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Understanding the Implementation of Renewable Energy Communities in  
Portugal – Hurdles and Benefits

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## **Abstract**

Renewable energy communities have made significant progress in certain European countries, and such experiences can offer a valuable on how citizens can come together to play an active role in shaping a sustainable energy future. These organizations have the power to become a game changer in tackling the global energy crisis and minimizing the impacts of climate change. They promote the shift from centralized energy production to a decentralized system that makes the energy grid more stable by reducing dependence on major, centralized energy sources. By joining forces and working together, renewable energy communities can implement renewable energy projects more quickly, speeding the integration of renewables into the energy mix. They also enable local residents to take an actively role in their energy future, which can build a powerful sense of ownership and a genuine commitment to the progress of renewable energy. Because they are community-driven, they have the ability to engage and educate individuals about the advantages of renewable energy, energy efficiency, and the importance of phasing out the use of fossil fuels.

In Portugal particularly, even as interest in renewable energy communities has grown, challenges persist. Among these are hurdles related to permitting, project financing, and ensuring that the shift is equitable for all citizens. Based on a series of case studies and expert interviews, this dissertation explores the feasibility of renewable energy communities as a solid response to the energy problem in the Portuguese framework, and argues that by promoting renewable energy communities, Portugal has a singular chance to become a leader in sustainable energy solutions, alleviate the effects of climate change, and forge a pathway to a more resilient, decarbonized future.

Keywords: Renewable Energy Communities, Decentralized Energy Production, Portugal's Energy Challenges, Sustainable Energy Solutions.

## Resumo

As comunidades de energia renovável fizeram progressos significativos em alguns países europeus, e essas experiências podem oferecer um valioso exemplo de como os cidadãos se podem unir para desempenhar um papel ativo na construção de um futuro energético sustentável. Estas organizações têm o poder de se tornar um fator de mudança no combate à crise energética global e na minimização dos impactos das alterações climáticas. Promovem a mudança da produção centralizada de energia para um sistema descentralizado que torna a rede de energia mais estável, reduzindo a dependência de fontes de energia grandes e centralizadas. Ao unir forças e trabalhar em conjunto, as comunidades de energias renováveis podem implementar projectos de energias renováveis mais rapidamente, acelerando a integração das energias renováveis no cabaz energético. Também permitem que os residentes locais assumam um papel ativo no seu futuro energético, o que pode criar um forte sentido de propriedade e um compromisso genuíno com o progresso das energias renováveis. Como são orientados para a comunidade, têm a capacidade de envolver e educar os indivíduos sobre as vantagens das energias renováveis, da eficiência energética e da importância de eliminar gradualmente a utilização de combustíveis fósseis.

Em Portugal, particularmente, mesmo com o aumento do interesse por essas comunidades, persistem desafios. Entre eles estão os obstáculos relacionados com licenciamento, financiamento do projeto e garantia de que a mudança é equitativa para todos os cidadãos. Com base numa série de estudos de caso e entrevistas a especialistas, esta dissertação explora a viabilidade das comunidades de energia renovável como uma resposta sólida ao problema da energia no contexto português e argumenta que, ao promovê-las, Portugal tem uma oportunidade única de se tornar um líder em soluções de energia sustentável, aliviar os efeitos das alterações climáticas e forjar um caminho para um futuro mais resiliente e descarbonizado.

Palavras-chave: Comunidades de Energias Renováveis, Produção Descentralizada de Energia, Desafios Energéticos de Portugal, Soluções Energéticas Sustentáveis.

## **Index of contents**

1. Introduction .....	1
1.1 A new paradigm in the production of energy.....	1
1.2 Gaps in the literature.....	6
2. Literature review .....	8
2.1 General panorama.....	8
2.2 European legislative energy framework and its correlation with some key aspects of a renewable energy community .....	9
2.3 Business model.....	12
2.4 Similar studies.....	13
2.5 The Portuguese regulatory framework.....	15
3. Methodology .....	19
3.1 Environmental.....	19
3.2 Societal.....	19
3.3 Economic.....	20
3.4 Planning.....	21
4. Results and discussion.....	23
5. Conclusion.....	28
6. Bibliographic references.....	29

