore wind power, increasing the share of RE is mostly outlined as an important strategy for sectors such as transport. It is expected that Norway will need to increase RE production significantly to achieve the energy transition and to counteract high electricity prices. The latest energy white papers [71,72] focus mainly on energy as a means to increase employment and the continuation of the cost-efficient renewable electricity system in the low-carbon energy transition. Technologies and industry within offshore wind and hydrogen are highlighted. Due to resistance to onshore wind, the Norwegian Water Resources and Energy Directorate (NVE) stopped all concessions for onshore wind power in 2019 while awaiting a new legal framework. The latest white paper on onshore wind power [73] signals

that local authorities will be given a stronger role in decision making than foreseen in the present Energy Act. In line with the latest energy white papers [71,72] NVE has now restarted processing applications for onshore windfarms that were in the last phase of approval before all licensing processes were halted. The white papers also have ambitious plans for offshore wind power.

4.3.2. Organizational multiplicity

The Norwegian electricity system is regulated by the Ministry for Energy and Petroleum and its subsidiary agency, the NVE. The electricity system is also regulated by the Ministry for Climate and Environment and Directorate for the Environment when it concerns environment and climate issues. Licensing of energy installations with >5 MW installed capacity is regulated through the Energy Act. Installations below this threshold have to refer to municipal spatial plans. The electricity grid in Norway is a natural monopoly subject to monopoly control. Grid operations, grid tariffs and grid companies' income is regulated. Electricity production and trading are exposed to competition, and the Norwegian Energy Act is based on the principle that power trading should be market-based. Distributed energy solutions have previously been mostly related to off-grid PV systems, but from 2017 the 'plus-customer scheme' was introduced granting prosumers with installations below 100 kW the rights to sell surplus electricity into the grid to any grid company and to use self-consumed electricity free of charge. Prosumers with an installed capacity between 100 kW and 1 MW are subject to pay the regular tariffs as well as an additional tariff for feeding in electricity [74]. In the present electricity system only licensed grid companies can distribute electricity beyond the metering points of households and other commercial or public entities. This represents an important barrier to the development of RECs as energy sharing within the community is prohibited. Based on the latest energy white paper a proposition for new regulations to extend the plus-customer scheme are in consultation process [74]. If approved the new regulations will allow sharing self-produced electricity between meter points within the same property and thus ensure equal treatment between private homes and condominiums. Grid companies are obliged to facilitate prosumer connection to the grid. Land-based PV is emerging and will be regulated by municipal or national spatial plans and regulations, or if larger than 5 MW by the Energy Act.

The increasing interest in distributed and community-based energy solutions means that regional and local institutions (e.g. municipalities and grid companies) will need to take an active and cooperative role in the energy transition to ensure environmental and social sustainability. Already, most of the energy resources are under public ownership.

4.3.3. Experimentation and flexibility

The specific characteristics of the Norwegian electricity sector and the narrative of the cost efficient and reliable supply means that decentralized energy solutions are met with some skepticism, in view of the potential disruptive impact on the existing system and distribution of costs and benefits if they are implemented on a large scale [75]. However, the regulator and Ministry have been working to facilitate for projects that provide valuable learning for optimizing integration of local and regional smart grids. To this end, the NVE has implemented a regulatory sandbox regime that provides advice and time-limited exemptions where projects (based on NVEs approval) are exempt from the regulations concerning e.g. electricity sharing between meters and properties, including for transport and storage. There are today a number of such projects ongoing in Norway. Only a few fit the definition of RECs outlined in the RED II, but will provide valuable information for enabling more distributed systems in the electricity system.

