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Designing Collaborative Energy Communities: A European Overview

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Abstract: Renewable energy has a crucial role in facing climate change. One promising strategy is the creation of energy communities that require active involvement from a bottom-up perspective. Their implementation is difficult, as they currently rely on local policies, community readiness, and technological availability. The objective of this paper is to provide a qualitative overview of energy community concepts and strategies at the European level. The aim is to identify common approaches that are framing the development of energy communities, and to understand the most successful steps leading to their creation and growth. To achieve this objective, a threefold methodology is provided: (1) an updated review on policies dealing with energy communities at the European and Italian level; (2) a qualitative overview of European-funded projects under the Horizon 2020 work program; and (3) a qualitative overview of some of the most successful existing energy communities in Europe. The results outline a series of considerations and lessons learned that are useful for implementing this transition pathway in a real case, which is also presented in the paper. The conclusions will identify some future directions of this research, particularly in relation to the results coming from the implementation of actions in the real case.

Keywords: energy communities; renewable energy; energy transition; urban climate transition; community participation; performative citizenship

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1. Introduction

Energy communities are increasingly being recognized by European institutions—kicked off by the well-known Clean Energy Package—as strategic assets contributing to reaching the decarbonisation goals set by the EU Green Deal, as well as fundamental examples of local awareness around energy. Indeed, the emergence of forms of activism in this domain is called to meet the 2050 goals of resource consumption and efficiency [1–3].

Despite suggesting the implementation of actions at the European level, the Clean Energy Package leaves the responsibility of defining operating instruments and paths to the national governments [4]. These governments are embedding their strategies in their own policies in asymmetric ways. For instance, the current Italian legislation sees a limited possibility to create energy communities, introducing them in the Decreto-legge 30 December 2019 n. 162, named *Milleproroghe*, where article 42bis sets forth the possibility to create collective energy self-consumption with a precise definition of conditions (i.e., total power under 200 kW, involvement of only low and medium tension). However, the restriction of this legislation is expected to be extended in the future, giving access to the broader public to join [5,6].

Despite the steps undertaken in normative terms, the concept of an energy community, and, in particular, its implementation, is still not fully clear [1–3,7,8]. Recently, it has been divided into two main categories by the European Commission—as detailed in the

next paragraph—but some taxonomy research is still ongoing [2]. Furthermore, among various aspects, the perimeter of action within the living context is not explicit. One issue lies in the difficult relationship between communities, energy providers, and institutions that prevents the participation of specific demographic categories (e.g., entrepreneurs, companies' staff), often generating conflicts and injustices. A second issue lies in the same definition of "energy community" from a taxonomical perspective. According with Moroni and colleagues [2], the concept should better consider the modalities in which people decide to be part of a "chosen community" built around a common goal or value. This social dimension of the energy community becomes relevant in order to understand the best strategies and steps to build and maintain these practices in time. The practical steps and their definition are the third issues in the implementation of energy communities. A shift lies among: (1) the willingness of people to group around the energy topic; (2) the path that needs to be taken for the creation of the community; and (3) the external factors that frame the broader context, such as existing policies, the availability of technology, access to funding, and even basic knowledge on energy-related issues [9–13].

These open questions have been taken into consideration in two first experiments taking place in Bologna, Italy: the GECO project (Green Energy Communities, EIT Climate KIC TC_2.2.15_190736_P125-1) and the GRETA project (GReen Energy Transition Actions, H2020 GA101022317). These projects will be examined as examples of the attempt to overcome limits and create opportunities emerging from the establishment of a district-scale energy community in a specific neighbourhood. The experimental strategies and steps exist at several levels: social, technological, and operational.

The modalities within which people decide to be part of a community have been investigated in several previous research contributions—also from an energy justice perspective [14–17]—but little research is present providing a deep overview of currently available and most commonly used key steps and actions for the growth and maintenance of an energy community from the long-term perspective. This point is covered by this paper, as explained in the next paragraph.

2. Objectives and Methods

The aim of this contribution is to provide a qualitative overview of successful strategies (e.g., processes, enabling platforms, and other aspects) that support energy communities to emerge and grow in specific contexts. With the aim of better understanding the most effective strategies to implement in energy communities, energy community concepts, drivers, and barriers are investigated together with a qualitative analysis on the most innovative and interesting instruments (digital or not) for enabling communities in the creation of those experiences and in their contribution to the creation of wide energy citizenships.

The methodology of this contribution has followed three main steps: (1) an overview of the current policy framework at a European and Italian level, considering the most recent developments and norms; (2) a qualitative overview of European-funded projects under the Horizon 2020 work program; and (3) a qualitative overview of some of the most successful existing energy communities in Europe.

The Horizon 2020 projects have been selected among those directly targeting the creation of energy communities in Europe and specifically aiming to improve their growth through innovative strategies and instruments. The energy communities have been selected as qualitative examples of well-established experiences with a long-term vision on their own growth. In particular, thirteen cases have been deeply investigated through published documents and reports, as well as information on their website.

Finally, a reflection on a real case study in the city of Bologna is provided as a site-specific reference in which a new energy community is in the creation process. In Bologna, two European projects are ongoing with the purpose of creating an energy community (GECO) and observing and understanding from this process (GRETA).

This paper is structured into six sections. The first section aims to provide an overview of the definitions and key aspects concerning energy communities; the second section explores policies related to energy communities both at the European and Italian level; the third and the fourth sections provide a case study analysis; the fifth section presents the specific cases of the GECO and GRETA projects; and, finally, the last paragraphs provide a discussion, a conclusion, and an explanation of future steps. Figure 1 provides a schematic overview of the methods and structure of this contribution.

