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Renewable Energy Communities in Positive Energy Districts: A Governance and Realisation Framework in Compliance with the Italian Regulation

Riccardo Trevisan , Emilio Ghiani  and Fabrizio Pilo 

Department of Electrical and Electronic Engineering, University of Cagliari, 09123 Cagliari, Italy

* Correspondence: riccardo.trevisan@unica.it; Tel.: +39-070-6755872

Abstract: Renewable energy communities, first outlined in the European Directives and recently transposed into the Italian regulatory framework, are introduced as innovative entities capable of fostering cooperation between active and passive users involved in the production, sharing, and use of locally produced energy according to innovative management schemes. Renewable energy communities empower the end-customers. Citizens and legal entities are committed to a rational and economical use of energy to achieve the community's climate neutrality goals and pursue the ecological and energy transition objectives defined in the national recovery and resilience plan. In the future, a significant number of energy communities different actors participating from the residential, industrial, commercial, and tertiary sectors are expected to develop within city districts or in suburban settings. This paper proposes and develops a methodology capable of bridging the complexity that can characterise the prototyping, implementation, and management of an energy community within a positive energy district. The approach presented here can also be extended to other application contexts in urban or rural settings. Requirements and best practices for administrative, technical, and technological management have been identified to achieve this goal. Italy is one of the first states to embed in its regulatory framework the European Directives regarding renewable energy communities. These will have a significant impact on network management models and will provide new ways for creating social inclusion that may help achieve climate sustainability goals. A governance model has been formalised for the empowerment of energy community members, outlining a framework useful for planning the proper implementation of a renewable energy community according to current Italian regulations.

Keywords: smart governance; regulatory requirements; best practices; energy communities; citizen empowerment



Citation: Trevisan, R.; Ghiani, E.; Pilo, F. Renewable Energy Communities in Positive Energy Districts: A Governance and Realisation Framework in Compliance with the Italian Regulation. *Smart Cities* **2023**, *6*, 563–585. <https://doi.org/10.3390/smartcities6010026>

Academic Editors: Aapo Huovila, Adriano Bisello and Guarino Francesco

Received: 9 January 2023

Revised: 1 February 2023

Accepted: 3 February 2023

Published: 9 February 2023



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1. Introduction

Energy communities loom large as a key player in the energy transition program outlined by the European community [1]. They attract private sector investment and contribute to the public acceptance of energy projects which, in the long term, will allow for taking advantage of renewable resources. In addition, the benefits generated for the community members affect multiple areas and are not limited to alleviating electricity bills. Other aims include the reduction of pollution and the revitalisation of local economies through the creation of new jobs. Citizens can thus contribute actively and have more responsibility to complete the energy transition [2].

Before the European Directives, some European countries had already formalised the renewable energy communities (RECs) in their regulatory framework, mostly in energy cooperatives, to actively involve the end customers. Figure 1 reports the trend of energy cooperatives in Austria, Germany, GBR, and Denmark [3].

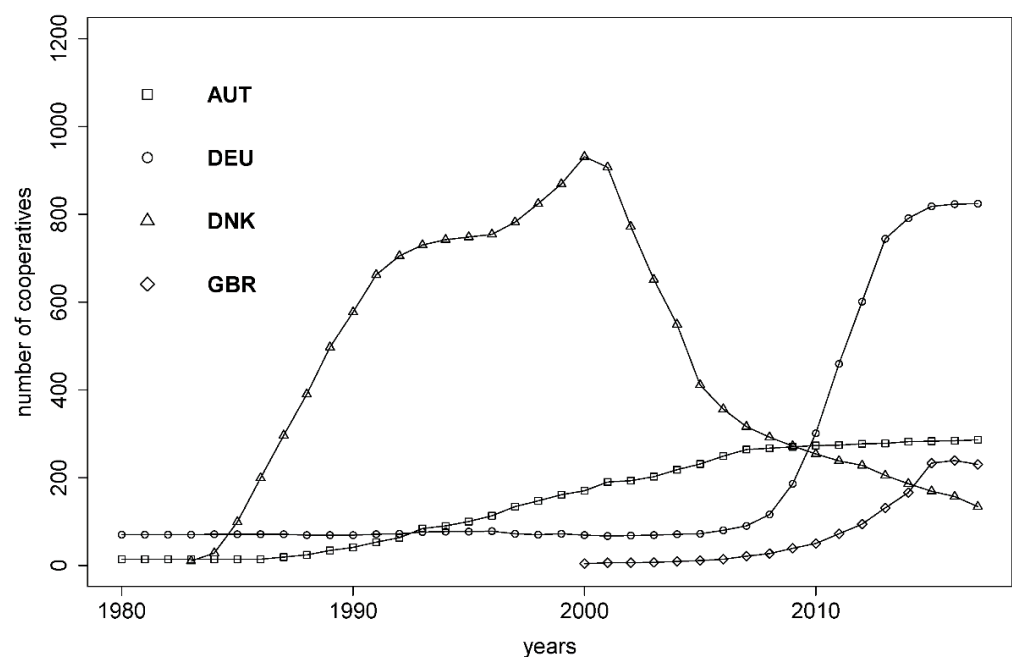


Figure 1. The number of energy cooperatives in Austria, Germany, Great Britain, and Denmark [1].

In [4], the REC phenomenon in Spain is studied from the promoters' perspective. In the UK, the term "energy community" has been used since 1990 [5] and social contextualisation of Energy Communities in the UK, realised thanks to the data retrieved via a survey, is described in [6]. To achieve these projects, the multidisciplinary expertise of professionals from different research fields is necessary [7]. Several studies have shown that part of the success of renewable energy (RE) projects concerns their acceptance among the local communities [8,9]. The social acknowledgement of a common path to walk together is a key driver in determining the realisation and fulfilment of renewable energy projects. In [10], a study in Germany has been conducted, and results show that German energy cooperatives differ in business models, economic characteristics, and coping strategies. Membership is another critical aspect. Results of studies conducted in Germany and Switzerland show that municipal support is helpful in gaining tools for developing municipal energy policy [11]. RECs have great potential to contribute to energy transition [2] in a fair way [12], but it must not be forgotten that said transition comes at a cost [13]. The challenges regarding the regulatory frameworks and policy designs have already been studied [14–16]. De facto, the design of RECs has been approached from a social-acceptance [17], economical [18], and technical [19–21] point of view. Other researchers conducted thorough studies with different approaches to conceive the optimal sizing of the communities [22,23] and by integrating innovative energy storage forms [24–27]. These forms of aggregation are starting to take place in Italy [28–31]. Recently the energy system research organisation (RSE, Ricerca Sistema Energetico in Italian), published a list of the 40 renewable energy communities registered at the Energy Service Manager (GSE, Gestore dei Servizi Energetici in Italian) [32]. At this juncture, it is important to note the lack of research about the internal organisation of the legal entities that will need to be created to institute RECs. Indeed, the role of these organisations in the energy transition is discussed in [33,34]. Still, the focus is on energy management (i.e., smart grid) and assessment perspectives, and the role of active new actors is still to be investigated systematically [20].

