Socio-technical conditions for a fair energy transition: a comparative gesture of Renewable Energy Communities' enabling framework in Germany and Italy

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Abstract

The concept of community energy is increasingly recognised as a key driver for achieving a fair and just energy transition through the active involvement of end-users in the production, sharing and consumption of renewable energy. Focusing on Renewable Energy Communities (RECs) and their recent prominence in the public debate, this paper aims to analyse the socio-technical conditions of these initiatives between Germany and Italy, with the aim of investigating the enabling frameworks for RECs in these two countries. The paper examines how differences in national contexts influence the implementation and outcomes of RECs, with a particular focus on the conditions for a "systematic change" towards a low-carbon and sustainable energy system, addressed through the lens of the multi-level perspective. In this respect, the paper contributes to the understanding of the socio-technical aspects behind RECs, i.e. of how social and technical aspects intersect in the development of RECs. In doing so, the paper also aims to provide insights into the potential for cross-national learning and policy development in the EU context. The findings highlight the differences between the two countries, with Germany having a more advanced framework for community energy, and the importance of integrating social sciences into energy research to better understand the complex interplay between technology, society and policy in energy transitions.

1. Introduction

The concept of 'community energy' plays a pivotal role on the path to achieving a fair and just energy transition. It also serves as a cornerstone for engaging end-users in the energy system, empowering them to take responsibility for renewable energy production and consumption (Kojon-

saari and Palm 2021; Wahlund and Palm 2022). Energy cooperatives, energy communities and other diverse models of citizen-led initiatives for the self-consumption of renewable energy have steadily begun to transform the energy system.

Today, our knowledge of community energy has matured to the point where an accurate definition of Renewable Energy Community can be identified, as the literature has considerably expanded in recent years (Bauwens et al. 2022; Brummer 2018; Busch et al. 2021). In a nutshell, Renewable Energy Communities (RECs) can be defined as local experiments that focus on the co-production, sharing and consumption of energy from renewable sources, aiming to accelerate the decarbonization of energy consumption and engage end-users in the energy systems (Soeiro and Ferreira Dias 2020).

The notion of 'community' in the energy system describes a specific network of social relations characterized by participatory governance and 'distributive justice' in relation to renewable energy, and concerned with the fair distribution of the burdens and benefits (Bauwens et al. 2022). Insofar as justice and democracy principles are embedded in the description of RECs and their goals, a complex configuration emerges. Organizational aspects intertwine with issues of decentralization, localization and technological innovation on the one hand, and the need to ensure benefits and strengthen social cohesion on the other.

With the aim of conducting a comparison between two national contexts about how they are dealing with RECs' implementation, this paper carries out a 'comparative gesture' (Robinson 2011; De Vidovich and Tzaninis 2023) between Germany and Italy, i.e. an exercise in the comparison of two different contexts based upon theoretically rigorous foundations. The paper aims to analyse the 'conditions of systematic change' (Sovacool et al. 2018) for RECs' implementation in Germany and Italy, relying on existing literature to depict the main differences between the two contexts, and looking at the enabling frameworks for RECs' development at the national level. Specifically, the paper focuses on regulatory and organizational frameworks on the one hand, and on the organizational forms behind community energy in the two countries on the other, distinguishing between a consolidated case of cooperative models (Germany) and a less consolidated case of community energy setting, influenced by the recently introduced RECs (Italy). These two points are key to understanding the systematic change of each national energy system, but also to looking at the main differences of the community energy system between the two countries.

On the theoretical side, the paper employs an analysis of the socio-technical implications of community energy, i.e. looking beyond technological determinism, embracing critical standpoints that social sciences bring to the debate, having long being marginalized by energy research (Sovacool et al. 2015). The paper adopts the multi-level perspective (MLP) (Geels 2002) to frame RECs as organizational innovations ('niches') within the socio-technical energy system. This system is shaped by national and European regulations designed to support community energy (the 'regime' in the MLP framework) and is influenced by a long-term trend ('landscape') driving a transition in the energy system.

To carry out this analysis, the main research question behind the paper can be identified as follows: considering a comparison between Germany and Italy, what are the main conditions of systematic change towards an energy system that embeds community-based energy initiatives in the two countries? What are the main differences between Germany and Italy in this regard? The choice of focusing on Germany and Italy is due to the gap in the advancement of community energy scenario between the two countries, as Germany results are more consolidated in this field, unfolding key conditions for a diffusion of renewable community energy projects. In particular, the paper will discuss how Germany employs established organizational structures and national legislations to support the broad field of "community energy" on the one hand, whereas Italy has put many efforts into a swift reception of the European legislation on RECs. The analysis will demonstrate how conditions for energy transition encouraged by community energy initiatives are quite diverse among Member States, as in the case of Germany and Italy. Both countries are devoting attention to the niche of community energy and the innovations they bring to the energy system. However, the organizational setup and the conditions for a systemic socio-technical change differ and such differences affect the whole landscape of energy transition.

To answer these questions and dive into the differences between Germany and Italy, the paper is structured with the following sequence: Section 2 is dedicated to the theoretical outline of RECs as new organizations, or rather, 'niches', in the socio-technical energy system. The choice falls on this framework due to its capacity to theoretically observe pathways of sustainable energy transition (Geels 2010; Bellamy et al. 2022). A twofold analysis is carried out: a brief presentation of RECs in the European framework (section 2.1) and a conceptualization of RECs in the socio-technical system (section 2.2). In section 3, methodological tools to set the stage for

the comparison between Germany and Italy are presented as follows: the concept of 'comparative gesture' is briefly introduced (section 3.1) and then, as a justification of the analysis, the focus is on the positioning of the paper in the research on community energy through social sciences (section 3.2). In section 4, renewable energy systems in Germany and Italy, as well as the main differences between the two contexts, are presented, whereas in section 5 the differences in the enabling frameworks for RECs are discussed. Against this background, the comparative exercise should not be seen as the result of a dense empirical study, but rather as an exploratory activity aimed at discussing synergies and differences in REC regulations at the EU level, by also providing insights into how two Member States have advanced in this area in recent years.