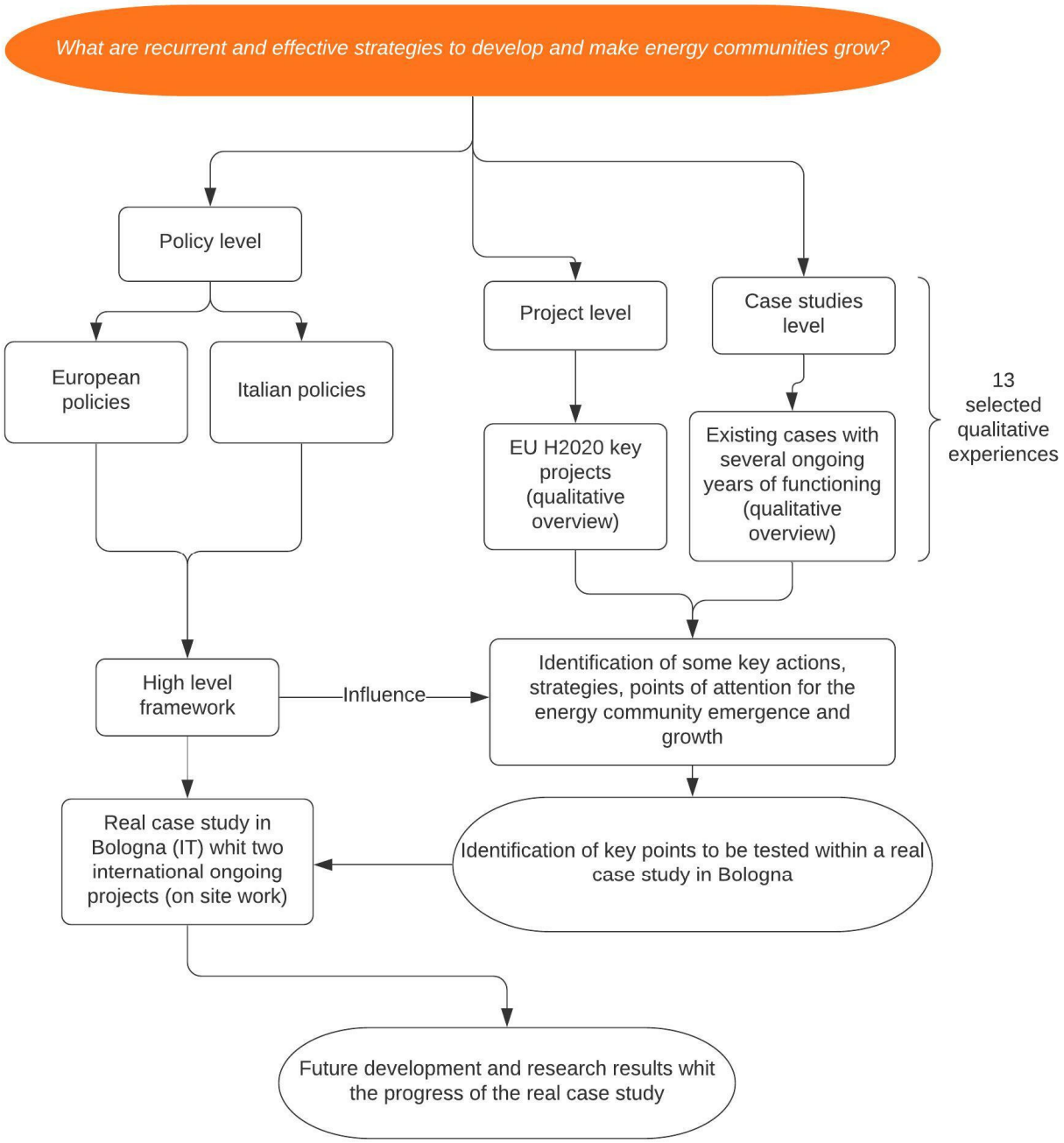

Figure 1. Schematic overview of the contribution structure and methodology. Infographic made by the authors.

3. Overview of Energy Communities: Definitions and Key Aspects

Energy communities can generally be defined as an organized group of users (private, public, or mixed) actively cooperating in developing innovative forms of energy sharing [4]. They can be intended as examples of citizens' participation that directly empower people

in acting on climate change issues, especially on the energy topic. They are based on the expectation that, by 2050, almost half of EU households should produce renewable energy [4].

Energy communities have been officially introduced into the European legislation through the Clean Energy for all Europeans package [18,19], with the aim to give more options to people for producing and sharing renewables locally or not. The idea lies in the potential to shift from a mainly centralized system to a decentralized one, where people can have the opportunity to make their own decisions on which type of energy they want to use with whom to share it. Two types of energy communities are included within the EU legislation: "citizen energy community" (CEC) and "renewable energy community" (REC). These two definitions are included in the revised Internal Electricity Market Directive (EU) 2019/944 (https://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:32019L0944&from=EN, accessed on 3 December 2021) (CEC) and in the revised Renewable Energy Directive (EU) 2018/2001 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L2001, accessed on 3 December 2021) (REC), as follows: CECs focus on returning the benefits to the groups of people involved in the energy project or to the local areas, thus linking a social dimension to energy, while RECs are bounded to a geographical dimension, hence strongly connecting the community with a proximity relation to the energy source. At the same time, these communities can place themselves at different stages of the energy chain; for example, communities can just focus on the generation of energy, or can expand their focus towards distribution, storage, and electric mobility.

Both definitions show elements in common:

1. They are based on creating a group of people that agree on clear and shared goals. In both cases, these groups can be composed of citizens, but also by local authorities, SMEs, and municipalities;
2. They are based on the voluntary and open participation of people in agreement.

However, there are some differences between CECs and RECs:

3. CECs focus on the return of benefits to the groups of people involved in the energy project or to the local areas, thus including a social dimension;
4. RECs are bounded to a geographical dimension, connecting the community at a proximity level.

As shown by Roberts and colleagues [18], both definitions entail the creation of new types of entities that are not oriented to a commercial purpose, but rather to redistribute benefits among participants and that are framed by specific types of governance, structures, and purposes that support people to concretely take actions regarding the energy sector. As described by Caramizaru and Uihlein [20], there are several governance and partnership structures that are possible in order to create these types of sharing communities, such as cooperatives, foundations, limited partnership, housing associations, non-profit customer-owned enterprises, public–private partnerships, or public utility companies. At the same time, these types of communities can place themselves at different stages of the energy chain. For example, from just focusing on energy generation, or expanding that focus toward energy distribution and storage, as well as electric mobility. According to Moroni and colleagues [2], energy communities are mainly groups of individuals, joined by particular interests and/or ideals who "voluntarily accept certain rules for the purposes of shared common objectives, in particular, energy related ones".

In conclusion, several factors are relevant to the establishment of this paradigm, including:

5. the structure of the energy system and the distributed generation from renewable sources [21] (for example, Italy has a well-spread structure of small–medium sized plants throughout its territory);
6. the political dimension, which includes the overall regulatory framework that enables or hampers the free association of people;

7. the market and the supply of technologies and solutions. ICTs are often leveraged to involve people in setting up an energy community, enabling smart solutions and capitalizing on investments made in renewables;
8. sustainability and economic factors, including the conditions of convenience for the energy system, utilities, and end-users;
9. the social structure of the same community and people's knowledge that frames the modalities within which energy communities form and grow.

4. Energy Communities for the Green Deal: An Overview from European Policies and Tools of the Italian Legislation Framework

4.1. European Policies

Europe has long been at the forefront of research and development of solutions to accelerate and facilitate the energy transition, particularly through the collective engagement of its citizens. Although present in discourse and political claims for decades (see for example the role of consumers in Article 2 (1) of the Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011), energy communities have been formally appearing in European legislation and policy documents since 2019. The Clean energy for all Europeans package marks the milestone for the pervasive deployment of energy communities, no longer as national best practices, but as legal resources for a long-term European strategy. The Package was followed by eight Directives that regulated energy issues, including: energy performance in buildings, efficiency, renewables, and the electricity market. The EU Directives, established by the CEP, seek to put in place appropriate legal frameworks to enable the transition and empower citizens in the energy sector, defining rules for the determination of enabling mechanisms for the participation of citizens in the energy market, how they would share it (collectively and individually), as well as the storage facilities and means.