RECs are also a viable option to achieve the vision formulated by the energy-positive districts (EPD) [35–38], given that the implementation of energy communities is an essential part of carbon-neutral urban districts capable of producing energy resources to cover their needs. There is a strong link between smart cities, smart grids, microgrids, and RECs [39]. The authors believe that it is necessary to create a body of knowledge, tools, and methodologies for a holistic approach to the energy and ecological transition. To this end,

the ideal to be pursued is that argued in smart cities [40], where data is used to identify solutions to support the community. Knowledge developed in the world of research on smart grids allows for the intelligent management of electrical grids [41,42], operating them in an efficient, rational manner while minimising costs and inconveniences, with the result of guaranteeing a higher quality of service to end-users. RECs, on the other hand, are a useful expedient to initiate a bottom-up process of change, involving end customers by gradually acclimating them towards the use of new technologies and making them aware of new issues. This change must be implemented in stages, and its results will become tangible in the future to come. RECs are the first step to channelling data, network technology, and society towards a greener future for generations to come.

At the European level, there is no unified approach to the development of energy communities, although supranational organisations are working in this direction [43]. Different approaches have been developed at the European level that are not limited to a single approach in the development of RECs. The promotion of energy sharing [44], cost-effective management of the system [45], inclusive policies [46], and regulatory issues related to network and energy markets [47] are all open issues that need to be tackled by the single state with several choices that might not be shared by others. For instance, Italy has adopted a systematic approach at the national level for the development of RECs policies that could lead to their comprehensive and quantitative development [48]. Such an approach could benefit from a bottom-up push from local identity hubs that could count on economic benefits, assume greater independence from traditional players, enhance the sense of belonging to a group of peers, and contribute to the decarbonisation process [49]. A peculiarity regarding the implementation of RECs in the Italian context is how the regulatory authority is interpreting the European Directives, as it has opted for a virtual model of diffuse self-consumption rather than a physical one as in Switzerland, where RECs' members share a single connection point to the public grid [50]. The virtuality of the model allows customers to use the public distribution network to share energy among actors on a widespread area.

Members of the RECs can opt for different degrees of technological support: a network where monitoring and control technologies have a greater degree of penetration allows members to enhance the collective performance by coordinating their actions but also enables the community to provide services to the grid, enhancing its generated value [39]. At the time of writing, the authors are not aware of other regulatory frameworks in other states implemented according to the European Directives as in the Italian approach.

This manuscript is organised as follows: the first part will introduce the European legislation outlining these new forms of active participation to better understand how they have been defined and what role is envisaged for them. The Italian scenario is then presented as a good example for the integration of RECs in the national regulatory framework. A brief discussion of the principles that should distinguish the legal entity that will be used to establish the REC is then provided. The challenges and barriers faced by renewable energy-based projects are discussed in Section 3. A thorough investigation of issues afflicting the full development of such initiatives is mandatory to successfully advance projects based on communitarian participation. Once the context in which RECs operate has been defined, a governance model is proposed that can be replicated in various contexts, including that of positive energy districts, implemented following the Italian regulatory framework.

2. Overview of the European and Italian Regulations

An overview of the European and Italian context in which REC initiatives are developed is proposed in this section. Basic knowledge of the history of such aggregative forms is necessary for a more thorough understanding of their proper development. Furthermore, to comprehend the evolution of the Italian context is fundamental to anticipate possible problems and future challenges related to the integration and implementation of RECs.

2.1. The EU Scenario

The “REPowerEU,” at the time of writing, is the latest plan realised by the European Union that aims at providing solutions to energy issues [51]. Its objectives are to reduce dependence on fossil fuels, save energy, and diversify supply sources in favour of greener ones. However, the energy transition path developed in the European context has much deeper roots. To fulfil its commitments under the United Nations Framework Convention on Climate Change [52], in 2015, the EU established the Energy Union [53], which is in charge of defining the strategic principles for governance in the transition towards a cleaner and more sustainable Europe. The Energy Union marked the beginning of the transition of the entire European economy towards a greener future. It builds upon five closely related and mutually supportive dimensions: the first fosters solidarity and cooperation between EU countries to ensure energy security; the second aims at the creation of a fully integrated EU energy market; the third considers energy efficiency to reduce dependence on energy imports and to lower emissions; the fourth is committed to the decarbonisation of the economy; and the fifth and final dimension supports research, innovation, and competitiveness in low-carbon and clean energy technologies. Those ideals were then disseminated through the directives contained in the Clean Energy Package for All Europeans, the development of which began in 2016 and was completed in 2019 [54]. It comprises eight pieces of legislation and finalises the vision of the Energy Union by integrating it with the latest priorities. The directives that make up the Clean Energy Package focus on energy and efficiency and aim to transform the economy and society according to a new sustainability paradigm.

In the future, the customers will be integrated in the energy markets in an aggregated form. It is believed that this will foster their empowerment, making them responsible for their consumption. Consumers must be guaranteed the possibility of directly managing the energy at their disposal to achieve this objective.

Following the change of the European executive bodies in 2019, the new five-year presidency was immediately oriented towards the development of environmental sustainability. The reformulated objectives are the subject of the European Green Deal (EGD) [55], which revisits and extends the priorities previously defined in the Clean Energy Package. The Energy Union development is set with a far-sighted perspective, and new themes such as digitalisation, green mobility, and circular economy are introduced. One of the EGD main points is the energy transition, which envisages the European citizen as the protagonist of the future at the heart of the transition.

Eight legislative acts form the Clean Energy Package, but for this paper, two of them are of key importance: the RED II Directive (2018/2001) [56] and the IEM Directive (2019/944) [57]. In the RED II Directive, an ambitious target is set: by 2030, renewable sources must meet 32% of the total European energy consumption. The concept of self-consumption and renewable energy communities is defined for the first time in Articles 2.14 and 2.16, respectively. The IEM Directive, on the other hand, discusses the energy market and lays down rules for the generation, transmission, supply, and storage of electricity, as well as consumer protection aspects, to create an integrated, competitive, consumer-oriented, flexible, and fair energy market. The organisation and role of the Union’s electricity sector are then revised. Particularly, some themes are treated with more emphasis, such as consumer empowerment and protection, open access to the integrated market, third-party access to transmission and distribution infrastructure, unbundling requirements for operators and distribution systems, and rules on the independence of regulatory authorities in the member states. RED II and IEM are essential to conceive how RECs might emerge at an early stage of development and how they can develop in future phases following their deployment. Indeed, it is believed that citizen energy communities (CECs), introduced in the IEM Directive, can act as a lever to exercise the local power of RECs on a larger scale in the energy sector. For this to be possible, the appropriate legislative and managerial tools are required to facilitate the coordination of these forms of aggregation. The RED II Directive defines RECs as legal entities with

an open participatory basis, autonomous and controlled by shareholders (or members) located near the production facilities owned and developed by the legal entity representing the community. The purpose of the community is to provide environmental, social, and economic benefits rather than financial profits. Members or shareholders of the community may be individuals, small and medium-sized enterprises, local authorities, or municipal governments. The directive also establishes the rights and duties of energy communities that will have to be transposed into the regulatory framework of each member state. It is stipulated that members participating in these forms of community aggregation for the production and consumption of energy must be able to maintain their rights and duties as end customers without incurring discriminatory or unjustified practices. Private companies whose principal commercial or professional activities would be their participation in the REC are explicitly prohibited from taking part in the REC. It is envisaged that member states will give RECs the right to produce, consume, store, and sell electricity, including exchanging it among community members through the facilities held or selling and purchasing it from the appropriate markets in a direct or aggregated manner. Member states are also required to solicit and promote the development of these forms of aggregation for local energy production and consumption [58].

Thus, RECs are proposed as an innovative tool based on open participation for widespread dissemination of renewable energy generation sources developed by actors directly attached to the local area, who then take on the burden of developing local projects. RECs also emerge as a tool with particular social qualities in that they may also be able to help curb the phenomenon of energy poverty, thereby delivering energy justice [12].