4.3.4. Ownership and accountability

90 % of electricity production capacity in Norway is publicly owned, though it is distributed between central, regional, and municipal ownership. These arrangements fit into the centralized system where power production is channeled into the regional distribution systems and where third party companies deal with the consumer interface. Several municipalities have a strong income base as power producers (especially within hydropower). Building up more distributed systems with local production, storage and distribution is challenging as self-produced electricity shared beyond the meter falls within the grid companies' monopoly and will be subject to tax and grid tariffs. The signaled regulatory change allowing sharing within the same property (e.g. condominiums) means that PV will be one of the most promising technologies for electricity production for RECs in Norway.[4] Enabling more distributed systems could shift ownership more into the private commercial sector. Development of onshore wind has included a much higher degree of foreign ownership (with implications for societal acceptance). As RED II is not implemented there is no particular focus on legal definitions of RECs or the requirements to provide social, economic and environmental benefits to the REC shareholders or community where the REC operates.

4.3.5. Equity and co-benefits

Within the energy sector, community energy is presented in conflicting ways. On the one hand, there is considerable concern that a high increase in decentralized systems will result in an unfair distribution of grid costs. Due to the cold climate the main electricity consumption occurs during the winter season and is reliant on an energy mix provided through national distribution, whereas the decentralized PV systems will reduce incomes from grid tariffs and the electricity tax, but mostly provide electricity in the warmer season. On the other hand, many actors point to the vast and unused potential of rooftop PV, and the need for creating new green jobs in the energy transition [76,77].

A key factor in this debate is that a significant part of the Norwegian hydropower is sourced from small-scale plants owned by farmers or landowners with waterfall rights that provide benefits to local areas [75]. In addition, 90 % of the hydropower plants are owned by municipalities and the state [78]. Several of the grid companies are also owned by the public sector. As a result, a large part of the income of electricity production benefits the citizens [79]. Norway's national energy resources are considered as commons and therefore oil and hydropower production are also subject to an extra tax on dividend [75].

4.3.6. Inclusivity and local involvement

Norway seems to have chosen a 'middle road' in terms of citizen inclusion in RE projects. Inclusion of citizens must be seen in connection to support for citizens to invest in RE energy production. As mentioned, NVE only defined prosumer rights and obligations in 2017. Due to the requirements for individual metering, the plus-customer scheme was only open to homeowners who resided in detached or semi-detached houses since self-produced electricity cannot be shared between household units. A system of virtual metering has been delayed for several years [80]. Several actors, such as housing associations and property developers have for many years advocated for a change of the existing regulations [81] and the mentioned pending regulations will expand the plus-customer scheme for apartment buildings by allowing the sharing of self-produced electricity between units within the same property [74].

In addition to the plus-customer scheme, the state-owned enterprise Enova provides individual households a guaranteed refund for part of their investment costs in rooftop solar.[5] Enova does not offer specific support for RECs, but RECs can apply for support alongside commercial

[4] The technical feasibility of solar in Norway and Arctic regions has been established though there are challenges to seasonal changes. For RECs PV is seen as the most suitable as it can be implemented on already existing buildings and thus avoid land conflicts and negative environmental impact.

[5] In 2019 Enova provided of 5.6 billion NOK (520 million Euro) to energy and climate projects.

actors [82]. The economic support is important to lower the threshold for private citizens to invest and participate in energy production, but there is no particular focus on low-income or vulnerable households. Rather, the need to cover up-front costs and regulations favoring private homeowners have led to prosumerism becoming a 'middle-class' phenomenon [83]. This phenomenon also has a gender dimension and research finds that Norwegian prosumerism is driven by men with the necessary financial and social capital [70,76]. Energy poverty exists in Norway but is assumed to be dealt with under other policies.

There has been some attention to the local and community level after the onshore wind protests, including more focus on the consequences of onshore wind power for the Saami populations [84–86]. The Saami population have formal rights in the decision-making process, but several wind parks have been built despite their protests. A supreme court hearing from 2021 ruled that two large-scale onshore wind power developments in Norway were in violation of the Saami population rights.