These aspects have been drawn by the Directive on common rules for the internal electricity market (DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources (recast) https://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:32018L2001&from=EN, accessed on 3 December 2021), where citizens willing to participate in such communities are granted rights and obligations, fair, equal treatment, and protection under the Union law (Art 16 of the Directive) as distribution system operators. It introduces the concept of renewable energy communities and fosters member states to ensure that renewable energy communities can participate equally in available support programs with other participants. In addition, RECs "*have led to significant added value in terms of local acceptance of renewable energy and access to additional private capital resulting in local investment, greater consumer choice, and increased citizen participation in the energy transition*" [22]. The directive frames these communities as legal entities controlled by local actors in proximity of the energy production facilities [7,22], tailored to the directives of the national laws.

In parallel, the revised Internal Electricity Market Directive (EU) 2019/944 defined the citizens' energy community as "*a legal entity based on voluntary and open participation*" [23,24], also including several actors such as local authorities, municipalities, and small businesses; the main purpose is to provide its members or partners or the territory in which it operates with "*environmental, economic or social benefits at the community level, rather than generating financial profits*" [25]. This also includes the participation of the community in the generation and distribution (in some cases also storage) of renewable energy for the benefit of their members. The two European Directives therefore draw these communities that, in the first case, provide for the sole production of renewable energy and only within the proximity of the legal entity established, with the possibility of participation for SMEs. The others also accept other sources, not necessarily in proximity, and only allow the participation of small companies.

These boundaries, drivers, barriers, and principles of energy communities [7,26] have eventually been strengthened by the Fit for 55 package (Renewable Energy Directive) of July

2021 to comply with the Green Deal objective of Europe climate neutrality by 2050, which foresees a greenhouse emissions reduction of 55% by 2030 and corrects the percentage of necessary renewables produced by 2030 from 30% to 40%. To achieve this collective goal, energy communities need to be fostered as complementary forces able to contribute to a large share of the renewables production. Since the package, in its solidarity policies and carbon pricing revenue distributions, affirms that "*100% of revenues from carbon pricing needs to flow back to EU citizens*", energy communities can consider if and how a revenue distribution plan could be useful to overcome economic barriers to their emergence and strengthening [25,27]. The development of solidarity schemes would help to overcome inequality issues in citizen engagement policies among European countries.

4.2. Italian Policies

As already mentioned in the Introduction, in Italy the Decreto-legge 30 December 2019 n. 162, (*Milleproroghe)*, converted in Law n.8 in February 28 2020, contains art.42-bis "Self-consumption from Renewables" which, anticipating the text of transposition of the Renewable Energy Directive 2001/2018, grants the possibility to realize collective self-consumption and renewable energy communities, taking up the parameters defined respectively by art. 21 and art. 22 of the Directive itself, but with few additional restrictions. In Italy, the decree concretizes some of the indications of the European "Renewable Energy Directive" (RED II) and establishes the possibility of creating communities that exchange energy for the purpose of collective self-consumption.

In Italy, the topic of collectively produced energy began to be introduced by the National Energy Strategy (SEN) (https://temi.camera.it/leg18/post/la-strategia-energetica-nazionale-sen.html, accessed on 3 December 2021) in 2017, a general policy and planning tool for national energy policy. The SEN 2017 has planned the following general goals:

- Enhance the competitiveness of the Country in order to reduce the gap between the energy price and costs compared to the EU while ensuring that the longer-term transition (2030–2050) does not compromise the Italian and EU industrial system in favour of extra-EU systems;
- Achieve, in a sustainable way, the environmental and decarbonisation goals (2030) determined at the EU level with a specific regard to the objectives defined by COP21 and in synergy with the National Strategy for Sustainable Development. On a national level, the scenario promises to phase out coal-fuelled thermoelectric plants by 2030;
- Continue to strengthen the supply security and system and infrastructural flexibility.

The SEN formed the programmatic and policy basis for the subsequent adoption of the Integrated National Energy and Climate Plan (PNIEC), which took place in January 2020. The plan is composed by 5 lines of action, intended as integrated and interlinked axis of actions: decarbonisation, efficiency, energy security development of the internal energy market, research, innovation, and competitiveness. The plan sets the objective of a 30% increase in the use of energy from renewables. The plan also implements the European Directives by declaring the will to strengthen the action and the establishment of energy communities, through a prior analysis to identify possible impacts on the system in relation to possible models of implementation of communities and aspects of discipline (e.g., physical and/or virtual configurations, geographical perimeter). The Plan also explores ways in which communities can be an additional tool to support households in energy poverty, particularly where direct interventions (e.g., with self-consumption facilities) are not technically possible. Finally, the plan explores the possibility for these communities, in addition to producing, storing, and consuming energy from renewable sources, to provide additional services such as efficiency services, charging services for electric vehicles, and the provision of other ones.

In 2020, the *Rilancio* Decree Law provided some fiscal measures in the field, which should be oriented to facilitate investment in energy improvement of the building stock. In this framework, tax deductions for expenses incurred (so-called Superbonus 110%) can also benefit energy communities or cooperatives with indivisible ownership for interventions

carried out on properties owned by them and assigned for the enjoyment of their members. In this vein, the Italian Recovery Plan (National Recovery and Resilience Plan) (https://www.governo.it/sites/governo.it/files/PNRR.pdf, accessed on 3 December 2021) has allocated 2.2 billion for the 100% financing for photovoltaic systems and configurations of collective self-consumption and energy communities. The recipients, however, will be Public Administrations, as well as families, and small enterprises in municipalities with fewer than 5000 inhabitants. The expected costs amount to 2.2 billion of direct investment, distributed as follows: 1600 million to renewable energy communities and 600 million for collective self-consumption.

4.3. Regional Policies

Despite the rich framework, and equally solid perspectives, the Italian administrative configuration compels one to observe the issue from the regional dimension. Before the enactment of the Decreto-legge 30 December 2019 n. 162 (*Milleproroghe)*, there were, in fact, cases of local vanguards in the field of energy communities, such as the case of the Piedmont region, which was the first to adopt a law on the subject: Regional Law n.12 of 3 August 2018 "Promotion of the institution of energy communities". This was followed by the Puglia region with the Regional Law 9 August 2019, n. 45 "Promotion of the institution of energy communities".

In recent years, the Emilia Romagna Region has implemented EU Directives and national laws through its Regional Energy Plan (PER), the updated version of which is currently being discussed and drafted. The plan adopts the European objectives for 2020, 2030, and 2050, in terms of climate and energy as a driver of development for the regional economy, and, in particular, the reduction of climate-altering emissions, the increase in the share of consumption coverage using renewable sources, and the increase of energy efficiency in buildings, public assets, transport, and production activities.

In parallel, the Region has published the Patto per il lavoro e per il Clima (Pact for Work and Climate) (https://www.regione.emilia-romagna.it/pattolavoroeclima, accessed on 3 December 2021), a strategic, choral document of declarations of intent for the ecological transition of the region. The Pact has several axes, including the one on ecology, which sets the goal of achieving carbon neutrality before 2050, in line with the European strategy, and the transition to 100% renewable energy by 2035, which the Region also intends to pursue by formalizing the role of energy communities.