## List of tables

Table 1. The new energy communities' management framework within RED II .....	11
Table 2. Profile of RECs studied during the work.....	23
Table 3. Environmental findings: people's perception and shaping of their local environment.....	24
Table 4. Societal insights: local community engagement and dialogue .....	25
Table 5 . Economic findings: local community economic benefits.....	26
Table 6 . Planning findings: local participation in the planning and operation of the REC..	27

## List of figures

Figure 1. Status of the implementation of the definitions of the Renewable Energy Community (REC) and the Citizen Energy Community (CEC) in the European members states .....	5
Figure 2. Long-term average of PV power potential, period 1994-2020.....	6
Figure 3: GHG emissions by 2030 necessary to accomplish with the target of 55%.....	16

# 1. Introduction

## 1.1 A new paradigm in the production of energy

In times of energy transition, the world needs a dramatically different energy system. Despite the disruption to burning fossil fuels, a decentralized system is needed to reach a landscape which all energy production is founded on renewable sources and community owned energies are a practical loophole. People and communities-centered plans represent a breakdown of a system which has been bringing issues to our society for too long.

Energy community can be summarized in a broader perspective such as a project or program started by a group of individuals bound together by a mutual local geographical proximity (city level or smaller) and/or a range of shared interests; whereby a portion or the whole of the advantages and burdens of the project are shared by the group of individuals; and which includes a decentralized energy production system (for power, heating, or transportation) which is derived from renewable energy resources (photovoltaic, wind, hydroelectric, biomass, geothermic) and/or energy conservation/efficiency practices/technologies. It also represents a shift from a rather centralized energy supply system to a more democratic one by allowing individuals to participate in the local supply network (decentralized system). Furthermore, they have a potential to achieve a more fair and inclusive energy transition, including with reduction of energy poverty (Caramizaru and Uihlein, 2020).

Renewable Energy Communities (RECs) have a long-standing existence, one of the pioneers being the Tvindkraft project, a windmill assembled and installed in 1978 by a group of individuals from the Danish local area of Ulfborg.. Not by a coincidence, it was a time of energy downturn (first and second oil crisis, respectively in 1973 and 1979) where the non-oil producers' countries strongly turned their attention to nuclear power but not without popular dissatisfaction. Tvindkraft is considered a real justification for why Denmark did not get nuclear power and in its definition brings some of the indistinctive characteristic from a REC:

“Tvindkraft is running, producing energy, symbolizing courage, determination, unity, care, and elbow-grease, symbolizing the fight against nuclear energy and for humanity’s symbiosis with nature.”<sup>1</sup>

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<sup>1</sup> <https://www.tvindkraft.dk/en/history/why-the-windmill-was-built>

In the years since, energy communities have flourished in Denmark, Germany, the Netherlands, and some areas of the United Kingdom. (Interreg Europe, 2018).

According to Lode et al. (2022), energy communities provide a way to restructure our energy systems through enhanced energy use, enabling citizens to actively participate in the energy transition, and providing potential direct benefits to citizens such as increased energy efficiency, reduction of their electricity bills, mitigating energy poverty, reducing carbon emissions, as well as supporting the local economy and creating local employment opportunities.

Following the Energy Union Strategy published in 2015, which sought to develop an energy unit that would provide European Union (EU) citizens - both homes and enterprises - with reliable, sustainable, affordable and competitive energy, in May 2019 the EU bodies finalized the regulatory acts for the Clean Energy for All Europeans Legislative Package (CEP), a legislative package that aims to enable the EU to achieve its 2030 climate and energy goals and marks a notable change in the citizens' position: from mere passive customers to become agents in the energy revolution. (Rescoop.eu, Client Earth, 2020).

Among several important definitions, one must be highlighted in the purpose to well-frame the topic which is the distinction made between REC and Citizen Energy Community (CEC). REC is defined under the Renewable Energy Directive (RED II) as a legal body founded on public and spontaneous involvement, which is independent and genuinely managed by shareholders or participants who are based in the vicinity of the renewable energy projects belonging to and implemented by that legal body; whose shareholders or participants are individuals, small and mid-sized businesses (SMEs), or regional or municipal bodies, and whose primary objective is to bring environmental, financial or societal gains to their shareholders or participants, or to the local areas in which they operate, instead of monetary returns. (Rescoop.eu, Client Earth, 2020).