2. RECs and the energy transition

2.1. RECs in the European framework

In Europe, RECs are aligned with the climate neutrality and decarbonization targets initially identified in the Paris Agreements, which were adopted at the twenty-first UN Climate Change Conference (COP 21). These targets were subsequently reinforced by the European Green Deal, which aims to achieve a low-carbon society by 2050. To achieve the decarbonization objectives, the EU overhauled its energy policy framework in 2016 with the publication of the "Clean Energy for all Europeans Package" (CEP)[1], which came into force in 2019. This package consists of eight new laws introducing legislative measures across various sectors, including energy performance in buildings, renewable energy, energy efficiency and the electricity market (Esposito et al. 2024). Two of these directives are pivotal in terms of the role of end-users in the transition process: Directive 2018/200 (RED II) focuses on promoting the use of energy from RESs and introduces renewable energy self-consumers and RECs. Directive 2019/944, the International Market Energy Directive (IEMD), establishes common rules for the internal electric energy market and introduces Citizen Energy Communities (CECs) that, differently from RECs, do not present membership restrictions or geographical constraints (Neska and Kowalska-Pyzalska 2022). Put

1 EU Clean Energy for All Europeans Package: https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en

simply, local production of renewable energy through community energy initiatives has recently experienced an upswing especially thanks to the EU Clean Energy Package, where RECs are introduced juridically as formal actors (Envall et al. 2023). The RED II defines RECs as legal entities that are based upon open and voluntary participation, controlled by shareholders (which can be natural persons, small-to-medium enterprises or local authorities) located in the proximity of the renewable energy projects owned by that legal entity.

In general, understanding factors behind community renewable energy historically revolve around issues of process (who the project is by) and outcomes (who is the project for) (Walker and Devine-Wright 2008). RECs are founded on three main principles, i.e. localization, decentralization and decarbonization of renewable energy (co)production, and their development and implementation is aimed at ensuring environmental, social and economic benefits for those participating in these initiatives (De Vidovich et al. 2023). In organizational terms, RECs are organizations managed by actors from civil society (including citizens, but also industries) that enable a collective procurement of renewable energy for their members (see Boon and Dieperink 2014).

From a technical standpoint, the concept of 'prosumerism' serves as a forerunner in describing a model in which end-users act as both producers and consumers of their own energy services (Campos and Marín-González 2020; Gržanić et al. 2022). Consequently, it has evolved into a descriptive term that highlights the active role of citizens and their empowerment in the energy system.

Social sciences are currently devoting particular attention to the organizational aspects behind the development of these initiatives, to observe the ways in which social benefits are ensured next to environmental and economic benefits, but also to identify the innovations they bring both to consumption patterns as well as the energy system. Environmental benefits result directly from low-carbon energy co-production sharing and consumption by RECs' members, whereas economic benefits are related to the possibility of receiving incentives on shared energy produced by power plants owned by the RECs and to more economically efficient energy behaviour through self-consumption settings. Social benefits are firstly given – or rather, foreseen – by the capacity to strengthen social cohesion in local communities (De Vidovich 2024a), although the link between social cohesion and RECs might be influenced by environmentalist ideologies that see these projects from an acritical optimistic viewpoint (Huybrechts

and Mertens 2014). Indeed, there is a risk of perceiving RECs merely as community-oriented energy projects that serve as alternatives within an unchanged energy system, rather than as experiments aimed at transforming that system through new organizational arrangements.

Since RECs may accelerate the socio-technical transition to a low-carbon society (Boyle et al. 2021), this transition is expected to be fair, just and transformative of the existing energy regime. It builds on the three key principles underpinning RECs – localization, decentralization, and decarbonization – while ensuring a system of benefits that are social, environmental and economic. To address these issues, considerable emphasis has been placed on the 'organizational innovations' introduced by RECs, which involve agreements among various actors for the co-production and sharing of renewable energy, as well as the new institutional and socio-technical frameworks they require (Dóci et al. 2015).

2.2. RECs in the socio-technical energy system

By linking the broad concept of 'community energy' and the specific concept of REC to the notion of innovation, theoretical insights from organizational studies are valuable in revealing the complex relationship between social and technical inputs (Sovacool et al. 2020). The concept of 'community energy' seen as a component of a socio-technical system is not new (Pinker et al. 2020; Shove et al. 2015; Walker and Cass 2007). Community energy projects involve potential mechanisms for accelerating the socio-technical transition to a low-carbon society (Boyle et al. 2021), as the interaction between technologies and social groups to co-produce, share and consume renewable energy unveils a socio-technical framework that can drive low-carbon transition (Geels et al. 2017). On this basis, socio-technical transitions can be described through the 'multi-level perspective' (MLP) (Geels 2002) as the result of an interaction between innovations (the 'niche'), structure (i.e. the existing system) and exogenous long-term trends (the 'landscape'), which jointly enable a transformative change (Grin et al. 2010). Here, the innovations correspond ontologically to community energy projects, not because they are innovative per se, but because these projects (and in turn RECs) introduce new organizational models for exploiting renewable energy sources, which inevitably transform the existing energy system, i.e. the existing 'regime'. On this basis, RECs represent niches constituted by "networks of local experimentation, facilitated and

coordinated by an intermediary infrastructure of shared knowledge, guidance and resource provision [...] through workable knowledge taken up by an increasing number and variety of actors, which becomes increasingly standardized and institutionalized" (Smith et al. 2016, p. 411). As stated by Frank W. Geels and Johan Schot (2007), transitions emerge when niche innovations gain internal momentum, when landscape-level changes exert pressure on the prevailing regime, and when regime destabilization elevates niche innovations. On this conceptual basis, RECs can be better interpreted as socio-technical 'niches' of an energy system that steadily but increasingly embeds diversified community energy initiatives (Arentsen and Bellekom 2014; Smith et al. 2016). As 'niches', RECs are seen as innovations that bring new organizational inputs in the existing energy system (the 'regime'), with the aim of contributing to sustainability aims and decarbonization, and to make the energy system low-carbon and more democratic. In fact, community energy projects have also been observed as 'movements' aimed at 'democratizing' renewable energy consumption by giving an active role to end-users next to incumbencies (Burke and Stephens 2018; van der Schoor et al. 2024).