The pact mentions the need to draft a Regional Law on Energy Communities to increase the production and use of renewable energy and storage, including in a widespread form. Another regional platform is the smart specialization strategy (S3 2021–2027) that was approved by the Legislative Assembly with resolution no. 45 of 30 June 2021. The Strategy will be an integral part of the Por Fesr 2021–2027. Eight areas of strategic specialization have been identified: agri-food, building and construction, mechatronics and motor engineering, health and wellness industries, cultural and creative ones, innovation in services, digital and logistics, energy and sustainable development, and tourism. Among the axis of intervention, the "Theme 10—Cities and communities of the future" of the Strategy, tackles "Affordable and sustainable technologies and solutions for energy efficiency (including Energy Communities, Positive Energy District/Building and hospitals)".

Hence, the regional framework is the main direct level to discipline energy communities and civic activism towards the topics. However, some local and municipal devices, such as the Sustainable Energy and Climate Action Plan (SECAP), are aimed at implementing and tailoring the local implementation of such objectives. In the same vein, European projects have been experimenting extensively with the possibility to create, organize, and maintain local experiences of energy communities. The following section will explore the lessons learned for these projects and the outcomes on the territory.

5. Key Enabling Strategies for Energy Communities: A Case Study Overview

This section presents and discusses some enabling factors emerging from two main sources of information: the European projects funded under the Horizon 2020 work program and a selection of real cases where energy communities have been established. Section 5.1 discusses the results of an analysis of six projects, while 5.2 considers the results of an investigation of seven projects.

5.1. EU Projects Working on Energy Communities

This sub-section includes a qualitative overview of some European-funded projects under the Horizon 2020 work program. The most interesting cases have been selected in the call period 2017–2020. In particular, the projects with a clear overview of enabling instruments and strategies have been chosen for this analysis. Table 1 summarizes the list and the major information of the chosen projects.

Table 1. Overview of energy communities and energy engagement in some of the most interesting related projects in Europe.

Acronym	Areas Involved	Enablers
BEcoop [1] (H2020—2020–2023) Type: RES coop Energy type: Bioenergy heating (biomass)	Poland, Greece, Italy, Spain	(1) Knowledge Exchange Platform (2) Self-assessment tool (3) Toolkit (repository of already existing instruments with full assessment and profiling) (4) E-market environment
CREATORS [2] (H2020—2020–2023) Type: CES community energy systems	Slovenia, Barcelona, Estonia, Belgium	Software suite and set of applications with a service package for helping cities in initiating, planning, implementing and operating CES
BENEFFICE [3] (H2020—2017–2021) Type: -	Austria, France, Greece, Spain, Denmark	Platform composed by 4 parts: (1) residential component (sensing components—IoT devices; gateway) (2) BENEFFICE platform backend (multi-service platform handling data) (3) Data processing applications (processing data) (4) BENEFFICE mobile application
LIGHTNESS [4] (H2020—2017–2021) Type: CEC	Poland, Netherlands, France, Italy, Spain	Early assessment tool
RENAISSANCE [5] (H2020—2019–2022) Type: RES	Spain, Netherlands, Belgium, Greece	Project Platform
NRG2peers [6] (H2020—2020–2023) Type: RES	Spain, Italy, Slovenia, Netherlands	Gamified Platform Competence Center

[1] https://www.becoop-project.eu/. [2] https://www.creators4you.energy/. [3] http://www.beneffice.eu/. [4] https://www.lightness-project.eu/. [5] https://www.renaissance-h2020.eu/. [6] https://nrg2peers.com/.

The six projects analyzed have all been funded under the Horizon 2020 work programme under different calls. Several of them have been answers to societal calls, some others to technical calls. Despite the differences that arise from the calls' specific requests, it is possible to see how all of these projects are specifically working in the community-building and enabling phase [28]. In fact, all of the projects are mainly dealing with creating the communities around energy sharing or enabling their upgrade through technical innovations [29]. Those innovations tend to be aligned to the creation of knowledge sharing strategies or in the development and use of digital platforms for delivering specific services.

An example is the BEcoop experience, a project aiming to provide several technical and business support tools for unlocking the market potential of community bioenergy,

as well as fostering new links and partnerships. As a cross strategy among the different cases, the project is developing a Knowledge Exchange Platform with the aim to enable collaborations among different stakeholders, minimizing costs, and sharing information in a peer-to-peer approach. This tool (that will be available in April 2022) aims to be a repository of knowledge, tools, and services for the specific domain of community bioenergy heating. Another example is the project CREATORS, whose aim is to create a software suite with applications that will provide services to community energy systems in cities.

The implementation of enabling platforms for services to give to participants of the energy communities is a key aspect of their development, particularly when it comes to innovative business models and market penetration. In fact, the different analyzed projects seem to be more focused on enabling innovations than on the specific technicalities of energy production and sharing. As observed in projects such as CIRCE and BENEFFICE, there is a deeper attention to the value chain development, the stakeholder's engagement, and on the market readiness rather than on energy technologies. In the CIRCE project, an e-market environment is under construction with the aim to enable stakeholders in creating contacts and proposing initiatives to carry out their own specific idea. The specific goal is to provide connections among the actors involved in the supply chain. In addition, the BENEFFICE project is working on creating IoT-based innovation able to leverage the ecosystem of stakeholders through low-cost, "plug-and-play-and forget" devices, but also on empowerment and a rewards approach based on an alternative monetary currency.

The involvement of communities is the third key aspect in the analyzed projects. In fact, the implementation of tools and platforms also has the goal of empowering citizens in becoming active toward the implementation of energy related actions, particularly around energy production and sharing from renewables. By using an alternative currency, the BENEFFICE project aims to support consumers in modifying their energy consumption behaviour to reduce energy consumption and increase the use of renewable resources. To boost this change, the project proposes to citizens specific voluntary and personalized paths of behavioural change that also gives monetary rewards in return for progress and helps to build an online community of engaged people. Similarly, the LIGHTNESS and the REINESSANCE projects are developing methods to support citizens' empowerment in the generation, sharing, and selling of renewable energy through local engagement processes, policy recommendations and, again, enabling platforms.

In line with all of these approaches, but using a slightly different method, there is the NRG2peers project. It uses a gamification approach to connect energy communities together, in a peer-to-peer approach aiming to support knowledge sharing on finance, business models, specific actions, and other aspects of creating and upscaling energy communities. In particular, the platform will assess the community readiness to become a peer, it will provide mechanisms and support for the optimization of energy consumption, and it will stimulate co-creation experiences. In addition, the NRG2peers project is creating a Competence Center as a strategic initiative, to connect, at an international level, energy communities with experts and regulators. It will in fact be based in Brussels at the Housing Europe office.

5.2. EU Level Case Studies

This sub-section analyses some of the most interesting energy communities in Europe, looking further at a particular selection from the 2020 document "Energy communities: an overview of energy and social innovation" [29]. Table 2 resumes the list of the key projects identified and analyzed. The selection has been made on the availability of updated materials and news on the websites in English.

Table 2. A qualitative overview of energy communities in Europe (some of the first experiences not necessarily linked with EU projects).