In turn, CEC definition is under the Internal Electricity Market Directive (IEMD) as a legal body established on the basis of spontaneous and public cooperation and under effective governance by individuals, local governments, inclusive of cities and town councils, or micro and small businesses; has as its principal objective the provision of environmental, financial or societal advantages to its constituents or its shareholders, or to the geographical regions in which it is established, as opposed to the generation of monetary returns; and can

be engaged in production, also from renewable energy sourcing, dispatch, supply, demand, pooling, energy storage, energy efficient operation services, or electric vehicle (EV) recharging services, or can offer further energy services to its constituents or shareholders. (Rescoop.eu, Client Earth, 2020).

Hence, the main material distinction between the REC and the CEC lies in the fact that the latter is able to work throughout the power industry and does not pursue a particular technology orientation, while the REC is particularly oriented towards renewable energies. As cited in Ceglia et al (2022), a REC allows 39.5 t/year of CO<sub>2</sub> emissions avoided versus the conventional setup with no shared solution (experiment conducted in Southern Italy, comparing a REC, a conventional system drawing power from the network, and a System of Efficient Users, whereby each ultimate consumer can purchase power from an external supplier through a proprietary network link and a purchase agreement). The participants in this community could become more conscious of environmental matters and foster a greater sense of sustainability.

The development of energy communities, in particular those founded on renewable energy solutions, might also have societal implications, such as improving the quality of health, advancing technology, improving climate patterns, increasing the standard of education, and improving the quality of life (Kumar, 2020). In fact, energy community does not include monetary gains, but it seeks to address the challenges of energy justice, energy poverty and decarbonizing by working from the bottom up and engaging citizens. (Heldeweg and Saintier, 2020).

Following its tradition of rapidly transposing EU directives, Portugal has not lagged, and the REC regime has been in force in the national legal framework since October 2019. The Decree-Law 162/2019 (25 October) establishes the legal regime applicable to (i) own consumption of renewable electricity, which allows the own consumer - besides generating and utilizing - to carry out operations of pooling, storing and trading the extra electricity, being a regime whereby one or more renewable energy generating units can be connected to one or several places of consumption, and (ii) RECs that enable participants to meet in a localized neighborhood context, i.e., a context of geographic closeness, and may organize themselves collectively and engage in common self-use among themselves or form an energy community. These two types of structure differ from among themselves: the first one is characterized by internal rules that define both rights and responsibilities, and the second, by

a legal body of the cooperative or corporate type in which consumers as well as other subjects engaged in the project of self-consumption participate. Therefore, both individual consumers and consumer collectives - organized jointly or in energy communities (including home complexes, metropolitan areas/neighborhoods, commercial areas, farming entities, industrial facilities, townships, and cities), which infrastructures are adjacent and close to the energy project, are the addressees of Decree-Law 162/2019.

Effectively, in 2020, it was launched the first solar neighborhood (“*Bairro Solar*”), a Renewable Energy Collective Self-Consumption Community (CACER) in Portugal, municipality of Sintra.<sup>2</sup> Therefore, the efforts of timely legislation do not reflect a positive scenario for REC in the country. According to Portugal’s Ministry of Environment, at the end of October 2022, there were only three certified REC and there were 170 (licensing) processes initiated. Among them, one involving Sines Municipality, APS – Administração dos Portos de Sines e do Algarve SA and the Portuguese Agency for Investment and External Trade (aicep) Global Parques, to develop a study to support the creation of a REC in Sines<sup>3</sup> and another one in Cascais Municipality at Cascais Smart Pole (a lab that results from a partnership among the city, foundations, private companies, and the academy). The panels, with 1160 MWh annual production forecasted and investment circa 400.000€, will be installed on the roof of NOVA School of Business and Economics, surrounding residential buildings, and anyone interested can participate in the REC by investing, buying energy, or lending their roof or panels to the REC.<sup>4</sup>

The EU country with the highest number of REC, according to a study by the EU’s Joint Research Centre 2020, is Germany with 1,750 communities (Caramizaru and Uihlein, 2020). There, the energy transition, the so-called *Energiewende*, has placed Germany as one of the countries with the highest share of renewable energy production not only in Europe, but in the world. As an illustration, 42.9% of the electricity produced in Germany in the third quarter of 2019 came from renewable energy sources, compared to 31.6% in 2016. Additionally, 42% of the renewable electricity produced in Germany in 2016 came from projects carried out by the citizens or with strong public participation (Friends of the Earth, Rescoop.eu, Energy Cities, 2020).