4.3.7. *Information, demonstration and innovation*

Since Norway has not implemented REDII and its climate target is not connected to a specific growth strategy for RECs there are no common guidelines or regulations on the topic. Further, Norway is not required to implement an enabling framework or transparent cost-benefit analysis of distributed energy solutions in all aspects or timeline set for EU Member States. The above-mentioned agency Enova provides not only economic support but also standardized information for household prosumers. In addition, Enova provides information and guidance support to community energy actors, but this is dependent on applications in competition with commercial actors. However, a recent study [81] shows that lack of information is seen as one of the main barriers among potential RECs in Norway (see also [77]).

Despite skepticism towards distributed energy solutions' potential to disrupt the cost-efficient and fair electricity system, several grid companies are implementing their own pilot projects with storage and distributed energy systems to provide better load management in their grid area. Furthermore, Norway has the highest market share of electrical vehicles that require increased flexibility in the electricity system [87]. There are also examples of arrangements between prosumers and grid companies to provide flexibility. Recently attention has been given to measures for flexible electricity consumption as seasonal variations and peak-hour demands and new trends in household devices (e.g., electric vehicles) challenge grid capacity. There are several financing instruments available for research and development for distributed energy systems for commercial and research projects to stimulate innovation. These are less available for potential REC shareholders who may lack competence, networks and other resources [81].

5. Discussion

The cases of Germany, the Netherlands, and Norway illustrate a variety of ways for European countries to meet aspirations for a low-carbon energy transition. Specifically, the historical and potential future role of RECs is key since they are meant to be one of the important actors driving this transition in the European Union's CEP. In this article we sought to understand the extent to which polycentric arrangements including local and transnational actors play an enabling or inhibiting role in bringing those aspirations closer to reality. Drawing on the literature, we identified seven variables for effective energy governance in polycentric systems: equity and co-benefits; inclusivity and local involvement; information, demonstration and innovation; ownership and accountability; organizational multiplicity; experimentation and flexibility; and clear goals set and enforced by a higher-level authority. Our cross-country comparison of these conditions enables an evaluation of to what extent the presence or absence of the enabling variables is able to contribute to the development of RE as a common good. The results of our analysis in Section 4 are summarized in Table 1.

Table 1
Summary table of 7 institutional conditions in Germany, the Netherlands, and Norway

	Germany	Netherlands	Norway
Clear goals, set and enforced by a higher-level authority	The national government exerts significant influence, e.g., by setting national targets for GHG emissions, and attractive feed-in tariffs and premiums.	Priorities for energy and climate policy are set at the national level, but are not imposed, as the RES regions have relative autonomy to decide on regional transition goals.	Climate mitigation targets are set at the national level, and the state apparatus plays a dominant role in the development of RE infrastructure.
Organizational multiplicity	Many actors play an important role in RE governance, ranging from the national government, subnational institutions, municipalities, cooperatives, municipal utility companies and various associations and umbrella organizations.	Development of the RESs implies the strong involvement of regional and local governments (including water boards), and network operators. The involvement of the business community, social partners and civil society varies between the RES regions.	Most of the energy resources are publicly owned, and the electricity system regulation is centralized on a national level.
Experimentation and flexibility	Many federal states have played a pioneering role in promoting the use of RE and community energy initiatives and acted as "laboratories for experimentation".	RES regions are flexible in defining and pursuing an energy transition strategy, and setting up experiments.	Experimentation has been limited to projects that provide learning for optimizing integration of local and regional smart grids.
Ownership & accountability	Decentralized actors, such as citizens, SMEs, and municipalities, contributed significantly to the local implementation of the energy transition.	Many energy cooperatives are active, but in total they own only a small percentage of RE generation capacity. Private actors are dominant.	90 % of electricity production capacity in Norway is publicly owned, though it is distributed between central, regional, and municipal ownership.
Equity & co-benefits	Several federal states and the federal government adopted policies and measures requiring or facilitating active and/or passive financial participation of local communities in RE projects.	Locally, much emphasis is put on sharing the benefits of RE production with local actors, be it co-ownership or establishing a local fund.	As a result of significant public ownership, a large part of the income of electricity production benefits the citizens.
Inclusivity & local involvement	Both municipal utilities and energy cooperatives are locally oriented and the number of cooperative arrangements between those actors is growing, leading to high	The Dutch Participation Coalition recommends far greater involvement of residents' initiatives, farmers, energy cooperatives,	Inclusion of citizens must be seen in connection to support for citizens to invest mostly in PV installations on detached or semi-detached properties, leading