Acronym	Areas Involved	Key Strategies
Courant d'Air [1] Cooperative—national level Energy type: solar, wind	Belgium	(1) High social values; (3) Platform CoopHub
Marstal Fjernvarme [2] Cooperative (non-profit)—city level Energy type: solar (with storage)	Denmark	(1) Assemblies and board to take decisions; (2) large heat storage
Svalin co-housing complex [3] Co-housing community—neighbourhood level Energy type: solar (with storage), electric cars, geothermic heat pumps	Denmark	(1) High social dimension and values; (2) real time data gathering and mobile application at different scales; (3) sharing economy principles
Enercoop [4] Cooperative (collective interest)—Energy supplier—national level Energy type: solar, wind, biogas, hydraulic	France	(1) "Social enterprise" cooperative; (2) energy supplier that buys energy from energy communities and local producers; (3) collects energy from local producers at national level
SAS Ségala Agriculture et Energie Solaire [5] Cooperative (collective interest)—national level Energy type: solar (PV), methanization, biomass (wood), wind	France	(1) Cooperative focused on agriculture; (2) cooperation as a major key point; (3) participation to several new projects around the sharing of energy; (4) regular income to the farmers from renewable energies
Som Mobilitat [6] Cooperative (non-profit)—national leves Energy type: electric mobility	Spain	(1) web app for providing services of sharing mobility; (2) high collaboration among the local units and the national network with the international REScoop mobility; (3) crowdfunding and association quote
Solbyn Association [7] Eco-village—neighbourhood level Energy type: building heat exchange system, building energy efficiency	Sweden	(1) high sense of community; (2) high level of participation and engagement; (3) "slow systems" of conflict solving inside the community

[1] https://www.courantdair.be/wp/. [2] https://www.solarmarstal.dk/. [3] https://www.housingevolutions.eu/project/svalin-co-housing-p2p-energy-community/. [4] https://www.enercoop.fr/. [5] www.fermesdefigeac.coop. [6] https://www.sommobilitat.coop/. [7] https://theecologist.org/2015/feb/23/green-living-swedens-ecological-village-solbyn.

The seven projects analyzed are not necessarily linked with the European-funded projects. Some of them have been supported by several types of funding (crowdfunding, national, regional, and other typologies). Several different points can be highlighted as groups of key strategies.

The first one is the use of technologies and digital platforms. If the European projects have more deployment of innovative digital instruments, the seven cases analyzed rely less on the use of these types of instruments and focus more on the "community" dimension of the energy community concept. Both in the local cooperatives and in the national or regional ones, the role of the aggregation of people is key.

A major part of the investments in innovation are directly linked to the renewable energies more than to other enabling tools. All of the projects report in their documents advances in the size of the cooperative with new members, or in the size of energy production, sharing, and use. The main exception is the Courant d'Air experience, where there is a large effort in the use and development of the CoopHub platform that aims to be used together with other community networks. However, the CoopHub platform would make it possible to connect several experiences in Belgium and France together, creating a larger network.

A common approach in those projects is the social responsibility that the energy community entails. This aspect is exemplified in projects such as Courant d'Air, Svalin, Som Mobilitat, and Solbyn. In fact, several of these experiences are not focusing on gaining

profits from renewable energy production, but are selling and using profits for territorial regeneration projects, involving communities within the local areas.

For example, Courant d'Air is a citizen cooperative that deals with renewable energy projects with a social component. It aims to create a democratic energy transaction through the active voice of the community. It has been active since 2009, with a community of 2800 members and six employees. They produce 30,000 MWh/year. Each citizen can buy up to three parts/shares that cost 250 € each. They have access to all of the activities, will earn dividends, and have an active voice in all of the investments made by the company. Courant d'air plays a very active part in society by informing the citizens about energy related themes, such as the efficient use of energy. They have also been present in schools through the project "Génération Zéro Watt", giving kids tools to know how to be more conscious of energy consumption.

Another example linked with a particular type of energy sharing (electric mobility) is the Som Mobilitat community, which is organized as a non-profit consumer cooperative, to overcome the idea of private mobility, and at the same time an environmentally friendly and efficient model of mobility. The activity involves the rental of electric cars—owned by cooperatives, individuals, enterprises, or public institutions—that can be used through a digital app. It is also working to develop micro-mobility services. The ultimate aim of the project is to develop automated shared vehicles. The decision-making process is also bottom up in the decision of cars to be bought and where to locate them. Members of the community can crowdfund cars in their own area, thus contributing not only to the growth of the community and the equipment, but in fostering something they personally belong to as well.

A last observation is the importance given to the community engagement and cohesion more than the typology of energy used. In all of the projects, in fact, the typology of energy used is not as central as the way in which communities have chosen to organize themselves. The type of energy seems just to be linked with territorial specificities and the general availability of one type or the other in the surrounding area, as in the cases of the agricultural community of SAS Ségala, the multiple energy sources of the Enercoop network, or the specificity of the electric network in the SOM Mobilitat. Conversely, the methods with which people group themselves into the community and develop a common path of behavioural change is one of the key points shared by all of the cases, in addition to their external communication.

6. Results: Lessons Learned and Open Issues

This paper provides a qualitative overview of energy community case studies coming both from European-funded projects and real implementations, highlighting the presence or absence of the most successful and used strategies in enabling the communities to emerge and grow in specific contexts. This contribution qualitatively analyzed 13 experiences in Europe that were found to have some elements in common and some divergencies. From this analysis, some lesson learned and open issues can be identified as major results, as detailed below.

The analysis showed that the generation and implementation of such experiences can be triggered by several aspects. The three aspects presented here seem to be crucial:

1. The willingness of individuals, or groups of them, that decide to organize themselves into forms of community ("chosen communities"), where they transition from being only consumers to becoming prosumers. This transition can be done via knowledge sharing, engagement mechanisms, and nudging actions oriented towards collective behavioural change. This point emerged, in particular, within the literature review about key concepts.
2. There is a substantial interest in developing different typologies of technological instruments as supporting infrastructure to the interaction among actors (platforms), as a verification grid for the effectiveness of some actions (sensors), and as a source of knowledge and access to information (data collection). This point emerged within the

case studies analysis. In addition, innovative technologies seem to be triggered by very innovative actions such as European projects and are only later embedded into real cases (as it is showed by the Enercoop experience).

3. The focus on energy community barriers and ways to grow is centred more on the effectiveness of the community in its internal relations than on energy aspects. In other terms, what seems to make a community grow in time is linked more with the personal relationships among people or the effectiveness of the cooperative/community created than on energy-related aspects. These last points seem to be crucial at the founding of the community than later in time. This point mainly emerged within the case studies analysis.

The first aspect is supported by the operational policy context described by the EU, where the logic of citizen science becomes essential in any project and process of transforming urban environments. The focus then falls on the components of the community itself, and on the actors involved and their patterns of agreement to operate in the common interest on energy issues. In fact, the energy communities listed differ not so much for the type of renewable energy they use, but rather for the type of engagement and agreements within the community. As such, the main issue still appears to be that of convincing people to act and counter the negative effects of climate change on energy resources. This happens regardless of the specific type of energy, which generally seems to simply be relative to the local availability, and therefore has geographical and climatic determinants.

From a technology perspective, projects seem to focus primarily on the market and value chain readiness rather than renewable specifications—the enabler (whether technology or market) is the most relevant aspect along with people engagement. The reflection on technological features of energy communities appears to be mostly investigated in European research and innovation projects. This might be linked to the nature of the European calls requiring testing and promoting engagement via new technologies, but could also be connected to the growing interest in extracting data from these investigations and systematizing the knowledge to be acquired in an automatic manner. In this sense, enabling technologies are key to this objective.