2.2. RECs in the Italian Regulatory Framework

Figure 2 reports the stages of the energy supply chain according to the operator of the Italian transmission network (Terna) [59]. RECs introduce new elements of complexity in the management of the electric grid, namely distributed energy sources (DERs), such as photovoltaic (PV), wind, etc., installed at the distribution networks level and within the premises of end-users. In the future, end-users will be able to take part directly in local energy markets, providing services to distribution and transmission system operators [60].

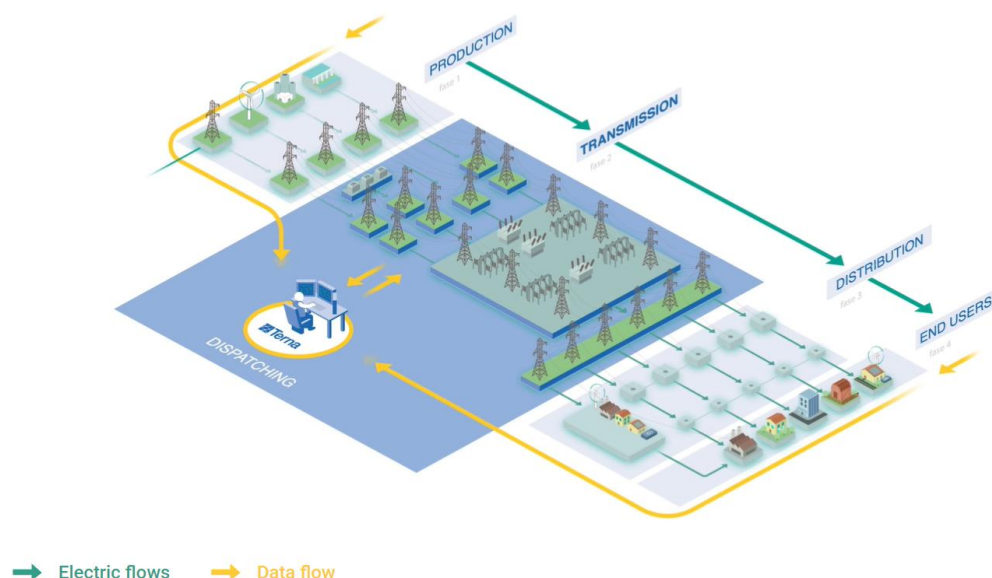


Figure 2. Graphical representation of the Italian energy supply chain [59].

The characteristic of non-storageability of energy at the power distribution or transmission grid complicates the use of distributed energy sources, which can also lead to the reversal of energy flows during peak generation times. The transmission and distribution systems were designed to “connect and forget” the end loads that lead to radial configurations. In a system that will have to account for a rising number of decentralised resources,

the role of active consumers becomes crucial: they are expected to modify their behavioural attitude from a purely passive one to a proactive one by adapting their consumption and production profiles in response to changes in market prices and to provide grid services if the appropriate conditions are in place to do so. The end-user's role will thus no longer be limited to the choice of his or her supplier, being able to rely on self-generated or locally produced energy within the energy community equipped with storage systems and energy-sharing policies among users.

In Italy, renewable energy communities have been introduced experimentally with Decree Law 162/2019 [61] through Article 42-bis. The subsequently implemented decree 8/2020 [62] definitively integrates the RECs into the regulatory framework. The RED II Directive was implemented with Legislative Decree No. 199 of 2021 [63], which changes the constraints previously defined for REC implementations. For the present discussion, RECs are considered in their latest form, synthesised in the most recent resolution of Arera [64] where energy communities are conceived in a more complex context that includes various forms of widespread self-consumption. At the time of writing, the implementing of a decree regarding Legislative Decree No. 199/2021 has yet to be issued.

The Italian legislator did not distort the nature of RECs in the transposition into the national legislation but instead adequately defined these forms of aggregation and the entities that can participate under the existing country regulation. The possibility of providing a range of services to members of local communities is also not precluded, for example, the participation in energy markets, the provision of local and global ancillary services, and the development of initiatives not necessarily related to the energy world. Thus, the active participation of community members is required and favoured outside of their role as energy consumers and producers. The need for professional figures who can design, operate, and maintain RECs could also generate new job opportunities from the management, plant installation, managerial, and legislative side in terms of economic relations among users. RECs could also act as a catalyst to promote the redevelopment of inland areas [65].

In compliance with European regulations, the Italian authorities have also defined incentive tariffs dedicated to shared energy among the members within the community's perimeter. This aspect confers onto the RECs the important characteristic of attractiveness for the territories. Finally, the Italian transposition of RED II stipulates that the REC members must all be fed by the same primary substation and that the capacity power of any generation plant among those under the control of the REC must not exceed 1 MW [66]. Some exceptions regarding state-owned facilities and buildings are included.

At the administrative level, a REC must profile itself as a legal entity with open and non-discriminatory participation whose purpose is to provide environmental, social, and economic benefits rather than financial profits to its members or the territories in which the community operates. Members belonging to a REC continue to benefit from their end-customer status and may also disassociate themselves from the community body at their discretion. Those who wish to create an energy community need to establish a legal entity and define rules to govern the relationships among its members. In addition, it is essential to identify a contact person who will maintain relations with the GSE, which is the authority in charge of the monitoring and access to energy valorisation and incentive services. In the case of energy communities, the contact person is the community itself. Since this paper does not provide details on how and what to include in the formal documents to be drafted by a general entity, reference is made to the guides developed by the appropriate authorities [67].

Regarding the type of legal entity, various solutions can be opted for (e.g., consortium or cooperative societies). Cooperative or unrecognised social-purpose associations can easily comply with the regulations set in the national framework and provide sufficient flexibility to operate RECs of different sizes involving heterogeneous profiles.

Cooperatives and Unrecognised Membership Bodies: Responsibilities and Institutional Bodies

Unrecognised social-promotion associations enable, especially at the local level, the pursuit of a common, cultural, ideal, or philanthropic purpose and can be operated with reduced formality and cost. To fully understand and justify the governance model formalised in the next section, it is necessary to determine what must be defined at the stage of establishing a social-promotion association to fulfil its obligations. As previously mentioned, it is not in the scope of the present work to discuss the details of establishing such an entity, as there might be significant differences among countries, but rather to highlight the basic elements of interest. Some aspects that motivated the decision to establish energy communities as cooperatives or associations in the Italian context are hereby discussed.

The social-promotion association reflects the principles listed in the European enactments. It is suitable for establishing renewable energy communities because they have the appropriate flexibility for adaptation in the context in which they are implemented. The peculiar inclusive nature on a relatively limited territorial scale requires knowledge of the local culture.

Another option for establishing the legal entity is the social-purpose cooperative. Cooperatives are societies with variable capital based on mutualistic, solidarity, and democratic principles established to jointly manage an enterprise to provide members with goods or services to achieve its corporate purpose. The cooperative principles are, in general, voluntary membership, democratic control by the members, economic participation of the members, autonomy and independence, and concern for the community. Management must therefore be democratically operated by the members who actively participate in the cooperative's policies and decisions. The cooperative also benefits from the perfect patrimonial status, i.e., only the company is liable for obligations with its assets. Generally, in the so-called Latin system, the corporate bodies are the assembly of members, the board of directors, and the board of auditors. Similarities with the previous association of social purpose are numerous. It is believed that cooperative societies may be a more popular alternative for realising energy communities, so much so that other European experiences have also realised such forms of aggregation according to cooperative schemes [3,68,69].