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<sup>2</sup>[https://www.bongasenergias.pt/comunidades-energeticas-portugal/?doing\\_wp\\_cron=1677095145.6471369266510009765625](https://www.bongasenergias.pt/comunidades-energeticas-portugal/?doing_wp_cron=1677095145.6471369266510009765625)

<sup>3</sup> <https://noticiasdesines.com/2022/09/13/iniciada-criacao-de-comunidade-de-energia-renovavel-de-sines/>

<sup>4</sup> <https://cascaissmartpole.pt/energia>

Next in the energy communities' European ranking is Denmark (700 RECs) and the Netherlands (counting 500 RECs). While Spain is mapped with 33 projects, Portugal is not even mentioned by the survey (Caramizaru and Uihlein, 2020).

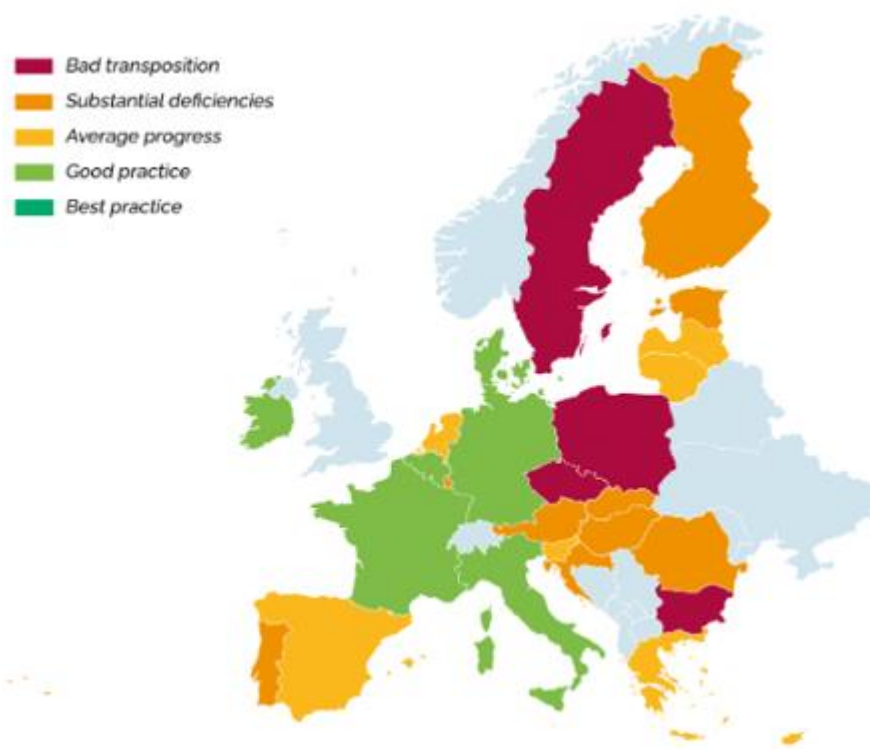


Fig. 1. Status of the implementation of the definitions of the Renewable Energy Community (REC) and the Citizen Energy Community (CEC) in the European members states<sup>5</sup>

Having such importance in the future of energy system, why does Portugal have such a minor position in such a REC panorama compared to other EU countries, especially if it is considered that the country enjoys a privileged geographical position which allows it an outstanding potential for photovoltaic energy, as shown in Figure 2? The challenge is to understand how the implementation of RECs are running in Portugal and to analyze the hurdles that prevent the country from catching up with other best ranked EU countries. In addition, we assess the benefits that the REC provides to the communities where they are placed.