Some open issues are also present both in the literature and, more evidently, in the real cases. These barriers can be highlighted in the diffused push to the generation of initiatives of energy communities; above all, the existing difficult relationship among citizens, energy providers, and institutions, which prevents the participation of specific categories of people (e.g., entrepreneurs, companies' staff), and that often generates conflicts and injustices. Another barrier lies in the necessary reduction of the knowledge and technical gaps in the access to technology, to decision-making, and knowledge and information towards energy. A final remark is about the policy level. The readiness of national laws and regulations does not exactly follow the timing of European regulations. As shown by the Italian regulation overview, there is a shift between what it is possible to do for Europe and what is possible in the Italian country.

7. Discussions and Implementation of Results in a Pilot Action in Bologna

The emergence of forms of activism in the energy domain, the strong commitment of the European policy framework, and the attention provided by the national Recovery Plans seem to urge a collective citizens' call to meet the 2050 goals of resources consumption and efficiency. However, a limited number of experiences are actually present in Europe, even if this number is growing. Some of the major aspects that emerged in the analysis are: (1) the necessity to build the community by taking into account the values around which people decide to cooperate for energy saving purposes; (2) the potential role that innovative technologies have; and (3) the importance of the community effectiveness, knowledge, and activism. These aspects are taken into consideration in a pilot intervention held in the city of Bologna, where two new European projects are actually ongoing, GECO and GRETA. The reflections and lessons learned stated in Paragraph 6 hold true in the case of GECO and GRETA projects. The energy community concept extends to the neighbourhood level

through the ability to self-consume on-site energy produced in the neighbourhood. As the size of the community increases, so do the benefits for the electricity system and for the prosumers, but there are also difficulties in managing the distributed resources due to the more complex technical constraints to be considered. At the same time, building an energy community could create wider social gaps within the neighbourhood, particularly for those with a strong social fragility, by widening the polarization among engaged people and people excluded from these processes due to technical and knowledge gaps. Several empirical investigations have been tackling these issues in the attempt to overcome them and re-define the perimeter for the action of energy communities and their inclusion (or exclusion) mechanisms. Among them, the GECO and GRETA sister projects in Bologna are paving the way for the Italian debate on energy communities and citizenship. Both projects work in the Pilastro-Roveri area of Bologna, a social housing and industrial district in the first periphery of the city. GECO is creating the conditions for the emergence of the energy community with the use of a collaborative platform aggregating a series of enabling technologies: data collection, smart optimization algorithms for day ahead and intra-day dispatching of battery storge systems and biogas power flows, and blockchain technologies. On similar premises, GRETA is planning to reinforce and widen the role of the energy community, understanding the complex processes steering citizen motivations and willingness to engage in energy citizenship behaviours, as well as exploring the forces working against it. GRETA will follow the transition towards the creation of an Energy Citizenship Contract, packaged policy instrument, embedding local goals and targets, as well as broader strategies and plans that support communities in achieving fair agreement guidelines on harnessing energy citizenship. The two projects are interesting because of the enabling environment they aim to put in place for the emergence of energy communities (GECO) and the exploitation of their potential towards policy goals and deeper societal transformations towards decarbonization (GRETA). The eventual creation of a packaged policy instrument can further support communities in achieving fair agreement guidelines on harnessing energy citizenship.

The GECO project (https://www.gecocommunity.it, accessed on 3 December 2021), promoted by AESS, the National Agency for New Technologies, together with Energy and Sustainable Economic Development (ENEA) and the University of Bologna (UNIBO), with the participation of CAAB/FICO and the local development agency Pilastro-District Nord Est, envisages the creation of the first energy community in the Pilastro-Roveri area for distributed generation, energy storage, and consumption optimization through the smart city logic, offering its members a below-market energy cost and energy services [30]. With the support of ENEA, the project aims to stimulate the development of the national regulatory framework, providing support to national stakeholders for the creation of the new regulation of the energy sector in the Italian territory.

GECO has focused on building a district energy community in the form of an entity that can take advantage of opportunities in the new energy market within the development framework of national and regional legislation [31]. This system would allow users to exchange energy, promoting a new and flexible community model for a sustainable district. The methodology of GECO was based on engagement, training, outreach, advanced optimization modelling tools, and promotion of behavioural changes within the community, as well as communication and dissemination of success stories [32].

GRETA—GReen Energy Transition Actions (https://projectgreta.eu, accessed on 3 December 2021) is a Horizon 2020 project, funded by the call H2020-LC-SC3- CC-1-2020 Building a low-carbon, climate resilient future: secure, clean, and efficient energy, in the topic "Social Sciences and Humanities (SSH) aspects of the Clean-Energy Transition".

This project aims to improve the understanding of the conditions and barriers to the emergence of energy citizenship. This definition represents a form of active participation within energy systems that ultimately supports local and global decarbonisation goals. It can be manifested in many ways, such as personally choosing renewable solutions or electric vehicles, participating in energy communities, or advocating for climate change.

Through an international survey and six participatory case studies, GRETA will develop interpretive frameworks and action models designed to reveal what factors influence the emergence of energy citizenship. The mechanisms being explored are Community Transition Pathways (CTPs), which are routes that support individuals or communities in transitioning between different levels of citizenship engagement. CTPs establish roadmaps for decarbonisation that explore and enhance positive energy citizenship behaviours. These will be used to identify problems, frame solutions, and achieve a shared approach to energy transition, formalized through Energy Citizenship Contracts (ECCs), a specialization of the forthcoming climate city contracts, which form the basis of the "100 climate neutral cities by 2030" mission. ECCs, as an outcome of CTPS, are packaged instruments, embedding local goals and targets, as well as broader strategies and policies, that support communities in achieving fair agreement guidelines harnessing energy citizenship. Results throughout the project will be used to inform and encourage local and international policy makers to support energy citizenship.

Both projects work and research on different case studies, virtual energy communities, networks, cooperatives, and districts where these types of communities are (or will be) present. In the case of Bologna, the focus is the district that includes the Pilastro area and the Roveri area, which the two projects share. This area (Figure 2) was chosen for its geographical configuration (large area but physically well-delimited), its functional configuration (residential, services, and productive use), and its social configuration (presence of a high percentage of associations, active citizens, organizations, and civic committees, particularly in the Pilastro area). In addition, it is the home to the largest rooftop solar photovoltaic plant in the EU (caab) and has a district heating plant (waste-to-energy plant). It is a populous area hosting small and medium–large energy-intensive businesses that can become producers, but also suppliers, of energy. These are rather dynamic actors that can play different roles depending on the needs.