3. Materials and Methods

The critical aspects for the formulation of a governance model are discussed in this section. The literature regarding experiences with a socially oriented vocation conducted in the European context helps identify the critical factors that lead to success. The vision and mission for RECs are formulated, governance defined, players and stakeholders identified, and informational fluxes mapped. However, the governance of responsibilities for operational activities will not be dealt with in detail.

The governance infrastructure model has been specifically designed to put the members or, in general, the shareholders at the centre of the decision-making process and to check the fulfilment of the community objectives. Finally, this section considers the formalisation of the process for creating an energy community by sequencing the implementation steps which, in turn, comprise a series of activities. A practical graphical framework is then proposed to provide a general idea of what should be undertaken during the creation process of a renewable energy community.

The authors would like to clarify that the considerations in this section do not define a business model (BM), i.e., this paper does not aim to analyse how the entity fulfils its mission and vision in terms of strategic partnerships, creation of value, customer/provider relationships, key resources, activities, etc. Neither is it the authors' aim to identify the cost and revenue structures. One motivation is that other researchers have already conducted such an analysis [70]. Another predominant reason is that the research objective is to provide structured knowledge, which should help realise RECs linking "corporate" and "operational" governance.

Nevertheless, it is inevitable that some of the considerations made share some commonalities and are mandatory and valuable even during the definition of a business model since, obviously, for coordinated and functional management, a shared vision and shared values must be defined. The governance model formulated can be identified as an organisational governance model in conformity with ISO 26000 [71], which defines it as “a system by which an organisation makes and implements decisions in pursuit of its objectives.” Particularly, a focus on how the members can be empowered to take a more active role in community activities is the object of investigation.

Analysis of Success and Critical Factors

Defining a governance model is critical when multiple figures are expected to work together for a common purpose, and even more so if the participants are doubtful of each other, as might happen. Complexity must be conveyed and harnessed by the executive boards, who, in turn, must exercise their decision-making power and control over those who conduct more operative activities. The definition of a governance structure in the previous section makes it possible to activate “the machine” and properly monitor and maintain it. The power of a governance model also lies in its specificity. What will be presented is expressly tailored to RECs. That said, this model can also be applied in other domains in which sustainability, collaboration, and decision-making power should be entrusted to members. The replicability of this model is desirable. Adapting the governance model to various contexts is a fundamental requirement. It is hoped that the model defined will be useful in ensuring clear and transparent coordination and effectiveness of the RECs.

Social projects to empower its members or, in general, its beneficiaries have been documented in the literature, although not necessarily in the energy field. To this end, the literature has been reviewed to define the most common criticalities to better address them in the proposed governance model. It emerged that the social acceptance of these projects is crucial. In [72], the importance of belonging to a particular geographical area and the resulting sense of attachment is analysed to facilitate social acceptance. A framework for the operational governance of RECs cannot transcend from the individual community member, who must therefore be able to exert his or her influence on the decision-making processes and future developments of RECs. It is believed that democratising energy dictated by the energy transition can act as a driver for social transformations and technological innovations [73,74]. Projects developed and focused on renewable energies can contribute to addressing the decarbonisation challenge. Still, the path to their realisation intersects with a community’s cultural, territorial, and social roots, which are identified as a success factor [75,76]. A deeper analysis is realised in [77], where proximity, coordination, flows, and connections are considered crucial links between innovation and the economic geography of a territory. Participation in energy development projects through cooperation among stakeholders fosters their inclusiveness and participation [78], acceptance by members, and the sense of power they can exert through their influence in decision-making processes [73,79]. It also emerged that many community projects are more influenced by a few participants identified as leaders, especially in rural areas [73,79]. [80] concludes that leadership could help form a strong base towards the success of community projects. In [81], it is argued that funding could lead to complications that might involve the whole community. Funding schemes could play an important role from the social-acceptance and cooperation point of view. [82] reports other experiences that show a lack of success is due to the inability of the members to align their objectives. It has also been shown that projects whose intent is to contribute to the democratisation of energy and active participation show an increase in their acceptance by the local populations [83].

In [84], the development of biogas projects in the Netherlands and Denmark in the agricultural sector under a socio-cognitive evolution perspective is studied. The study showed how the history of the development of such plants is strictly linked to the expectations and perspectives of the actors involved. Furthermore, grant schemes and developing regulations greatly influence the development of community projects.

The authors of [85] studied the energy transition with a multi-level perspective (MLP) and concluded that niche innovation (PV, wind, biomass, etc.) is the seed for such system changes. In [86], the role of prosumers as niche innovators with an MLP approach is investigated. The geographical differences factor, i.e., the differences among the actors that join an RE project, is a key factor which enables the understanding of the different territorial perspectives. Public administrations (geopolitical factors) are considered important players in organising projects involving communities and renewable energy.

RECs enable the cooperation of different subjects of the social structure and institutions system. [87] investigates the distinction and interrelatedness of social institutions, categorizing them into households, private firms, public agencies, and non-profit organizations. It is possible to conclude that RECs foster the collaboration among social institutions to provide new social welfare services.

It appears that a top-down management of RE projects is the cause of the disempowerment of the local actors. The EU directives promote a decentralised approach to RE projects realised at a local level. It is worth mentioning the so-called environmental governance ideology, which includes government, businesses, and civil society in the decision-making processes to capture a wider range of inputs and provide a better answer to the complexity that characterises the system [88]. According to this ideology, embracing a more democratic decision-making model would facilitate governance whose effectiveness depends on the level of stakeholder participation. A management model characterised by strong community influences is the so-called co-management [89], a community-based natural resource management and multi-stakeholder model. The above models can provide a solid foundation for developing innovative governance, not just from an ideological perspective. Of course, adjustments must be made to better develop a model that best suits RECs. For instance, a collaborative governance model is flawed in legitimising consensus. The multi-stakeholder model instead provides this feature due to the assumption that consensus is only built if sufficient input is provided by all the actors involved. On the other hand, a collaborative model allows for the alignment of vision and the ironing out of internal differences [88,90]. In the past, different forms of governance have enabled dialogue between public and private (public–private partnerships) or between private and social (private–social partnerships). RECs seek to bring all actors into dialogue: public, private, and social. A table must therefore be set up to foster dialogue between the social, state (public), and economic (private) worlds.

However, energy communities also provide the opportunity for knowledge development in various fields, such as technology [91,92]. The activities that ensure their operation are high-tech and range from cybersecurity to communication systems to artificial intelligence to develop models that can optimise self-consumption performances [93]. Thus, it can be said that the requirements to realise an energy community are not only social in nature but also involve the sphere of technology that operates to support the activities. An infographic depicting the requirements in social and technological terms is provided in Figure 3: social will and commitment to information dissemination by local government, as well as a proper mechanism of funding RE projects, are fundamental. In terms of technology, network measurement and control systems are indispensable nowadays.

DERs cannot be fully integrated into the electricity network without the appropriate technologies, including those in information and computing and cybersecurity technologies.

From a social point of view, readiness and awareness of the energy transition process are crucial. To succeed, the broad participation of all actors, private citizens, public institutions, and commercial/industrial enterprises is desirable. It should be emphasised that a forerunner role is often required for such initiatives that can hardly be found in the individual member of civil society. The actors that will be involved must be willing to cooperate and carry out the necessary activity, also by accessing funding sources. Mutual trust is considered another crucial aspect.