Based on these assumptions, the paper uses the multi-level perspective (MLP) to conceptualize RECs as organizational innovations ('niches') within the socio-technical energy system, governed by national and European regulations that aim to promote community energy (representing the 'regime' in the MLP framework), and is influenced by long-term trends ('landscape') driving the transformation of the energy system towards the embodiment of RECs and community energy initiatives.

The recognition of Renewable Energy Communities (RECs) as a specialized component within the broader socio-technical energy landscape is also focused on addressing theoretical debates with key perspectives from social sciences, an area that appears to be underrepresented in the comprehensive analysis (Pellizzoni 2018). In so doing, the deployment of MLP enables the disclosure of ways in which community energy initiatives (and in turn RECs) may contribute to transforming the existing regime, bringing new organizational models, as well as benefits in the environmental, social and economic spheres for the end-users. However, benefits and innovations of RECs should not be seen uncritically. RECs are today characterized by a fragmentary nature, also due to the condition of 'niche'. This means that RECs are not consolidated models that are effectively transforming the energy system, but emerging initiatives that steer a systematic change in renewable energy co-production, sharing and consumption, in addition, the

benefits they provide are categorized into three main areas: environmental benefits (sustainable and low-carbon energy use), economic benefits (energy savings) and social benefits (community engagement through shared renewable energy). However, the effective realization of these benefits remains unclear (Scotti 2024).

Therefore, some caveats are to be considered "in a situation in which niches, regimes and landscapes – every kind of bordered field – tend to be rigid and not communicating, even if shared by many people" (Osti 2024, p. 162). Scaling-up these niches is anything but easy (Bauwens et al. 2020; van Doren et al. 2018), as the capacity of RECs to transform the existing regime of renewable energy (co)production faces socio-technical constraints (Carrosio and Magnani 2024). When new 'unconventional' organizations remain in a niche, they may miss opportunities to shape the existing regime (see Besio et al. 2022). Nonetheless, the diffusion of innovations in renewable energy (see Blasutig 2017) is today fueled by RECs, as they potentially innovate the socio-technical energy system, bringing new social practices and new socio-technical inputs (De Vidovich 2024b). Prior to undertaking the comparison between Germany and Italy, it would be beneficial to further navigate in the existing literature to gain a comprehensive understanding of the distinctions between the two national contexts as previously elucidated by other scholars. This activity would facilitate the description of the German cutting-edge community energy scenario. Before doing this, a note on methods behind the comparison is presented.

3. Notes on method

The paper draws on an extensive body of literature on community energy, examining both the regulatory framework and the current state of play of RECs' implementation in Germany and Italy. Therefore, the paper does not report and discuss empirical findings, but rather advances a discussion based on existing literature and a particular form of 'desk comparison'. However, some elucidations about the methodological line drawn in this paper are needed, navigating on a dual track: the use of the specific method for the paper's purpose, identified with a 'comparative gesture' (a term borrowed from urban studies) for the twofold analysis between Germany and Italy on the one hand, and the configuration of the paper among the corpus of knowledge pertaining to the usage of social sciences in the field of energy on the other.

3.1. The methodological tool: a comparative gesture

Relying on concepts taken from urban studies, the paper employs a 'comparative gesture' (Robinson 2011), which means addressing diversities between two or more cases working with concepts, comparative tactics and theoretical components (Robinson 2016). This approach stems from the incommensurability of the different kinds of contexts, be they cities, regions or other contexts. The comparative gesture does not stress the differences between two cases in a 'planar' dimension (Peck 2015), but deals with differences looking at the conjunctural and relational aspects that enable the definition of a theoretical outline (see also De Vidovich and Tzaninis 2023). Therefore, the comparative gesture is theoretically drawn on Jennifer Robinson's call for a reinvigoration of an international 'comparativism' (Robinson 2011), to make an interaction between different aspects – such as those related to REC analysis – in view of an inevitable 'locatedness' of theory-building (Pickvance 1986). In this view, comparative gestures also act as a strategy that "seeks to unsettle and destabilize knowledge and theory as it is produced, and that seeks to reconstruct and develop new lines of inquiry" (McFarlane 2010, p. 738). The comparative goal is aimed at mobilizing the locatedness of the study of community energy's development and implementation, embodied by the need to simultaneously look at the international scenario on the one hand – related to the European recommendations on RECs, in this case – and at the domestic context on the other hand, outlined by national laws, decision-making processes, intermediary actors of community energy landscape and by the technical features of each national energy system. As it will be demonstrated, there are many differences between Germany and Italy in this regard.

A comparative gesture differs from a rigorous comparison based on case studies in that it lacks a detailed examination of one or more aspects common to both cases, does not involve thorough assessments or analyses using qualitative research tools and prioritizes promoting conceptual and theoretical innovation over empirical discoveries (while recognizing their relevance). Whether it relies on first-hand materials collected via empirical activities or on existing literature and information about two cases (as in the case of the countries dealing with new experimentation of community energy), a comparative gesture does not necessarily produce new findings, but rather works on a theoretically informed framework to better systemize existing knowledge on a specific theme, identified with community energy and RECs, in this regard. In other words, comparative gestures embody a

descriptive aim with the attempt to "systematically analyze and categorize other events, past and present that provided social stress of similar type and similar scale" (Rochlin 2014, p. 180). For the purposes of this paper, the 'event' is the increasing relevance attributed to RECs in democratizing low-carbon energy transition, the 'social stress' is related to the emerging socio-technical landscape of RECs and the scale is the national one, unfolding novel insights comparing the framework for REC implementation in two different countries.