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<sup>5</sup> <https://www.rescoop.eu/transposition-tracker>

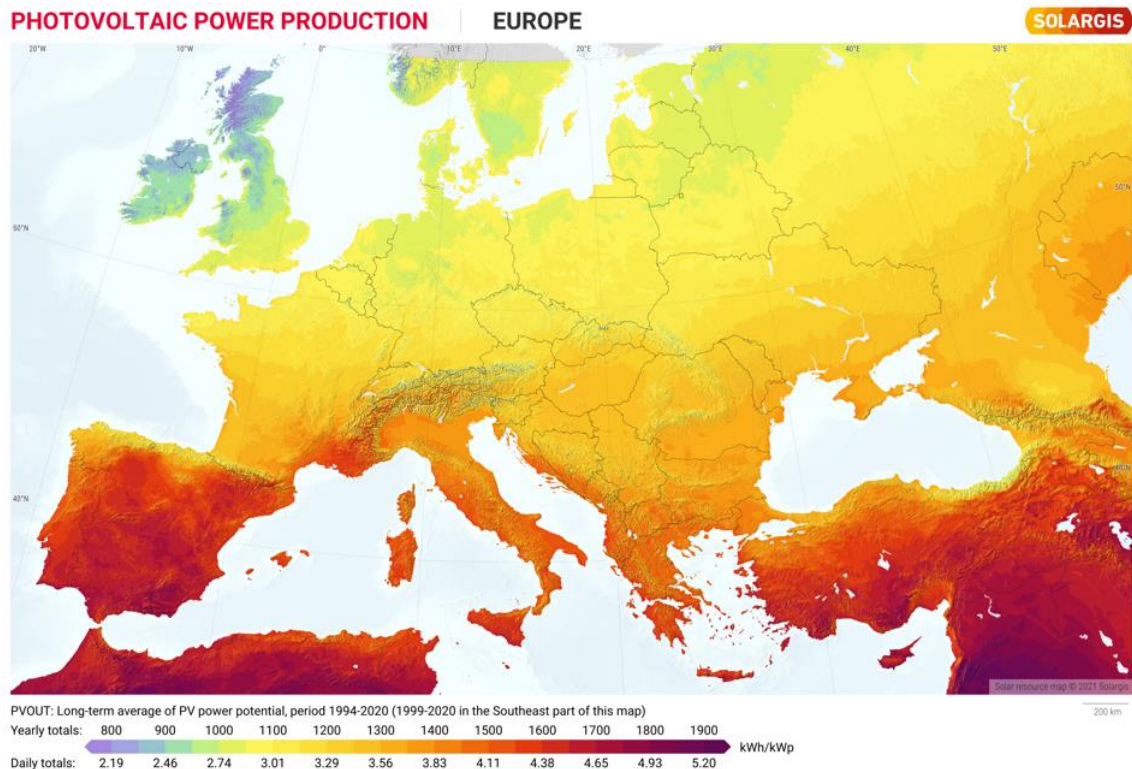


Fig. 2. Long-term average of PV power potential, period 1994-2020

To answer the question abovementioned, the methodology to be applied will be empirical research: qualitative interviews with REC participants in Portugal, i.e. based on open questions, divided into the following types: (i) informal conversation (more or less structured); (ii) interview guide/semi-structured; (iii) open standardized, in which the formulation of the questions can be changed by simply obtaining the views and opinions of the participants; or quantitative, standardized or structured, which use closed questions in which the interviewee has an interview protocol that is applied to all participants.

## 1.2 Gaps in the literature

There is a lack of literature that provides a comparative analysis of renewable energy communities in Portugal with those in other European countries, which could highlight differences in implementation, acceptance, technology adoption and regulatory frameworks. The specific economic models and financial incentives available to renewable energy communities in Portugal, as opposed to other European countries, are sometimes not well detailed. Potential barriers in the form of regulations, bureaucratic processes or policy

frameworks that could limit the growth and success of renewable energy communities in Portugal are not fully explored, and real-world narratives showing the triumphs and especially the challenges of renewable energy communities in Portugal are still scarce. By interviewing coordinators from three different renewable energy communities in Portugal, the proposal aims to provide first-hand accounts and data, an insight into operational challenges, success stories and realities on the ground. The communities studied range from the north (Porto) to the capital (Lisbon) and beyond to Marco de Canaveses. This geographical diversity can shed light on regional differences, challenges, and opportunities. By exploring the impact of these communities on their local residents and vice versa, we address how socio-cultural factors influence the success and challenges of renewable energy communities in Portugal.

## **2. Literature review**

### **2.1. General panorama**

The term community indicates in a linguistic form a social group which has commonalities, such as habits and traditions, principles, and a feeling of place (Huang et al., 2017). In the energy framework it refers to an aggregation of users located in a small area that share an energy supply solution (Ceglia et al., 2020).