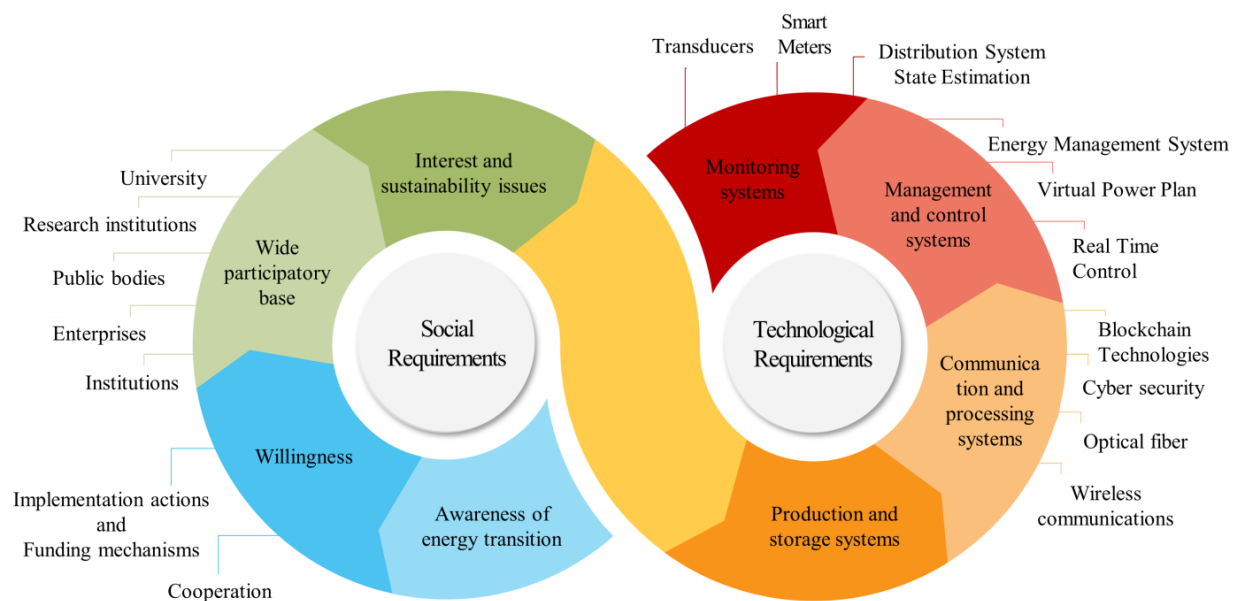


Figure 3. Social and technological requirements.

The technologies are already available, although many of them can be costly. However, they will play a leading role in the future, particularly in the automation of the community smart grid. The technological level that the community adopts will determine the level of direct involvement of the actors and the costs associated with investment and maintenance. But, thanks to the system's operational and control algorithms, the users might perceive higher quality, positively impacting the REC project acceptance. The factors that determine and influence the success of REC initiatives are multiple and transversal. Figure 4 shows the factors that can help to analyse the political, economic, socio-cultural, and technological changes in the business environment (PEST analysis, [94]) for identifying critical influencing factors. In this case, the analysis is not limited to external factors.

Political factors are associated with the uncertainties or delays in transposition into the national regulatory framework of European Directives. Also, priorities in the government's agenda may determine the timing and scope of the RECs. Bureaucracy is another critical point. Convolved bureaucratic processes hinder the realisation of REC causing a strong entry barrier. In addition, sufficient room for manoeuvring must be ensured for energy communities in terms of development options. If excessively circumscribed or constrained, they may not be sufficiently attractive. Attractiveness is also strictly linked to tax regulation, which is usually facilitated for RE projects. For instance, the incentive for shared energy, reserved for energy communities in Italy, is not taxed since it is not compared to a profit but rather as a non-refundable aid. On the other hand, the sale of excess energy is considered a profit and is, therefore, taxed according to national regulations.

Economic factors can be related to the landscape in MLP theory. The identified factors are relative to a macroeconomic context and determine its structure and degree of attraction for the actors involved. The presence of an incentive tariff is a positive element in the attractiveness of energy communities, considering the cost of energy is rising sharply. In addition, the prospect of solid and lasting economic growth may make stakeholders and investors, respectively, tend towards the contraction and granting of long-term loans for realising the investments required to build the necessary infrastructure for the REC.

Many technological factors, particularly their degree of maturity, also determine the possibility of realising energy communities. As noted above, the operations of a REC are ensured by a sophisticated energy-monitoring and control architecture that can take on increasing degrees of automation. The level of innovation and life cycle of renewable energy technologies, as well as communication and control technologies, are relevant aspects due to their direct influence on costs. Technological aspects of supporting the

development of energy communities are not only related to the community's environment, since considerable investments by grid operators are necessary. In the PNIEC (National Integrated Energy and Climate Plan) [95], measures are identified to realise a flexible, stable, and controllable electricity distribution network. The same document states that estimating the overall extent of the modernisation measures needed to achieve the objectives is extremely complex, given the varied geographical placement of distributed generation (predominantly from photovoltaic conversion) and end-use electrification. For the latter, the most substantial effects are expected in areas having a high population density. In contrast, the effect of distributed generation is more recognisable in rural areas having a small load. In any case, the spatial coherence between generation and load does not guarantee a temporal coincidence between production and off-takes, with injections that are not consumed locally (by a single utility or by neighbouring utilities) possibly returning at higher levels of the network. In this scenario, the cost estimate according to the plan for upgrading the electricity distribution network is EUR 21.4 billion.



Figure 4. PEST analysis.

The link between social and technological factors must also be considered: generally, the elderly population is less accustomed to new technologies and thus exhibits more resistance to changes [96]. It should also be considered that many social factors are often mutually interconnected. Individuals with lower incomes cannot afford the financial outlay for renewable generation facilities, but statistically, it is also known that their income correlates with their education level [97]. This is also why approaches have been investigated to facilitate acceptance of the energy transition [98]. The acceptance of projects

aimed at sustainability is also linked to the population's involvement level and their political orientation [99].

Generally, as is often the case in such complex systems, the critical factors for the success or failure of RECs are dynamically interconnected. Given all considerations, the proposed governance model is intended to enable community members to exercise their due influence effectively without incurring excessive responsibility of the singular, particularly in operational activities. Therefore, the governance model must ensure that the REC is community-driven. Hence it is important to focus on the decision-making structure. Light, sustainable, and collaborative are the attributes that characterise the governance model. The underlying principles on which the model is based are:

- Proportionality (in the narrow sense): An excessive burden on the individual, in relation to the objective sought to be achieved, must not be imposed [100].
- Accountability: It is required in the processing to live up to expectations and demonstrate the effectiveness when requested [101].
- Inclusiveness: Participants must be made part of the decision-making process [102].
- Transparency: The highest degree of transparency must be ensured wherever possible, as this strengthens the democratic nature of the institution and the public's confidence in the administration [103].

To ensure users' centrality, RECs must be, not only by regulatory provisions, inclusive and accessible and ensure transparency, security, and confidentiality (where necessary) of their activities. RECs should develop best practices that can be applied to broader scenarios. These ideals must be reflected by the social purpose of the entity that will be formed. At this point, it is possible to define the vision and mission of an energy community. These may vary from case to case and should be developed following the social sentiment of the region where the RE project is conceived. In this scope, we abide by what is stated by European and national bodies. The vision of a community relates to the contribution it can make to the decarbonisation process, as a zero-emission energy and economic system aimed at sustainability and circularity of resources can do. Still, it can also consider more "intimate" and restricted community goals of particular importance for the community. The mission, in turn, must also reflect national and European goals: to reduce greenhouse gas emissions through the decarbonisation of energy supply sources, to reduce the cost of energy, to curb energy poverty, to increase local competitiveness, to revitalise the local area, etc., but even then, it can be customised according to the needs and tendencies of individual communities. Even so, energy communities require heterogeneous and transversal competencies to properly be developed and managed, but their final goals are also peculiar. In the next section, a governance model for the infrastructure of the REC is formalised. The players are highlighted, and the information flows among them are represented to properly contribute to a decision-making process that considers the directly interested personalities.