3.2. The comparison: unfolding the conditions of socio-technical change

Nevertheless, comparative gestures alone provide limited insight into methodological approaches when without contextualization within the broader field of 'energy social science'(see Sovacool 2014; Ryan et al. 2014; Sovacool et al. 2015). The tie between research on energy and social science has been particularly strengthened over the past decade, overcoming the common underutilization and undervaluation of social sciences in the energy field (Sovacool 2014; Spreng 2014). Besides, the increasing cultivation of interdisciplinary knowledge on energy has enabled scholars, decision-makers, practitioners and policymakers to perceive the social and technical dimensions of energy production, consumption and policy (Wallenborn and Wilhite 2014), and in particular to realize that a future energy system that is low-carbon, safe and reliable will require fuller and more meaningful collaboration between the physical and social sciences (Sovacool et al. 2015). How humans behave facing technologies and transformations of the ways they access and consume energy is a pivotal issue that attributes a key role to social sciences (Shove and Walker 2010; Shove and Spurling 2013), as "without […] social science input, applied energy researchers can only guess at the human behaviors that drive current decision-making and will inform selection, adoption, and continued use of new technologies" (Sovacool et al. 2015, p. 97). Multidisciplinary research on the field of RECs is already growing (Barabino et al. 2023), along with the utilization of different theoretical frameworks to observe sociotechnical change in energy transition (Sovacool and Hess 2017). Against this background, further reflections on the epistemological underpinnings of socio-technical perspectives have identified the 'conditions of systematic' change among the pillars for interdisciplinary energy research (Sovacool et al. 2020). These conditions include both endogenous socio-technical system factors and

broader societal, political and institutional factors (Sovacool et al. 2020). The focus on these conditions entails a comparison aimed at unfolding the main conditions under which the socio-technical transformations of the energy system led by RECs are framed at a national level via enabling frameworks.

Related to RECs, the analysis delves into the conditions for supporting and accelerating REC implementation – and whether these conditions are influenced by existing knowledge and consolidated experiences of community energy – and the societal embedding of innovations, i.e. how end-users, also through the role of intermediaries, are familiarizing themselves with, embracing or – in the best case – participating in these new experimentations, contributing to systematic change. In this paper, the focus is limited to the current national scenario without deepening local or regional best practices. This is not only for the sake of brevity, but also to provide a discussion on national energy policies facing decarbonization and new community energy models, with the intention of exploring 'socio-technical imaginaries' of the social dimension of energy transition, which are strongly determined by national policies (Jasanoff and Kim 2013). To sum up, the object of the twofold analysis of the conditions for systematic change in community energy systems of Germany and Italy are identified as follows: (1) characteristics of the state of play in the energy mix, looking at how the system currently relies on renewable energy; (2) an enabling scheme for the implementation of Renewable Energy Communities (RECs), according to the definition of RECs provided by the EU, and the most recent updates disciplined by the EU Directives RED II and IEM.

However, this focus is not sufficient to provide a comprehensive overview of the two contexts. Instead, it represents the outcome of a comparative exercise aimed at drawing an initial outline of socio-technical change for community energy in the two selected countries. Before conducting the comparison, it is useful to briefly delve into the literature on community energy in Germany and Italy. The comparison of the two contexts is based upon desk research with data retrieved from IRENA (International Renewable Energy Agency) and 'Our World in Data'.

4. The comparative gesture: community energy in Germany and Italy

4.1. Community energy in Germany

Through the *Energiewende* (energy turnaround), Germany aims to achieve a climate-neutral energy system by 2045, with a new planned target of 65 % renewable electricity by 2030, with the twofold goal of a comprehensive transformation of the energy supply system and its regulation, and an active engagement of citizens in energy co-production.

As many have pointed out, Germany currently has the highest number of energy communities in Europe, in diversified forms (Esposito et al. 2024; Hewitt et al. 2019). This is thanks to the Renewable Energy Act (*Erneuerbare-Energien-Gesetz*)[2], which introduced incentive tariffs for renewable energy generation for 20 years, with several updates over the years (the latest being until 2023)[3]. In Germany, citizens, SMEs (small-to-medium enterprises) or cooperatives which own renewable energy assets are considered RECs and are eligible for incentives or loans (Haji Bashi et al. 2023). Based on this well-defined groundwork, various community-led and renewable energy cooperative models have emerged over the past two decades in Germany, prior to the definition and ongoing affirmation of RECs as identified by the European Commission (Herbes et al. 2021; Kalkbrenner 2019; Kalkbrenner and Roosen 2016; Yildiz et al. 2015). The most paradigmatic example of the cutting-edge framework of community energy in Germany is that of renewable energy 'cooperatives', a traditional setting – both in Germany and (Alpine) Italy – which has acted as a vehicle for investing jointly in infrastructure for rural electrification especially since the early 20th century (see also Holstenkamp und Müller 2013), as well as increasing the social acceptance of renewable energy technologies (Punt et al. 2022). Government adoption of a feed-in tariff scheme[4] to support the installation of renewable energy technologies was a watershed in the affirmation

2 *Bundesministerium für Wirtschaft und Klimaschutz, Das Erneuerbare-Energien-Gesetz,* introduced in 2000: https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html.

3 Further info about the Renewable Energy Act *('Erneuerbare Energien Gesetz')* in Germany (2023): https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/amendment-of-the-renewables-act-2060448, https://ec.europa.eu/commission/presscorner/detail/PL/ip_22_7794

4 Feed-in tariffs are a policy mechanism aimed at speeding up investment in renewable energy technologies by providing long-term agreements to renewable energy (co)producers.

of a community energy movement (Brummer 2018; Romero-Rubio and de Andrés Díaz 2015). Overall, the dominant field of community energy (*Bürgerenergie*) in Germany can be linked to cooperative models including ownership shares (Radtke and Bohn 2023) and it can be argued that this field strongly contributes not only to the definition of alternative models able to challenge the existing energy pattern of energy supply (Fuchs and Hinderer 2014), but also to the installed capacity of renewable energy in the country. Studies in this field accounts for more than 800 energy cooperatives across Germany (about 34 % of the citizenship) (Yildiz 2014).

In 2020 – the year when the share of intermittent renewable energy sources in German electricity generation rose to 50.5 % (Halbrügge et al. 2022) – a total of 118.3 GW (gigawatts)[5] was installed by owner groups, of which the majority (30.2 % of the total) was from private citizens, followed by project developers (14.2 %) fund/banks (14.1 %), business entities (13.2 %), and to a lower extent by other groups (farmers, energy utilities, and energy utilities). Overall, with 847 community energy schemes, Germany presents the largest number of community-led initiatives in Europe (mostly based on solar energy), followed by the Netherlands, Denmark and United Kingdom (Koltunov et al. 2023).

Given the increasing share of renewable energy in total electricity generation and the establishment of well-developed energy communities – where cooperatives contribute approximately 3.5 % to the country's renewable energy production – Germany has emerged as a key example of community energy. Energy cooperatives – thanks to their 'unconventional' organizational forms – contributed to the construction of a novel, decentralized infrastructure of energy supply centered on renewable energy sources, sharing values related to social inclusion behind energy co-production, and placing sustainability at the core of their models (Besio et al. 2022).