(*continued on next page*)

Table 1 (*continued*)

	Germany	Netherlands	Norway
	levels of inclusivity and local involvement.	and environmental organizations in RES planning.	to prosumerism becoming a middle-class phenomenon.
Information & demonstration	Ministries at federal and state level, national and regional energy agencies, regions, districts, municipalities, community energy associations, etc. play a key role in supporting the development of community driven initiatives through advice, guidance, capacity building, and networking.	Each RES region relies on different knowledge providers (often private consultancy firms) and data sources that might be specific to the region, making comparison and learning among the regions difficult to achieve.	Lack of information is seen as one of the main barriers to REC development.
Impact on REC development	The federal government has had a strong impact on REC development, being responsible for overall target setting, electricity market design and designing the main support schemes for RE.	Responsibility for increasing the use of RE is devolved to 30 energy regions. While this opens the possibility of extensive flexibility and local inclusion through the support of RECs, it can also result in higher overall costs, prolonged deliberations and negotiations and disorganized information sharing.	RECs are no priority in the Norwegian energy transition strategy. In the dominant narrative, distributed electricity sources are even problematized as a potential threat to the cost-efficiency of the present system.

In two of our cases (Norway and Germany), we found evidence for the need of strong central government intervention in order for RE to flourish, thus contradicting to some extent Goldthau's [88] unqualified plea for more decentralization and polycentricity in energy governance. Norway is clearly the most successful case when it comes to RE development, with over 95 % of the electricity supply being renewable. At the same time, Norway has achieved this result with a very low degree of polycentric governance combined with strong government interventions at multiple levels, favored by fortunate natural and societal conditions. Furthermore, as illustrated in the latest energy white papers [71,72], the Norwegian government continues to emphasize the importance of large-scale industrial efforts and the benefits of the current system. Decarbonization of the electricity sector lacks momentum since Norway is almost fully self-sufficient in renewable electricity and technologies such as solar PV (most relevant for the further growth of RECs) are given less prominence in policy. In the dominant narrative, distributed electricity sources are even problematized as a potential threat to the cost-efficiency of the present system. The governance of the energy system and the definition of the common good to which it contributes is dominated by traditional actors and has constrained other common good narratives with a focus on citizen empowerment, gender perspectives, minorities and social equality [75]. This finding resonates with recent analyses on the difficulties of reconciling tensions between the climate urgency and the need for energy justice and recognition of local knowledges, cultures and traditions in the Global South [89]. In our view, there is an opportunity here for productive conversations that go beyond the North-South binary, and the space for Northern contexts to also speak to this ongoing debate.

Germany's 'moderate' decentralized approach has proved to provide a favorable institutional environment for polycentric governance (cf. Table 1), while it has also led to a significant share of RE (41 % of electricity supply in 2021) and large investments by cooperatives (many of which will qualify as RECs under the definition of RED II) [90]. The federal government has had and continues to have a strong role in RE development, being responsible for overall target setting, electricity market design and designing the main support schemes for RE. The market design has had a major influence on REC development (e.g., feed-in tariffs promoted growth, auctions as a barrier). Also, spatial planning rules for wind power at the state level can be a barrier. The federal government takes steps to improve vertical coordination with the federal states through special coordination mechanisms but also through top-down steering (e.g., the new legislation prescribing minimum territorial shares for wind energy for each federal state). The federal states, regions and municipalities bear responsibility for spatial planning and designation of suitable areas for RE installations. This latter factor has enabled both experimentation and flexibility as well as a degree of organizational multiplicity.