4. Results and Discussion

4.1. Infrastructure Governance Model

Energy communities should try to involve as many players as possible located in the proximity of the production plants and, in any case, connected to the same primary substation. Local stakeholders must define the goals that the community shall try to achieve. Verifying that the goals are accomplished will be necessary by comparing them with the obtained results. A performance assessment process [104] requires metrics [105], i.e., key performance indicators (KPIs), to perform the verification of energy performances, as well as the achievement of economic and social goals. KPIs can also be used to inform and actively involve community members. A REC should be able to identify, plan, execute, control, and evaluate its actions in a continual improvement process.

In Figure 5, the model for effective community governance is represented.



Figure 5. Areas of the governance model: Advisory, Tactical and Strategic.

The model is structured into three areas. Each area is characterised by its participant actors and functions that must be accomplished cooperatively and coherently with the other areas. The system (i.e., the REC) output is the result of each area's joint and coordinated actions, which determines the ability to achieve the predefined mission and, ultimately, the vision.

The Advisory area is responsible for community engagement: any single member should be able to exercise decision-making power in an organised, results-oriented manner. Community engagement should not be limited only to members or shareholders. Still, it should also include external stakeholders, which can be audited to identify unseen needs and solutions to enhance the performance.

The Strategic area oversees prioritisation, defines best practices to reach objectives, operates its controlling power, and reports directly to the members to operate a retrospective analysis. Achieving the defined objectives and fulfilling the REC's mission and vision are also monitored.

The Tactical area involves the actors contributing to realising the required activities to achieve the REC's objectives. Solutions can be provided by specialised external parties that otherwise cannot be found among community members.

The intersection of single areas distinguishes what the joint effort leads to. The contribution of external actors (i.e., non-members) should be considered and evaluated first by the Strategic area, which then will refer to the community. The ability to define solutions should result from the interaction of the Advisory and Tactical areas. The Advisory area should present problems and needs, whilst the Tactical area should address them effectively. The Strategic area acts as an intermediary that holds the process together. Strategic and Advisory areas interact to assess and evaluate the achieved results. The coordinated effort of all three areas possibly delivers fruitful governance.

Reporting and communication activities between community members, delegates, or third parties in charge of carrying out operational activities are fundamental for aligning the community and achieving an unambiguous consensus. Figure 6 illustrates the previously defined areas and the exchange of information between them.



Figure 6. Areas and information exchange.

The members of the configuration must define the REC mission and vision. The community's internal governing bodies operate towards fulfilling this mission and vision using internal and external resources, adopting the technical and managerial tools required. The Strategic area serves a pivotal role, as it is responsible for the translation of the needs of the community into specifications, whilst the Tactical area provides the operating solutions. The Strategic area is responsible for controlling and reporting activities as well.

The proposed model fits Latin, monistic, and dualistic system-based governance models. The authors believe that the Latin model is the preferred one because there is strong control of the shareholders' meeting over the board of directors (BoD). Also, by virtue of what was defined in Section 2, in Italy associations or cooperatives must have an assembly and a governing board. In the case of a cooperative, it must also institute a board of auditors. In this paper, a distinction is made between governing and supervisory bodies to achieve a model that is as general as possible. Nevertheless, it is easy to bring back the same principles to the monistic and dualistic governance models as administrative and control functions are always highlighted.

Figure 7 shows the previously defined areas and internal organisational figures, shareholders, stakeholders, and the functions/actions they perform as participants in the entity are also reported.

Shareholders ensure their decision-making power by expressing their needs, requirements, opinions, and decisions. These are formalised during the assembly of the REC. The community engagement process must involve community members and third-party stakeholders, i.e., executive implementation solution providers who contribute by providing input and support at the Advisory level regarding Technical and Technological solutions to ensure acceptance of the project by the broadest possible user base. The Tactical area has been divided into two sub-areas. The Technical area aids in implementing the facilities and counselling regarding funding and bringing about the interventions the community wants to carry out. The Technological area is where services required to ensure the operation of the energy community and the consolidation of performance are identified. This subdivision, which will be further delineated in the following section, aids in the decomposition into sub-problems.

The assembly defines the lines of development for the Strategic level, where the BoD is responsible for the REC advancing in accordance with what members decided. The BoD also plays the roles of facilitator and mediator: the literature shows that direct involvement for some members results in disassociation from the project's intent. The components of the BoD must be trusted personalities recognised by the community. Additional BoD functions are supervision, control, and monitoring of the activities performed in accordance with the assembly. These activities, materially executed by the Tactical area people, are supervised and controlled by the Strategic area, meaning that the BoD shall provide the organisation with those functions. The BoD, together with the board of auditors (BoA), as considered in this context, must enable the community members to alleviate any management and

administrative burden that might fall on them, increasing the perception of value generated by the community.

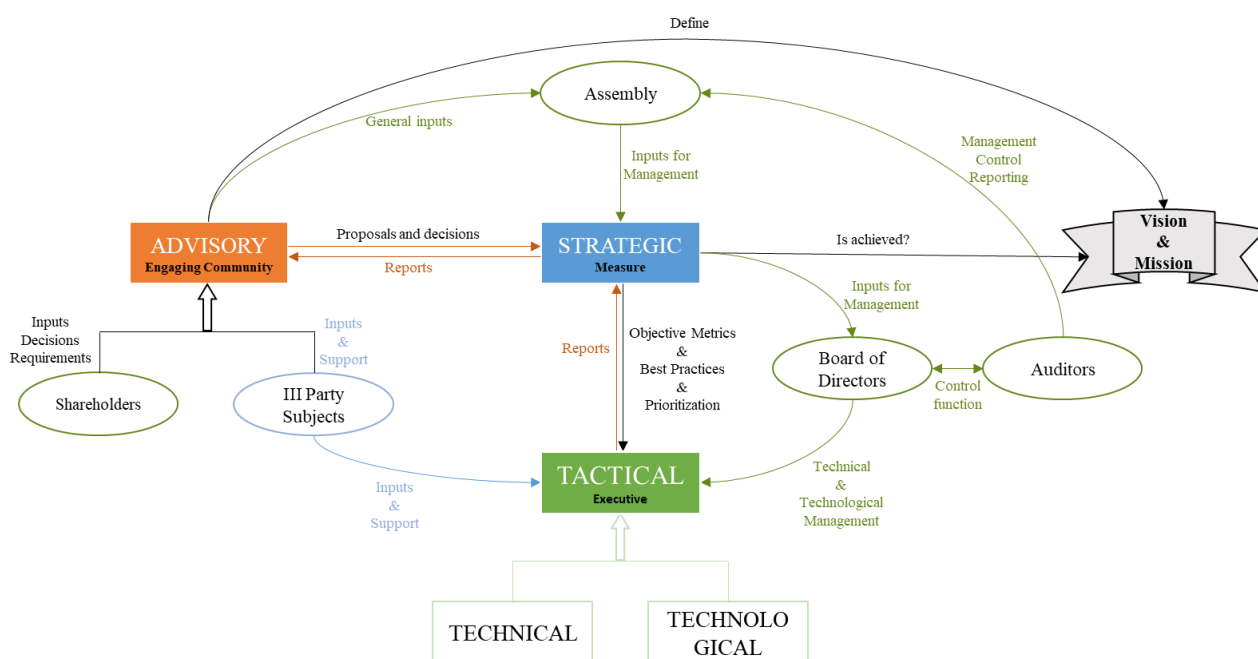


Figure 7. Governance model, information exchange, and bodies of the organisation.