Literature about the German context began to inform European scholars and decision-makers on many societal aspects behind community energy, such as the limited participation of certain groups (women and younger people) in community energy and, as a consequence, the lack of inclusiveness (Radtke and Ohlhorst 2021). As illustrated by a survey among 113 German energy community schemes, the capacity to reach vulnerable households and involve them in RECs and similar initiatives is limited to a few cases, due to the absence of specific regulatory support, unawareness of

5 Without considering pumped storage, offshore wind, geothermal and biogenic share of waste.

the importance of involving vulnerable groups and making community-led initiatives accessible for all, along with limited resources (Hanke and Guyet 2023). This echoes the debate about the (currently limited) capacity of RECs to deliver energy justice addressing the energy needs of underrepresented and vulnerable populations (Hanke et al. 2021; Standal et al. 2023).

Conversely, the topic of motivations behind the involvement in community-led renewable energy initiatives has been largely investigated for the expectation of receiving returns on investment, the goal of securing a localized energy supply from own sources, the ambition to contribute to decarbonization in the light of climate targets and national energy transition aims, and the desire to participate in the co-production of electricity (and even heat) by being a member of a local community (Holstenkamp and Kahla 2016). In addition, studies of German cases suggest that success conditions for renewable community energy projects are also identified at a sub-national and municipal level when public administrations strongly support such initiatives (Martens 2022; Meister et al. 2020; Schmid et al. 2020), as well as in the integration of decarbonization aims and rural development (Li et al. 2013; Mahzouni 2019). This brief background information indicates that Germany probably has one of the largest community energy sectors in Europe and worldwide, although the current changes in community-led renewable energy projects leading to RECs as a new model raise some novel issues (Holstenkamp 2021). According to the consolidation of community energy in the German energy system, the role of RECs is currently secondary. From 2017, an amendment to the Renewable Energy Source Act not only established the gradual phasing out of the feed-in tariff, but also introduced so-called "citizens' energy companies" (*Bürgerenergiegesellschaften*) (Grignani et al. 2021) prior to the new EU framework for RECs. Yet the transposition of Directive RED has been conducted via Federal Law 574/2021, but the national government has not (yet) used the Clean Energy Package as a window of opportunity, as in other countries with less strong community energy heritage, to foster or revitalise Germany's stagnating community energy sector – despite or due to being a community energy front-runner (Holstenkamp 2021).

4.2. Community energy in Italy

While Germany has been engaged in disseminating information about the significance of community energy to other member states for decades,

particularly through the examination of numerous, well-established cooperative models, the Italian context has a disparate historical trajectory. Today, Italy benefits from a well-defined regulatory framework specifically targeted for RECs, which has been promulgated and updated over recent years. Between the end of 2019 and 2020, the transposition process of RED II regarding RECs and collective consumption schemes took place through Art. 42 bis of Decree Law *Milleproroghe* 162/2019, then converted into Law 8/2020. Then, some updates were introduced with Legislative Decree No. 199/2021, which came into force in December 2021. This decree outlines the specific rules governing RECs, including technical and legal requirements for their formation and operation. In 2022, the long procedure to formally implement the new measurements culminated with new documentation from ARERA (the Italian Energy Authority), released on 27 December 2022 (*TIAD—Testo Integrato Autoconsumo Diffuso*, Resolution 727/2022/R/eel). Ultimately, between late 2023 and 2024 the Italian Minister of the Environment and Energy Security presented a new decree on shared energy and community energy projects and self-consumption schemes, defining three new main criteria: (1) a new system of incentives for shared energy in the power grid according to the dimension of the plant; (2) the allocation of non-refundable financial contributions to small municipalities identified within the post-pandemic National Recovery and Resilience Plan (NRRP); and (3) the maximum power that can be financed (De Vidovich 2024c). Translated into action, the Italian framework is currently characterized by three main regulatory aspects: (1) the Italian government provides several incentives to encourage the creation of RECs: the Italian Energy Authority (ARERA) offers feed-in tariffs and other forms of financial support for the energy produced and consumed within RECs (including premium tariffs for energy shared within the community and reduced fees for grid access); (2) a specific administrative procedure defined by the pertinent Minister includes procedures of (allegedly) simplified licensing and grid connection; (3) the government provides tax breaks for the installation of renewable energy infrastructure, such as solar panels, which benefit REC members. In addition to the national legislation, the institutionalization of energy communities in the Italian context has generated the development of several regional laws to promote self-consumption and REC schemes.

Although it has been slow to come into force, this new framework suggests that the literature on community energy in Italy is quite recent, and this is indeed the case. In fairness, localized initiatives of energy communities began to appear in the Alpine areas of the country at the end of the

1800s, to self-supply remote areas and satisfy their emerging energy needs by using local resources and creating rural electrification cooperatives. Nonetheless, the relevance of the topic is recent, as from the 2000s community energy models began emerging as new paradigms of people's engagement in the energy transition to renewable energy production (Candelise and Ruggieri 2020). Italian cooperative projects created in the early 2000s have been largely analyzed as models able to foster social engagement through the co-production and co-provision of renewable energy (Barroco Fontes Cunha et al. 2021; Tricarico 2021).

Following the transposition of the EU Directives and the subsequent establishment of a new regulatory framework from 2020 onwards, there has been a notable increase in the amount of scholarly attention dedicated to RECs. Recent research outlined three main organizational models of RECs: public lead (mainly driven by public administrations), pluralist (resulting from public-private or citizen-led partnerships), and community-energy building (where intermediary actors ensure the construction of the project) (De Vidovich et al. 2021, 2023). Other investigations demonstrated the technical, economic and energetic sustainability of recently launched RECs (Di Silvestre et al. 2021; Ghiani et al. 2022; Mutani et al. 2021), whereas – in the same field – a key distinction between self-consumption schemes, RECs (Renewable Energy Communities) and CECs (Citizens Energy Communities) (for this twofold difference, see also Bielig et al. 2022), has been made by also providing an overview of the recent regional updates (Barbaro et al. 2024). Regions are considered a key target of analysis, as they enable the disclosure of how Italian local authorities encourage or hamper the implementation of RECs (Bonifazi et al. 2022). Also, using Actor-Network Theory, one study focused on case studies of pluralist models based on the alliances among different actors, such as professionals, institutions, NGOs, and citizens (Musolino et al. 2023). Furthermore, as discussed in Section 2.2, several critical reflections from the academic field of social sciences addressed the 'effectiveness' of social implications behind RECs (Carrosio and Magnani 2024; Magnani 2021; Scotti 2024). Ultimately, Italy is in general an insightful context for looking at the organizational forms of RECs in the light of the most recent EU guidelines.