Of the three cases investigated, the Netherlands has opted for a highly decentralized approach to RE governance in response to a problematic top-down approach that has so far led to a relatively modest share of 33 % RE in electricity production. The Dutch government's targets, while significant, are non-binding with unclear enforcement mechanisms. Responsibility for increasing the use of RE is devolved to 30 energy regions which work with municipal and regional governments, setting their own goals on what targets to achieve and operating without enforcement power. While this opens the possibility of extensive flexibility and local inclusion, it can also result in higher overall costs and disorganized information sharing.

All of this suggests that clear goals and frameworks, set and enforced by a higher-level authority, might be needed to reach higher levels of RE. Even discounting Norway's use of hydroelectric power as an exceptional case, Germany shows the benefit of a higher-level authority coordinating the transition through targets and enforcement. But there are other issues besides simply power production guiding the EU's approach to the RE transition. Community energy seeks not just to produce more RE, but to produce energy in a more democratic, inclusive, acceptable, and flexible way that opens space for local innovation [91].

Thus, it is necessary to turn to our second question on the extent to which the presence/absence of the seven enabling variables brings about these other benefits. As suggested by Creamer et al. [92], one should "strive to be critically alert to the risk of strategic misappropriation of 'community' to manipulate or sugar-coat decisions and impacts relating to energy developments", and therefore submit a (proclaimed) development of RECs to a careful investigation regarding their actual contribution to a just energy transition. On a similar note, Laes and Bombaerts [93] point out that some forms of 'energy community' actually correspond very well with a neoliberal logic. These findings suggest the need for further research not only into the question whether polycentric settings are conducive to REC development, but also whether they lead to the development of the right kind of RECs.

This being said, from our analysis we can conclude that many factors stand in the way of creating a favorable institutional environment for polycentrism and RECs in Norway. These include grid companies having a monopoly on distribution, strict rules on individual metering, public opposition to onshore wind, fears about increased inefficiency and cost, and a lack of motivation to further develop RE given the large quantity already being produced. At the same time, there are significant drivers suggesting the need to continue developing a more polycentric energy approach. The polycentrism literature suggests that concrete benefits through ownership and inclusivity can overcome opposition to RE projects such as onshore wind. These benefits can also lead to a more just energy system that better incorporates vulnerable and low-income

households, brings more gender balance to the energy system, and potentially makes space for better cooperation with marginalized populations such as the Saami on energy projects. The success of small hydroelectric energy projects suggests that the further development of unused potential with regard to community solar and wind would be met with success. And despite the high amount of RE being produced, some grid operators who are skeptical of decentralized energy have nonetheless begun their own pilot projects in distributed energy for better load management. Thus, there may still be significant benefits to Norway in pursuing a more polycentric energy system.

The German and Dutch cases show mixed results at the local level with issues such as ownership, inclusivity, and information sharing often requiring significant time and financial resources on the part of individuals and small organizations (as illustrated e.g., by the federal insistence on the auction model for new energy projects). However, there are positive signals since the new government has decided to exempt civic wind energy and PV projects below EU de minimis thresholds from auctions. The German states can also play an important role in 'de-risking' community energy initiatives, a good example being the 'Citizens' Energy Fund' to provide start-up and risk capital in the initial phase of collective RE and energy efficiency projects. This fund helps citizen energy projects in the planning and start-up phase and to reduce financial risks. All in all, Germany seems to have a sufficiently enabling institutional environment for the polycentric system to function properly to overcome barriers to implement RE projects and it may only take moderate adjustments on the federal government's part to help those models spread to other German states.

Compared to Germany, the Netherlands has opted for a more decentralized approach, as a result of heavy resistance to earlier attempts at centralized planning. In particular, wind energy projects encountered substantial resistance. The devolution of responsibility and emphasis on community ownership in the targets can be seen as a way to make such projects more inclusive and to give communities a stake in the projects, thus increasing acceptance and accelerating the transition. Nonetheless, there are some signs that the new polycentric system may be unbalanced in terms of targets and enforcement such that municipalities may refuse to have projects in their areas on the presumption of their unpopularity. Thus, experiments in regions such as North Brabant to fund the risk in new projects and incentivize ownership and inclusivity could be crucial in accelerating such acceptance. Such funding might also be critical in increasing inclusion which has been limited despite strong targets set by all of the RE planning regions.