By enabling communities to develop compact power plants (boroughs, towns, smaller localities), a set of micro-communities can be set up, thereby obtaining positive consequences not just in the form of savings in energy use, carbon dioxide output decrease, and tax advantages, but also allowing for local jobs, skills enhancement, and the involvement of local inhabitants in the use of the energy supply (Ceglia et al., 2020). In fact, the existence of onsite renewable energy supplies is often the main driver for creating an energy community, such as the example of Waita, Japan, created as a geothermal energy community (Suwa and Sando, 2018).

For the last twenty years, RECs have emerged as a crucial player in driving Europe's citizen-driven energy transition (de Brauwer and Cohen, 2020). Furthermore, the advent of the prosumer as an active player, spanning both consumption and production of renewable energy, as pointed out by the European Commission (European Commission, 2015c), could bring a sense of common purpose to whoever wants to participate in the energy community development, and therefore the prosumer player is also capable of boosting the acceptance of renewable energy sources by pushing the rest of the community players in the utilization and pooling of energy resources (Ceglia et al., 2020).

The main objective of a REC is to generate environmental, financial or welfare advantages for its partners, associates, or the surrounding region in which it works, instead of monetary gains. In this manner, lawmakers in Europe have emphasized that energy communities are a key component not just in reaching decarbonization, but in battling energy poverty and achieving what some advocates have referred to as energy justice or, yes, more rarely and more politically, energy democracy (Heldeweg and Saintier, 2020).

## **2.2 European legislative energy framework and its correlation with some key aspects of a renewable energy community**

Following the COP21 in 2015, where all countries represented signed the Paris Agreement, the European Commission initiated a thorough review of the joint legislative energy framework, with a special focus on the promotion of renewable energy, end-use efficiency, and the role of citizens for a soon-to-be decarbonized energy system. The outcome is embodied in the Clean Energy Package (CEP) for all Europeans, a package of specific eight legislative measures that encapsulate the vision for the energy transformation (Cielo et al, 2021). Within this set, two regulations envisage, for an unprecedented moment at the European scale, a concrete acknowledgement of the concept of the energy community (Caramazaru and Uihlein, 2020). In detail, the 2008/2001 Directive (called RED-II) establishes the concept of Renewable Energy Community (REC) and can be considered as a crucial element to achieve the EU's 2030 and 2050 climate goals by updating its energy policy. If properly implemented and effectively translated into national legislation, RED II has the power to foster a more equitable and sustainable energy transition by easing the full-scale deployment of RECs. RED II lays out three guiding principles for implementation, notably facilitating REC competition on an equal basis with large-scale actors, bearing in mind the characteristics of RECs when shaping subsidy regimes, and giving regulatory and training support to public administrations and helping them to engage directly (Hoicka et al, 2021).

Community energy is a critical shift away from the centralized, profit-maximizing model of power production and transmission that prevails in the majority of developed countries. (Burke and Stephens, 2018). Studies have revealed that community energy has the power to release private investment and funding for renewable energies (de Brauwert and Cohen, 2020), deliver a social benefit (Burke and Stephens, 2018) and make the most efficient grid usage (Koirala et al., 2016). Moreover, by committing to renewable energy projects on a local basis, they raise the consciousness of the energy transition and build value on the ground by strengthening income flows, enhancing know-how, building capacity, and cutting CO<sub>2</sub> emissions (Hanke et al, 2021).

REC members benefit from pooling electricity and other sources of energy amongst themselves or their shareowners, whether or not they use the national grid. Also, essential aspects of being eligible for REC status are the geographical closeness of the REC's controlling members to the renewable energy installations and the heterogeneous membership,

where no single owner holds a control stake. The geographic closeness of the members in control guarantees that regional stakeholders are represented, and the diversity of the members keeps it that way (Hoicka et al, 2021).