Despite this increasing attention, the emerging scenario is that of an encouraging field that is still a 'niche' of the Italian energy system (De Vidovich 2024c). The delay in publishing this regulation and the financial support mechanisms for RECs through 2022 have also delayed the publication of NRRP calls for supporting and stimulating the development of

RECs in Italy and, as a result, the deployment of large-scale RECs in Italy has been hindered (Tatti et al. 2023). In terms of numbers, without considering cooperative models non-compliant with the current framework, the second *Rapporto semestrale Energia e Clima* published by *GSE* (*Gestore Servizi Energetici*, national energy services manager*)* in 2024 accounts for 35 RECs and 74 self-consumption schemes counted halfway through 2023 (a total of 104 configurations). Another mapping carried out by *RSE S.p.A.* (*Ricerca Sistema Energetico*) counts 293 RECs (between RECs under development and those already enacted) in eight regions (Valle d'Aosta, Piedmont, Lombardy, Trentino-Alto Adige, Friuli Venezia Giulia, Emilia-Romagna, Calabria, Sicily) (Cilio et al. 2024). In 2025 these figures have significantly increased. However, they establish a first difference to the German context.

4.3. Introducing the gap: differences in community energy between Germany and Italy

The figures in question are considerably lower than those observed in the German cooperative models (more than 800 projects), albeit the comparison is inappropriate, as it considers energy cooperatives on the one hand and RECs on the other. Clarification is needed in this regard. What is identified as an 'energy cooperative' in Italy is far different from the widespread German model, as it refers to players in the Italian energy supply system, i.e. energy (co)providers of renewable energy, which can contribute to the co-creation of RECs (acting as intermediary actors), but – due to legal requirements – cannot create a REC alone. In other words, energy cooperatives and RECs belong to different business and regulatory models in Italy, making the Italian framework of community energy more fragmented and less consolidated compared to the German one. Therefore, a notable disparity emerges at first glance when comparing the community energy settings in Germany and Italy. Before going into the comparison, it has to be noted that the transposition of RED II is underway in most Member States, but the indications from the 'Clean Energy Package' allowed for significant interpretative flexibility, giving each Member State the autonomy to decide how the key aspects of the transposition process should be addressed (Frieden et al. 2021). Hence, REC frameworks vary widely depending on geographic, cultural, economic and political factors across the EU (Tatti et al. 2023). The manifold papers that provided comparisons of REC advancement among Member States are helpful to reveal the main

differentiations between Germany and Italy, given that community energy niches intrinsically have different forms.

To comprehend how these niches take shape, considerations about the 'regime' (regulatory frameworks) are useful to grasp different trajectories in the regulation of community energy initiatives. As suggested in a review of the different implementation schemes among Member States, a key difference between Germany and Italy is the very identification of RECs within the energy system. Whilst in Germany, citizens, SMEs or cooperatives which own renewable energy assets are considered RECs and are eligible for incentives or loans (Esposito et al. 2024), in Italy RECs are identified with the regulatory framework enacted between 2020 and 2023 meaning new projects face specific criteria: the members have to be linked to the same primary electrical substation HV/MV, from high voltage (HV) to medium voltage (MV); a REC can be created by citizens, public administrations, third-sector actors, research or religious bodies; finally, RECs technically observe the guidelines of the ARERA's Integrated Text Widespread Self-Consumption (*TIAD*) and *GSE*'s rules. This comparison indicates that in Germany RECs are a piece of a large puzzle of different community energy settings (where energy cooperatives are predominant), whereas in Italy they are subject to exacting recently introduced regulatory requirements that strongly distinguish them from existing cooperative cases created before the transposition of EU Directives.

In addition, a key difference is about the role of municipalities. As argued by Anfinson et al. (2023, p. 4), "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.". In Italy, similar cases are limited to Alpine public cooperatives in small rural areas.

Therefore, the comparative gesture suggests that in Germany the awareness, knowledge and modalities of community energy are not limited to RECs but are consolidated on models existing before the EU Directives RED II and IEM. Conversely, in Italy the arrival of RECs on the public scene invigorated a debate that until that moment was predominantly limited to some best practices of cooperative models in two ways: on the local scale of self-production and consumption (as for the case of Alpine regions), on forms of 'prosumerism' thanks to renewable power-plant ownership (usually identified with photovoltaic panels) that enabled benefits from incentive tariffs, and on effective cooperatives aimed at transforming

the energy market selling renewable energy from targeted power plants and developing community engagement through energy cooperative models, as for the case of 'ènostra', for instance (Dudka and Magnani 2024).

Moreover, there is the issue of how RECs are effectively involved in the energy system. As discussed at the end of the overview of Germany, the national government did not take the opportunity of REC to reinvigorate the community energy sector in the country (Holstenkamp 2021), whereas – on the contrary – this was the case of Italy, which dedicated particular attention to slowly defining a regulatory framework able to embed RECs in the energy system, although this has not yet occurred.

These differentiations run between concepts (from renewable energy communities to energy cooperatives), transpositions of the EU guidelines and the presence of past experimentations in both contexts. In doing so, they enable the stage to be set for a final discussion about the supporting schemes of RECs in the two countries.

5. Final discussion

Given the gaps in terms of community energy settings between Germany and Italy, the discussion of two cases – as indicated in the Introduction – is aimed at addressing two main aspects, leading also back to the theoretical framework: (1) the features of the state of play in the energy mix, looking at how the system currently relies on low-carbon energy; (2) the current enabling scheme for the implementation of Renewable Energy Communities (RECs) according to EU Directives. This twofold aspect reconnects the analysis to the multi-level perspective (MLP), as it reconstructs the interplay between niches (community energy projects, and RECs especially), regime (the regulatory framework of the community energy setting) and landscape (long-term trends towards community energy). This makes it possible to depict some key considerations about the ways RECs can produce the conditions of a "systematic change", as defined by Sovacool et al. (2018).