Following the provisions of the Italian Civil Code, cooperative societies must proceed to the appointment of a board of auditors whose duties are set out in Article 2403 [106] and 2403 bis [107]. The most important of these relates to supervising the adequacy of the company's organisational, administrative, and accounting structure. However, this legal obligation allows the verification and consolidation of management practices that, in case of irregularities, are reported directly to the assembly meeting. The BoA monitors compliance with the policies and rules reported in the community's bylaws.

The outlined governance conforms to the traditional (Latin), governance model in which the powers of administration and control are vested in two different bodies, the BoD and BoA. However, these needs highlight necessity for greater transparency and inclusiveness within the energy community. For this reason, the contamination of the controlling and reporting functions within the BoD are fundamental, as is the importance of the role of the Assembly in expressing to the BoD the will of the members on the future of the community; these roles are the instruments of empowerment of any community consumers, prosumers, and producers.

The Community Manager

Communication and dissemination of information are crucial for the energy community. Because of the known issues related to active participation and acceptance of projects aimed at sustainability issues, an internal role has been prototyped to contribute to the alignment between individual members and the community's institutional bodies, ensuring active participation and a greater acceptance of the project. Such a new role is the community manager (CM). In the outlined governance model, the CM's internal role is of paramount interest as the facilitator for fulfilling the community's mission and vision. The CM must have technical and social skills to manage the local community. The CM's widespread work can guarantee the users' alignment by creating further synergies among members and reducing conflicts, increasing the project's acceptance with economic, social, and environmental follow-ups. The CM role is the pivotal junction between the Advisory and Tactical areas, operating strategically. The CM could also assume a role within the BoD, but it is not mandatory. The CM can be a community member, or a manager hired by the

REC. This choice heavily depends on the context in which the initiative is developed, the participants and the relationships between them, and the level of specialisation required. The CM operates according to the rules of the community, which have been laid out in the statutes, and supervises the operations to ensure they are carried out accordingly. The CM can be responsible for the apportionment of incentives among community members and may carry out referral activities with the GSE if mandated. The CM may be entrusted with the organisation of scheduled maintenance of the community facilities. In this context, the CM can control the third parties that provide goods or services to the community to allow the right of association and the right to leave the community to everyone. These activities require configuration updates that must be communicated to the GSE. The CM may be entrusted with additional tasks, such as, managing the relationship with users, not only administratively but also aiming to create greater synergy within the community. The CM, thanks to diagnostic information provided through energy-monitoring and reporting systems, can support users with reports containing statistics about their energy performance and recommendations for increasing it. This activity of raising awareness and stimulating proactivity is also one of the cornerstone principles of energy communities or PEDs. The CM may also promote community awareness to increase territorial inclusiveness, expand the REC's catchment area and action, and create connections and relationships between member and non-member entities that can create virtuous win-win cycles. Testing internal sentiment is relevant to stimulating active participation of and acceptance by users. Therefore, monitoring activities to probe the level of member satisfaction could be part of the CM's activities, and it may be useful to check the status of the project and, possibly, identify and resolve issues. The CM's general tasks are summarised in Figure 8.



Figure 8. Tasks of the community manager.

4.2. Proposed Framework for the Creation of RECs

The framework to support REC creation is not designed to provide a minute level of detail for implementation but rather to identify the main points to consider during this process. For its formulation, it is essential to define the project's phases that enable the REC's creation and full operation. As illustrated in Figure 9, five stages have been identified. Each stage includes multiple activities.

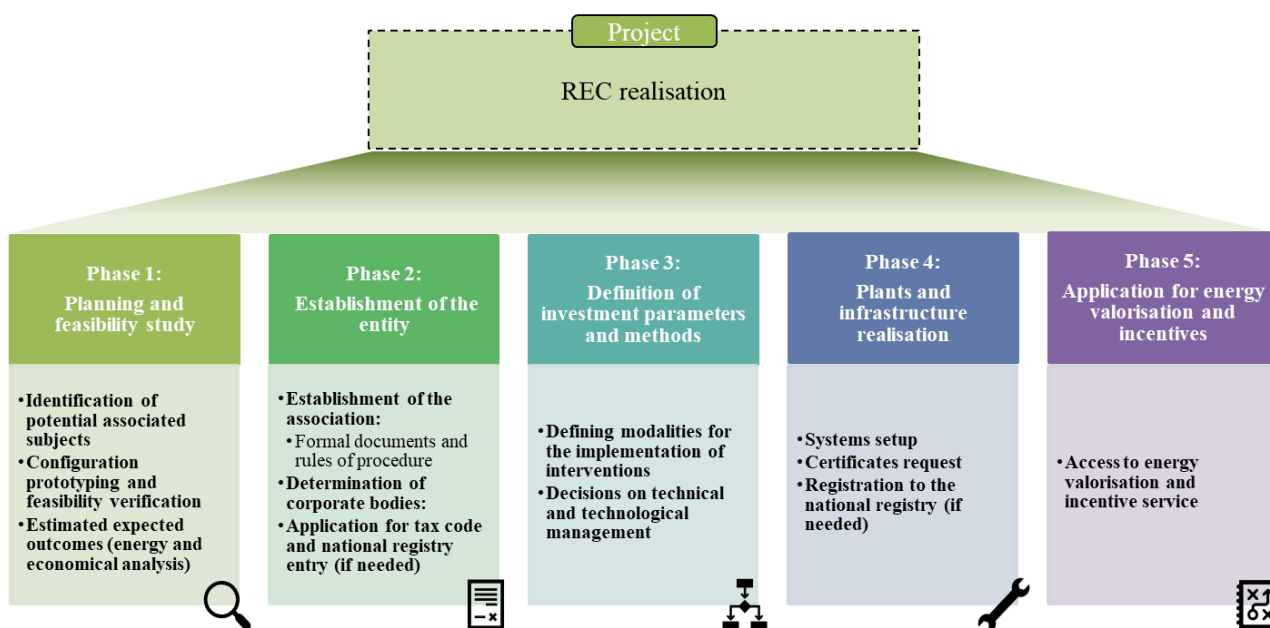


Figure 9. REC realisation process.

The first phase is the initial planning, which includes the identification of local stakeholders, potential members, and the economic and energy benefits. PEDs and RECs are dynamic entities: members can join or leave at any time, but it is important to define a mission and a vision. These must be as consensual as possible, not only for the current members but also for future members. Other studies to investigate the local territory and the social fabric may be conducted depending on the needs of the specific community. Future members must then proceed to the establishment of the entity. It is necessary to draw up formal documents and define the rules for managing relations among the members and establishing the internal bodies. The third stage involves the definition of the investment parameters and methods. Members must make technical and technological decisions, but appropriate professional figures should support them.

For the implementation of the governance model, a graphical framework is introduced in Figure 10 that summarises the multiple disciplines required to realise a REC or a PED.