Our analysis of course also has limitations that should be taken into account. First, even though we have taken care to select three cases representing a range of different energy governance systems, comparative research with only a small number of cases may not be representative of the broader range of contexts and conditions that exist across different countries and regions. Second, our research is possibly prone to a risk of oversimplification, as it required simplifying complex systems into easily comparable units (i.e., the seven institutional dimensions used as a framework for comparison). This can lead to a loss of nuance and detail, which can obscure the complexity of the systems being studied. Third, we faced challenges in accessing reliable and comparable data on each of the seven institutional dimensions for each of the three countries. Differences in data availability, quality, and reliability can make it difficult to make meaningful comparisons and draw robust conclusions. Finally, comparative research may not fully account for the unique political and cultural contexts of each country, which can shape the ways in which polycentric energy governance operates. These differences can influence the effectiveness of policies and practices and limit the transferability of findings across different contexts. Overall, while we believe that the research presented in this paper can be useful in identifying similarities and differences across different contexts, it is important to recognize its limitations and supplement this approach with other methods such as in-depth qualitative research on single countries or regions.

6. Conclusion

There is no 'one-size-fit-all' polycentric system that can be imposed on each country to produce successful energy and climate governance. Indeed, part of the point of a polycentric approach is to better enable conditions on the ground to play a significant role in shaping the system. As we have seen here, context matters. The high degree of decentralization in the Netherlands cannot be understood without accounting for the problems encountered by the previous centralized approach. Germany must adapt its approach to a federal governing structure with divided responsibilities. Norway is particularly situated with access to a supply of hydroelectric energy that has heavily influenced the form its RE regime has taken. Yet despite these differences, what the characteristics of successful polycentric energy governance systems discussed here show is an ability to better understand the comparative strengths and weaknesses of these approaches.

Our initial research question whether 'polycentrism delivers' can thus only be answered in a conditional sense. Firstly, in general, some degree of polycentrism appears to be beneficial for the energy transition. Even Norway, whose obligations with regard to the CEP have yet to be worked out, is making reforms that will create a more polycentric energy system. The primary change is an expansion of prosumer rights, which is critical for enabling community energy to get off the ground. This is the foundation for building local ownership and inclusivity and thus the emphasis is rightly placed there and could be expanded. Given the strong role of central government in existing energy policy, issuing regulations to specifically include community involvement (especially for onshore wind power) would likely be beneficial. As more community energy projects get off the ground, facilitating experimentation, innovation, information sharing, and greater organizational multiplicity will become more important.

Secondly, as perhaps demonstrated most clearly in the German auction system, issues of ownership and accountability stand out as key enablers of RECs and the additional common goods that they bring to the energy system. RECs need to be enabled in financial terms to deploy a sufficient amount of RE projects, e.g., by giving them access to risk capital in the early development stages, or in the case of Germany by reforming the present auction system. In turn, this requires clear regulations and accountability mechanisms being installed on what precisely falls under the definition of a REC.

Finally, building on the previous conclusion, these cases help reflect on polycentric theory as well. For example, even if polycentrism is a promising approach, we found that it does need to be anchored with a significant role for higher level government in order to function effectively. For instance, while the definitions and basic principles prescribed by the EU for community energy and in particular renewable energy communities have been adopted in the Netherlands, there is no enforcement authority to oversee compliance with these conditions, opening the door for abuse (cf. supra). This is not a surprise given the general lack of higher enforcement in the Netherlands energy governance approach. Stronger oversight and central steering needs to be developed further to better balance the weight given to organizational multiplicity and local involvement in the Dutch approach. These interpretations can be taken as a foundation for future research in other countries as well.

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

No data was used for the research described in the article.

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