Regarding the state of play towards decarbonization, the comparison of the two energy mixes relies on the 'energy profiles' from IRENA (International Renewable Energy Agency), mentioning – among the topics considered by IRENA – the Total Energy Supply (TES) and the renewable energy consumption on Total Final Energy Consumption (TFEC). Data are dated back to 2021. This is due to two factors: first, the availability of

the same energy profile for both countries using the same data source, and the possibility to look at the two energy systems before the energy shocks caused by the Russian invasion of Ukraine, and at a time of transposition of the EU Directives. Total Energy Supply for Germany and Italy is indicated in Table 5.1.

The table unfolds a situation where the energy supply from renewables is higher in Germany rather than Italy, but the renewable share is slightly higher in Italy. However, the comparison of TESs should also consider the dimension and the number of inhabitants of the two countries. In absolute terms, Germany needs more energy than Italy, since it is larger (in square meters) and more populated. Considering the growth of renewable energy in TES, Germany performed better than Italy from 2020 to 2021. In fact, Italy recorded a -1.2 % fall in renewable energy on TES, in contrast to Germany, where the share of renewables in total energy supply increased by 5.2 %.

	Germany (2021)	Italy (2021)
Total Energy Supply (TES)		
Non-renewable (TJ – terajoule)	10.198.032	5.048.243
Renewable (TJ)	1.916.559	1.145.275
Total (%)	12.114.591	6.193.518
Renewable share (%)	16	18
Growth in TES (2020–21)		
Non-renewable (%)	+4.3	+10.2
Renewable (%)	+5.2	-1.2

Table 5.1: Total Energy Supply in Germany and Italy, 2021. Source: IRENA

Looking at the long-term trend of energy production from low-carbon sources (including nuclear energy and renewables, i.e. solar, wind, hydropower, biomass and waste, geothermal and tidal), it can be seen that Germany has historically produced more renewable energy than Italy, and in this respect the role of energy cooperatives cannot be ignored, as they contribute to the 3.5 % of renewable energy production (data related to the year 2021, as introduced in Section 4.1).

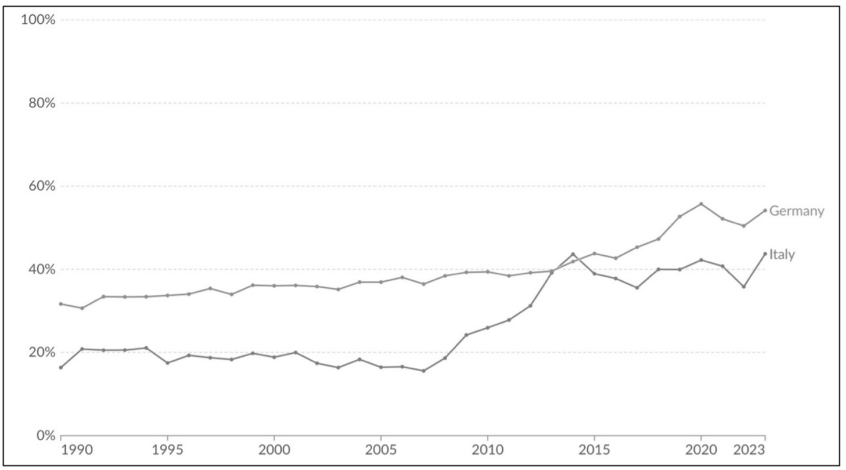

Figure 5.1: Share of electricity generated by low-carbon sources in Germany and Italy (1990–2023). Source: Our World in Data (CC BY) based on Ember (2024) and Energy Institute – Statistical Review of World Energy (2024).

The trends from 1990 to 2023 in the share of electricity generated from low-carbon sources for both Germany and Italy are shown in Figure 5.1, which illustrates how the energy system in Germany is much more supported by renewable and low-CO_2 energy. In 2023, this share reached 54.14 % of the total energy supply in Germany, whereas it was 43.72 % in Italy. These figures usefully illustrate that the differences of the energy 'landscape' between the two countries are evident enough to state that Germany presents a more advanced and mature energy system as regards the inclusion of renewable sources in electricity production. This is also legitimized by the aggregate contribution of energy community projects related to solar energy in the two countries. As demonstrated by Wierling et al. (2021), in 2021 community energy amounted to 600- 838 MWp (peak mega-watt) of the installed photovoltaic capacity in Germany (1.2 – 1.7 %), and 10.6 MWp of the installed capacity in Italy (0.07 %). The difference is striking.

Against this background and considering the advanced community energy setting in Germany (thanks to energy cooperatives), it is worth asking whether the situation is similar when it comes to the implementation of RECs according to the European Commission's guidelines. Recent insights suggest that although community energy development is more advanced in

Germany, the implementation of the RED II has been slow and fragmented, whereas in Italy RED II played a key role, as the transposition has been quite dynamic and encouraged a continuous growth of REC initiatives (Krug et al. 2022). Yet, RECs today still play the role of experimentations that are not fully embedded in the Italian energy system (De Vidovich 2024c). In fact, Krug et al. (2022) maintain that, for a broader adoption of RECs, both countries need structural adjustments in their governance systems, focusing specifically on multi-level governance and vertical policy coordination.

On this basis, the 'transposition tracker' provided by REScoop.eu (the European federation of citizen energy cooperatives)[6] to monitor the advancements in RECs' enabling framework and supporting scheme among Member States on the one hand, and on the other the definition of RECs (as well as that of CECs, Citizens Energy Communities, which is not considered in this paper) in the light of the EU definition, is helpful to complete the comparison. First, according to the most recent update (dated April 2024) from RESCoop.eu, the renewable support scheme for citizen-led energy initiatives in Germany is supportive and it has updated past frameworks. However, significant gaps remain, particularly in terms of the general expansion of an enabling framework, along with a regulatory framework that allows for RECs to share energy. Second, Germany has only transposed the EU's REC definition through changes that have been made to the existing 'citizen energy company' definition under the Renewable Energy Act 2022, and the national rules that apply for cooperatives in general under the Cooperatives act also still apply.