It was decided to adopt a decomposition approach to address a complex system to focus more on different areas. Therefore, three scopes were identified: administrative, technical, and technological. The last two were mentioned earlier, and their combination forms the Tactical area. The three scopes should not be considered watertight compartments. The interfaces between them are represented by the set of rules, procedures, and methodologies adopted by the community. The actors that take part in the life and activities of the community can still be identified: members, internal bodies, and third-party entities. External subjects, such as service providers, are reported in a semi-transparent blue box. A category of third-party subjects is the energy supplier reported in the figure to emphasise that, per regulation, members must be guaranteed to pertain to their preferred energy provider.

Within the three identified scopes, modules (white boxes) are located. Modules group sets of related aspects that must be addressed jointly. The module's corresponding elements identify specific tasks (orange boxes).

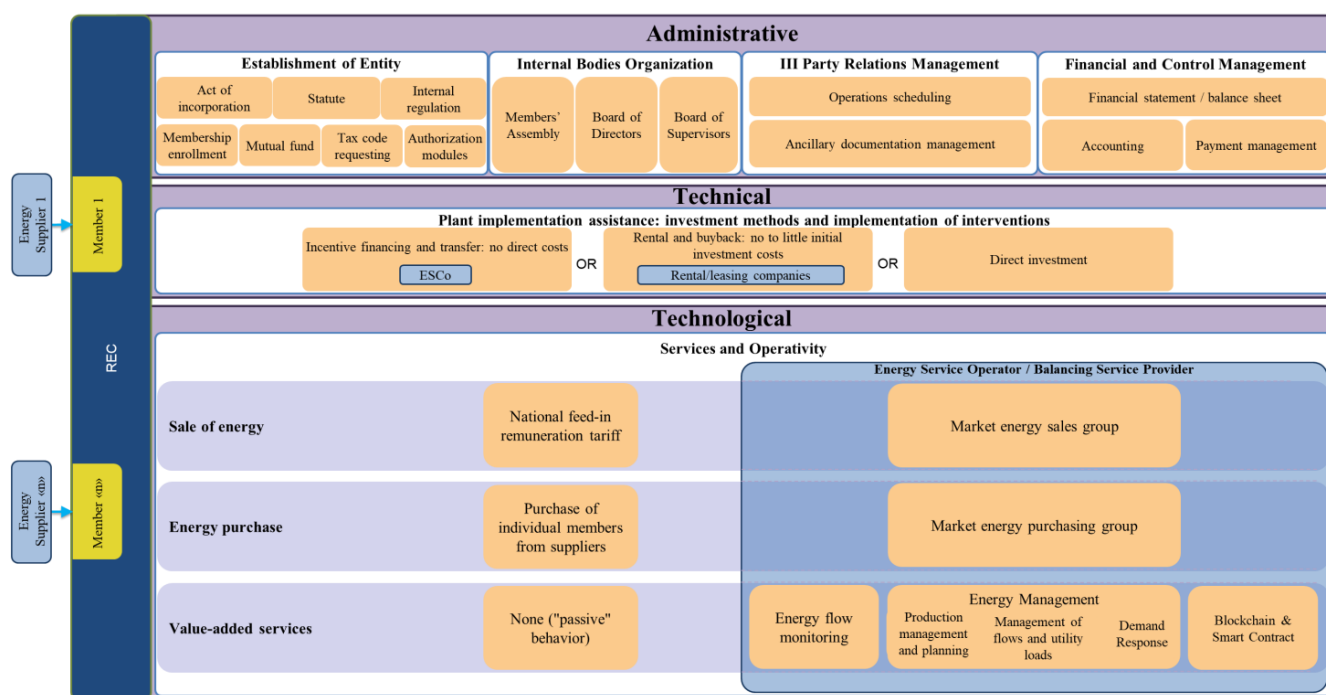


Figure 10. REC realisation framework.

The administrative scope has included a series of modules composed of tasks for the proper establishment and future management of the community under the previously presented governance model. It is necessary to establish the organisation, and then the organisation and arrangement dynamics of internal bodies must be defined. Subsequently, the entity should define how to manage the relations with third-party providers. Generally, such details should be defined by the BoD in compliance with the assembly indications, if any. The entity's financial management is another matter of relevance, as compliance with national regulations must be ensured. The account of the community's activity must be appropriately drawn up according to the national body of law. Operational and non-operational management items, such as financial management, may vary as individual member states may define specific support mechanisms and financial instruments for the development of energy communities. In general, a detailed study of the community's capacity and ways to generate income is required before the organisation is established. Annually, this plan should be reviewed and revised by the relevant internal bodies.

Investigation of the financial instruments available nationally and internationally for the implementation of facilities to serve members will need to be conducted. These aspects, together with national regulation, profoundly influence the dynamics of financial management to be adopted by the entity. In general, the entity will have to produce the balance sheet, the income statement, and the cash flow statement to comply with financial reporting requirements. Any interim reports may be mandated by the members for greater control and monitoring capacity. An important document, not related to financial reporting, describing the number of affiliated members could be requested and drafted as entry and exit of individuals from the organisation could affect future growth prospects. A more in-depth investigation into costs, revenues, and financial flows generated by a REC is realised in [70].

In the technical scope, the activities related to implementing the facilities required by the community and its members are grouped. Particularly the investment model is discussed. There are four options for the community or individual members to implement the required facilities. The first implies contracting with an ESCo. This solution must be evaluated for the individual case, but, in general, it does not involve an immediate direct cost. Alternatively, the community or a user may decide to access facility rental services to

reduce the initial costs of investment. Alternatively, there are possibilities regarding the direct investment solution which may vary from country to country.

In the technological scope, the module concerning the services for the operation that the community will decide to use is reported. In future electricity market versions, communities will have the possibility to decide how to operate concerning the purchase and sale of energy. Community members can choose to access the remuneration service for energy fed into the grid that, in Italy, is provided by the GSE, or enter the energy market as a sales group. Just as with the sale of excess energy, the community must decide how to purchase: members can establish a purchasing group to enjoy more advantageous prices. It is worth pointing out that most services that might generate added value to the community are provided by third parties, such as energy service operators (ESOs) or balancing service providers (BSPs) with specialised knowledge. In other words, the community's more "active behaviour" implies the need to be assisted by experts.

Since the proposed model stimulates awareness through participation, there is a risk that the operational life of the community will be slowed down or stalled due to conflicts between members, as highlighted in the discussion above. This can result in the creation of convoluted procedures that, while complying with the principles outlined above, can cause the organisation's inability to make decisions, thus causing the community to collapse. It is therefore necessary to opt for the right degree between formal rigour and flexibility.

5. Conclusions

In this paper, a governance model is presented for structuring the creation of a renewable energy community in a positive energy district. Its development is carried out under the dictates of current Italian legislation, implemented following the issue of European Directives. Considering the socio-technical-economic characteristics of renewable energy communities, two legal entities have been hypothesised: the cooperative and the association with a social purpose. A light, sustainable, and collaborative governance model has been formulated for these types of aggregation based on analysing the success factors and the criticalities that characterise the energy communities in European and non-European countries. The proposed model is inspired by proportionality, accountability, inclusiveness, and transparency principles to stimulate and allow for the active and interested participation of even the most vulnerable members in accordance with the national rules governing non-profit associations and cooperatives. For the development of energy communities, it is necessary to stimulate members with communication activities, support, and dissemination of a social and community culture that is conscious of the importance of energy; to this end, coordination and involvement of participants is necessary to define strategic and tactical goals.

Author Contributions: Conceptualisation, E.G., R.T. and F.P.; methodology, E.G. and R.T.; writing—review and editing, E.G., R.T. and F.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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