The Pilastro-Roveri area holds great potential from the energy engagement of communities and can be considered:

- a pilot to see some of the resilience strategies provided for in the urban planning tools of Bologna: Energy Communities are explicitly mentioned in the new general Urban Plan and in the PAESC. In particular, emphasizing that: "*the experience underway with the GECO project will have to be transferred to the territory and, to this end, the municipal administration will have to promote dialogue with other territorial realities (associations, cooperatives) to accelerate the process*" (http://www.comune.bologna.it/media/files/piano_azione_per_energia_sostenibile_e_clima_paesc_2.pdf; accessed on 3 December 2021);
- a laboratory to access the conditions that will be generated thanks to the new Regional Energy Plan whose involvement path has been concluded and will see the drafting of the real plan in the coming months, in line with Green Deal and national objectives;
- a place of learning to lay the foundations for the achievement of the objectives described in the Pact for Work and for the Climate (in particular the axis on ecological transition, which the Region intends to also pursue by formalizing the role of energy communities);
- finally, in the long term, it is also a key test for the PNRR, which talks extensively about ecological transition and energy communities.

The key challenge is to be able to assess the rather complex dynamics between these realities, aiming to maximize the benefits of self-consumption, both from an environmental and a technological point of view. Blockchain, for example, plays a key role in these dynamics because it certifies what is happening within the energy community and makes it public. The fact that the data is public allows for transparent information management.

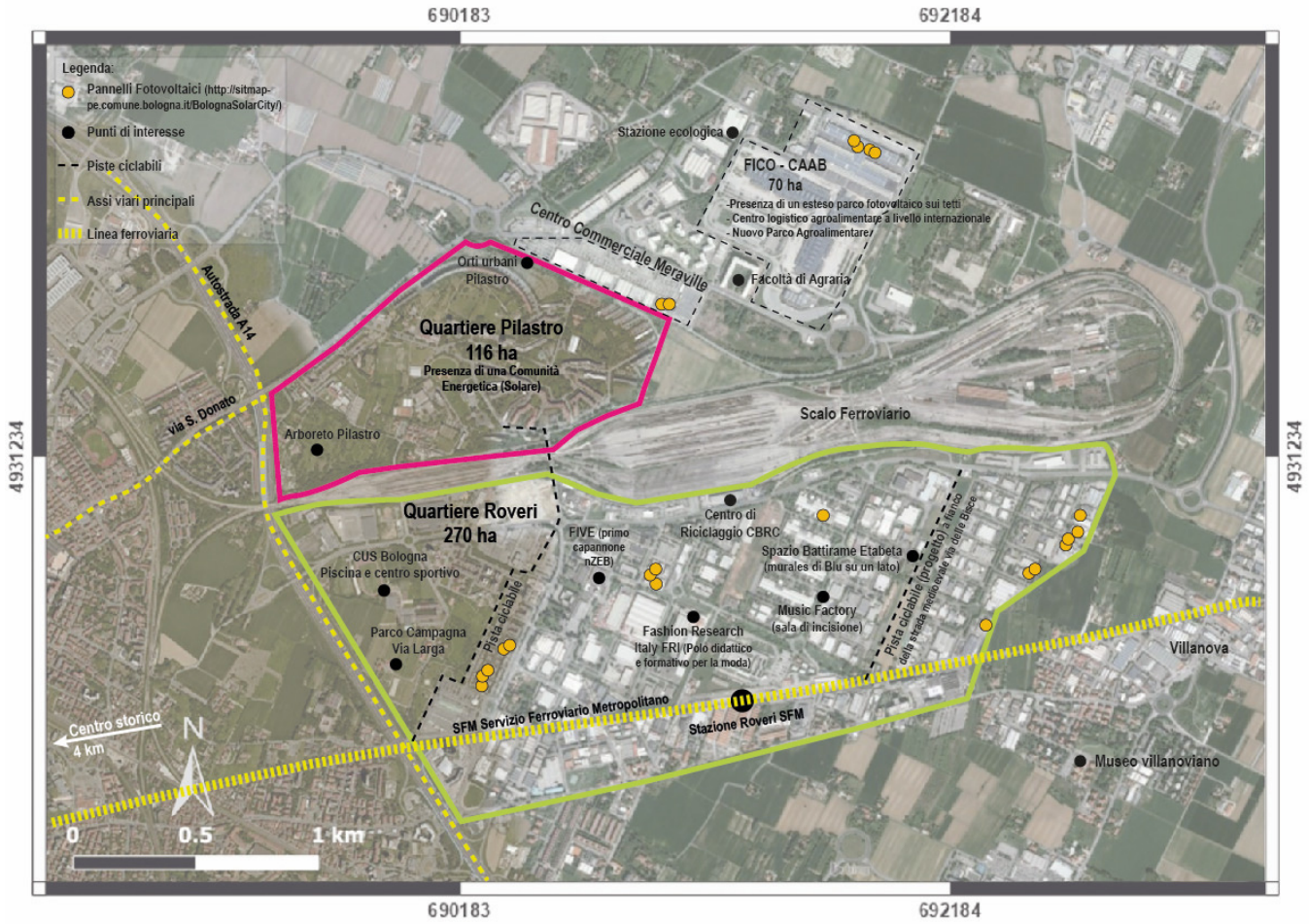

Figure 2. Image of the Pilastro-Roveri area. Infographic made by the authors.

8. Conclusions, Present Limitations, and Future Developments

In conclusion, this paper presented major results and some considerations on successful strategies in supporting energy communities to emerge and grow in specific contexts from a threefold perspective: at first, identifying the key definitions and components of an energy community through a qualitative literature review; then, identifying the main current policy strategies at the European level and understanding how they have been embedded into the Italian policies at different scales; then, this contribution identified some recurrent strategies through a qualitative analysis on innovative European projects and several real energy communities; finally, it reported some remarks on the process of the creation of a new energy community in the city of Bologna, in Italy.

The limitations of this contribution are directly linked with the initial state of the GRETA research, which has started in May 2021. Since then, several activities have been done in order to understand key aspects of energy communities, not only from a theoretical perspective, but mainly from observing and relying on a real case study. For that reason, a systematic literature review on the energy communities' key enabling factors from both a theoretical and a case study analysis would be needed. This will be one of the first objectives for future publication. A second aspect that will be implemented is the work inside the Italian case study. As the GRETA project goes on, the authors will have the chance to implement some of the actions identified within this contribution and validate their effectiveness. Further research and publications will be proposed on the Community Transition Pathways and Energy Citizenship Contract matter. Another limitation lies in the limited number of case studies analyzed. This is due to the quantity and availability of appropriate materials available in the English language.