As regards Italy[7], the RECs definition introduced between 2020 and 2021 refers to most of the criteria contained in the RED II, including autonomy and effective control, which were not touched upon in previous legislation. In addition, RESCoop.eu underlines that the REC definition in Italy promotes inclusiveness by mentioning the need to ensure participation is open to low-income or vulnerable households (although it is not specified how to achieve this aim). Besides, the transposition of the enabling framework for RECs is progressed and there are specific measures for RECs introduced in the national support scheme for renewables. However, an assessment of

6 "Transposition tracker" by REScoop.eu, Germany: https://www.rescoop.eu/policy/transposition-tracker/rec-cec-definitions/germany-rec-cec-definitions

7 "Transposition tracker" by REScoop.eu, Italy: https://www.rescoop.eu/policy/transposition-tracker/enabling-frameworks-support-schemes/italy

barriers and potential for the development of energy communities is still missing.

Going back to the main issues to be addressed in this paper, it is now possible to answer the main research question: what are the main conditions of systematic change towards an energy system that embeds community-based energy initiatives in Germany and Italy? It is possible to make out two diverse conditions of "systematic change" (Sovacool et al. 2018) in the community energy settings between Germany and Italy. In the German case, the existence of a consolidated community energy setting nurtured by citizens-led initiatives and cooperative models is already a tangible part of the energy system. However, the current state of play about RECs according to the EU Directives is limited. In the Italian case, community energy is a long-standing but episodic setting that is receiving renewed attention thanks to the recent transposition of EU directives and the definition of RECs (and CECs) at national level, together with a well-defined enabling framework. However, it is not yet clear how this emerging scenario will transform the energy system. In this respect, further insight into the socio-technical implications is needed to determine whether the existing national framework of the community energy system is conducive to effective change.

It could be argued that in Germany, community energy projects – and in particular energy cooperatives – are bringing about a systematic change that is transforming the existing regime that embeds community energy models in the energy system. In this case, RECs can be seen as a niche of a community energy setting that is undergoing a process of upscaling, thus transforming the regime with long-term trends (resulting in a landscape change, as the multi-level perspective suggests). In Italy, the systematic change is encouraged by the steady diffusion of RECs, which bring new organizational models into the existing energy system. However, the 'niche' condition is very visible for any kind of community energy project and especially for RECs, suggesting the need for upscaling processes with the support of intermediary actors (Moss 2009; Hargreaves et al. 2013; Hielscher et al. 2013), considered as key actors for the diffusion of RECs (see also De Vidovich 2024a, 2024b). However, some studies agree with the difficulty of scaling up local community energy initiatives to concretely transform the energy system (Dall'Orsoletta et al. 2022; Petrovics et al. 2022), due to several factors. First, the institutional arrangement of each national energy policy subsystem, for instance, can either constrain or enable community energy projects (Oteman et al. 2014). Second, the increase of social accep-

tance of RECs and similar initiatives requires a reasonable time (Wolsink 2012; Ruggiero et al. 2014; Lagendijk et al. 2021). Third, there are also technical barriers to be considered (Rae et al. 2020; Rahmani et al. 2020). One could argue that the scaling-up of low-carbon initiatives entails protracted processes of institutional change, driven by various contradictions, heterogeneous practices and the social construction of the field. These factors give rise to potential tensions that may impede the consolidation of localized community energy systems (Valta et al. 2022). In a nutshell, the development of RECs not only necessitates the application of technical expertise and know-how, but is also contingent upon the consideration of social and institutional factors, which can contribute to a prolonged development timeline.

6. Concluding remarks

RECs are novel experimentations that – across Europe – are steadily revealing a transformation where end-users are supposed to play an active role in the co-production, sharing and consumption of renewable energy. At national level, energy policy needs to account for the 'social role' of RECs with an enabling framework that enhances equity and support these projects (Hanke et al. 2022). After presenting the definition of the REC provided at EU level and the main features of these novel experiments, this role emerges from the combination of social and technical implications, as revealed by a theoretical framework defined by relying on the Multi-Level Perspective (MLP). In doing so, RECs have been framed as part of a socio-technical framework, viewed as 'niches' fostering a transformation of the existing regime through new organizational models for renewable energy co-production, sharing and consumption. Despite their potential, scaling up these community-led energy projects faces several challenges, including institutional barriers and the need for intermediary actors to support their development and integration into the broader energy system. Against this background, RECs face socio-technical constraints, but are seen as potential drivers of innovation in renewable energy production, consumption and sharing. They can also democratize energy access, particularly benefiting vulnerable groups through localized, decentralized energy systems. However, their impact is still debated (Scotti 2024). While RECs could promote fair energy transitions, challenges remain, especially in overcoming infrastructural and organizational barriers.

Considering these socio-technical aspects, a 'comparative gesture' (Robinson 2011; De Vidovich and Tzaninis, 2023), mainly based on literature reviews, aimed at identifying the main features of the 'community energy' framework and REC implementation in Germany and Italy and setting the groundwork for a comparison in the field of social sciences. This comparative gesture sounds useful for enriching the role of social sciences in the framework of energy research in defining the main tensions, issues and emerging urgencies that society faces when dealing with energy transition. Such issues revolve around technological inputs, social change and policy development.

Based on the comparative gesture carried out in this paper, it can be argued that Germany has a more structured enabling framework for community-led renewable energy initiatives, especially thanks to the numerous existing cooperative models, but limited attention to the challenge of embedding RECs in the renewable energy system, whereas Italy is disclosing a novel scenario for REC development thanks to the full transposition of EU directives, but – according to the plurality of organizational models emerged in Italy over the past years (De Vidovich et al. 2023; Musolino et al. 2023) – the Italian context reaffirms and reproduces the 'niche condition' of RECs in the energy system.

Therefore, the comparative gesture between Germany and Italy suggests that further research about the capacity of RECs to set the conditions of systematic change in the energy system is needed (see Sovacool et al., 2018). These further investigations could build on the main finding of this paper: while Germany employs established national legislation and organizational structures, Italy compensates with a swift reception of European legislation. Therefore, the conditions for the transition should not be the same. The crucial aspect is that they both ensure space for these innovative niches, but also that different forms of niche imply different mechanisms and possibilities for upscaling.

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