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References

1. Genus, A.; Iskandarova, M. Transforming the energy system? Technology and organisational legitimacy and the institutionalisation of community renewable energy. *Renew. Sustain. Energy Rev.* **2020**, *125*, 109795. [CrossRef]
2. Moroni, S.; Alberti, V.; Antoniucci, V.; Bisello, A. Energy communities in the transition to a low-carbon future: A taxonomical approach and some policy dilemmas. *J. Environ. Manag.* **2019**, *236*, 45–53. [CrossRef] [PubMed]
3. Fleischhacker, A.; Lettner, G.; Schwabeneder, D.; Auer, H. Portfolio optimization of energy communities to meet reductions in costs and emissions. *Energy* **2019**, *173*, 1092–1105. [CrossRef]
4. Rathnayaka, A.D.; Potdar, V.M.; Hussain, O.; Dillon, T. Identifying prosumer's energy sharing behaviours for forming optimal prosumer-communities. In Proceedings of the 2011 IEEE International Conference on Cloud and Service Computing, Hong Kong, China, 12–14 December 2011; pp. 199–206.
5. Di Silvestre, M.L.; Ippolito, M.G.; Sanseverino, E.R.; Sciumè, G.; Vasile, A. Energy self-consumers and renewable energy communities in Italy: New actors of the electric power system. *Renew. Sustain. Energy Rev.* **2021**, *151*, 111565. [CrossRef]
6. Cielo, A.; Margiaria, P.; Lazzeroni, P.; Mariuzzo, I.; Repetto, M. Renewable Energy Communities business models under the 2020 Italian regulation. *J. Clean. Prod.* **2021**, *316*, 128217. [CrossRef]
7. Heldeweg, M.A.; Saintier, S. Renewable energy communities as "socio-legal institutions": A normative frame for energy decentralization? *Renew. Sustain. Energy Rev.* **2020**, *119*, 109518. [CrossRef]
8. Roberts, J.; Frieden, D.; Gubina, A. Energy community definitions. *Compile Project: Integrating Community Power in Energy Islands*. May 2019. Available online: https://www.compile-project.eu/wp-content/uploads/Explanatory-note-on-energy-community-definitions.pdf (accessed on 3 December 2021).
9. Azarova, V.; Cohen, J.; Friedl, C.; Reichl, J. Desining local renewable energy communities to increase social acceptance: Evidence from a choice experiment in Austria, Germany, Italy and Switzerland. *Energy Policy* **2019**, *132*, 1176–1183. [CrossRef]
10. Karunathilake, H.; Hewage, K.; Mérida, W.; Sadiq, R. Renewable energy selection for net-zero energy communities: Life cycle based decision making under uncertainty. *Renew. Energy* **2019**, *130*, 558–573. [CrossRef]
11. Ullah, K.R.; Prodanovic, V.; Pignatta, G.; Deletic, A.; Santanouris, M. Technological advancements towards the net-zero energy communities: A review of 23 case studies around the globe. *Sol. Energy* **2021**, *224*, 1107–1126. [CrossRef]
12. van der Schoor, T.; Scholtens, B. The power of friends and neighbors: A review of community energy research. *Curr. Opin. Environ. Sustain.* **2019**, *39*, 71–80. [CrossRef]
13. Pons-Seres de Brauwer, C.; Cohen, J.J. Analysing the potential of citizen-financed community renewable energy to drive Europe's low-carbon energy transition. *Renew. Sustain. Energy Rev.* **2020**, *133*, 110300. [CrossRef]
14. Hanke, F.; Guyet, R.; Feenstra, M. Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases. *Energy Res. Soc. Sci.* **2021**, *80*, 102244. [CrossRef]
15. Reanos, M.A.T. Fuel for poverty: A model for the relationship between income and fuel poverty. Evidence from Irish microdata. *Energy Policy* **2021**, *156*, 112444. [CrossRef]
16. Hoicka, C.E.; Lowitzsch, J.; Brisbois, M.C.; Kumar, A.; Ramirez Camargo, L. Implementing a just renewable energy transition: Policy advise for trasposing the new European rules for renewable energy communities. *Energy Policy* **2021**, *156*, 112435. [CrossRef]
17. Longo, D.; Olivieri, G.; Roversi, R.; Turci, G.; Turillazzi, B. Energy poverty and protection of vulnerable consumers. Overview of the EU funding programs FP7 and H2020 and future trends in horizon Europe. *Energies* **2020**, *13*, 1030. [CrossRef]
18. Directorate-General for Energy (European Commission), Clean Energy for all Europeans. 2019. Available online: https://op.europa.eu/en/publication-detail/-/publication/b4e46873-7528-11e9-9f05-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=null&WT.ria_f=3608&WT.ria_ev=search (accessed on 3 December 2021).
19. Lowitzsch, J.; Hoicka, C.E.; Van Tulder, F.J. Renewable energy communities under the 2019 European clean energy package–Governance model for the energy clusters of the future? *Renew. Sustain. Energy Rev.* **2020**, *122*, 109489. [CrossRef]

20. Caramizaru, A.; Uihlein, A. *Energy Communities: An Overview of Energy and Social Innovation*; EUR 30083 EN; JRC119433; Publications Office of the European Union: Luxembourg, 2020. [CrossRef]
21. Kojonsaari, A.R.; Palm, J. Distributed energy systems and energy communities under negotiation. *Technol. Econ. Smart Grids Sustain. Energy* **2021**, *6*, 1–14. [CrossRef]
22. Weijnen, M.P.; Lukszo, Z.; Farahani, S. *Shaping an Inclusive Energy Transition*; Springer: Cham, Switzerland, 2021.
23. Abada, I.; Ehrenmann, A.; Lambin, X. On the viability of energy communities. *Energy J.* **2020**, *41*. [CrossRef]
24. Dóci, G.; Vasileiadou, E.; Petersen, A.C. Exploring the transition potential of renewable energy communities. *Futures* **2015**, *66*, 85–95. [CrossRef]
25. Martirano, L.; Rotondo, S.; Kermani, M.; Massarella, F.; Gravina, R. A "Power sharing model" (PSM) for buildings of the public administration. In Proceedings of the 2020 IEEE/IAS 56th Industrial and Commercial Power Systems Technical Conference (I&CPS), Las Vegas, NV, USA, 29 June–28 July 2020; pp. 1–7. [CrossRef]
26. Gui, E.M.; MacGill, I. Typology of future clean energy communities: An exploratory structure, opportunities, and challenges. *Energy Res. Soc. Sci.* **2018**, *35*, 94–107. [CrossRef]
27. de Vries, G.W.; Boon, W.P.C.; Peine, A. User-led innovation in civic energy communities. *Environ. Innov. Soc. Transit.* **2016**, *19*, 51–65. [CrossRef]
28. Romero-Rubio, C.; de Andrés Díaz, J.R. Sustainable energy communities: A study contrasting Spain and Germany. *Energy Policy* **2015**, *85*, 397–409. [CrossRef]
29. Magnusson, D.; Palm, J. Come together—The development of Swedish energy communities. *Sustainability* **2019**, *11*, 1056. [CrossRef]
30. Cunha, F.; Barroco, F.; Carani, C.; Nucci, C.A.; Castro, C.; Silva, M.S.; Torres, E.A. Transitioning to a low carbon society through energy communities: Lessons learned from Brazil and Italy. *Energy Res. Soc. Sci.* **2021**, *75*, 101994. [CrossRef]
31. Pulazza, G.; Orozco, C.; Borghetti, A.; Tossani, F.; Napolitano, F. Procurement cost minimization of an energy community with biogas, photovoltaic and storage units. In Proceedings of the 2021 IEEE Madrid PowerTech, Madrid, Spain, 28 June–2 July 2021; pp. 1–6.
32. Gambini, M.M.; Orozco, C.; Borghetti, A.; Tossani, F. Power loss reduction in the energy resource scheduling of a local Energy community. In Proceedings of the 2020 International Conference on Smart Energy Systems and Technologies (SEST), Istanbul, Turkey, 7–9 September 2020; pp. 1–6. [CrossRef]