RECs are defined in RED II, but do not represent the sole type of energy community that is possible, as under the provisions of European energy law, other private law arrangements are also possible (Jasiak, 2018). Rather than enacting a standard legal format for RECs, European lawmakers opted for an opt-in system in passing the new RED II regulations, offering the opportunity for community energy efforts to be considered RECs if they wished. The outcome is a market-driven framework in which only those communities that find the REC framework worthwhile will adopt it. The governance model in Table 1 must be followed in order to qualify as a REC and take advantage of the structure and power allocation benefits. For the incumbent, the cost of using this structure will be at the governance level (i.e., no higher than 33% equity interest). More commercial business models that do not offer the advantages of democratic involvement and decision-making, or a profit-sharing arrangement for retail investors, such as limited liability companies or limited partnerships, thus compete with RECs (Hoicka et al, 2021).

Table 1. The new energy communities' management framework within RED II

Criterion	Renewable Energy Communities in accordance with Art. 2 (16) RED II
Qualifications	Individuals Small and medium enterprises Local authorities, which includes cities and towns.
Main Objective	Environmental, financial, or societal advantages for its owner/members or for the communities in which it works, in contrast to monetary gains.
Affiliation	Based on non-discriminatory criteria, voluntary participation is open to all potential local members.
Ownership and control	Substantially controlled by owners or members based near the RE projects owned and deployed by the REC. Is independent (no single owner can hold over 33% of the shares)

The vicinity of REC members to a REC's generating premises influences whether they qualify as dominant shareholders, and also the kind of availability of renewable energy in that particular geographical region. Closeness rules guarantee that the locals are the recipients of a REC, but they also have impact on the technological and territorial requirements for participating. Member States have divergent responses to those issues. In the case of Portugal, Local Law 162/2019 of October 25, 2019 (Portuguese Republic, 2019) explicitly requires a case-by-case assessment when evaluating the closeness (Hoicka et al, 2021).

The RECs' own capacity to pursue their needs and politically engage is expanding (Brisbois, 2020). Nevertheless, there is significant downside potential for cooptation or misappropriation of the RED II vision by those with a vested economic and political interest in preserving the existing status quo. Local energy forms, which are privately owned and controlled by incumbents, may harvest the technical advantages of decentralization, but lack the numerous socio-economic gains of community energy concepts. This would be a wasted chance and would jeopardize the energy transition's success by hindering public buy-in (Devine-Wright, 2019).

There are many forms of political pressure against diversification of ownership. It may include easily apparent ones, such as targeted lobbying (Brisbois, 2020), efforts to bias public opinion by means of the mass media (Lee and Hess, 2019), and legal challenges against enabling policies (Hess, 2016). Data control over grid throughput has also been used to constrain both renewable energy and REC pervasiveness by alleging grid restrictions where it was later proven there were no constraints (Stokes, 2013). Policymakers who seek to realize the potential benefits of RECs will be required to be proactive in pursuing strategies that support and champion these ventures (Hoicka et al, 2021).

Community energy initiatives are frequently featured as a way to alleviate energy poverty, which is perceived as insufficient accessibility to basic necessities such as home heating and electricity (Bomberg and McEwen, 2012). The prosumership provisions of the RED II are compatible with the principles of energy equity and, if properly implemented and practiced, are meant to improve overall equity. RED II specifies that RECs shall be accessible to every possible local participant on the basis of non-discriminating principles (Hoicka et al, 2021).

### **2.3 Business model**

The suitability of an individual REC's business model is determined by its unique situation. It encompasses the socio-economic and demographic outlook of the participant community, the general governance and regulatory framework, and the capabilities and capacity of technical and physical resources. Business plans for RECs demand (i) adequate flexibility to encompass diverse types of co-investors; (ii) consideration of an equitable distribution of obligations and benefits among them; and (iii) compliance with the governance requirements of RED II. Although cooperatives are the primary legal structure used for energy communities to this point, the Consumer Stock Ownership Plan (CSOP) model has been emphasized as an option in scenarios in which initial funding is scarce, membership is diverse, and individual members are small in number and require guidance to secure protection from other corporate owners (e.g., SMEs and cities). CSOPs can also be helpful when projects are planned for scalability. A CSOP is a business scheme that deploys an intermediate operating entity and makes it easy for single consumers to be engaged as investors by means of a trust; it is especially appropriate for instances in which individuals do not have initial capital. The CSOP may purchase existing facilities or acquire new RE facilities and may use third-party funding and therefore benefit from financial leverage (Hoicka et al,

2021). Although RED II connects an empowering environment to stimulate and simplify the development of renewable energy communities with the commitment to guarantee the engagement of all customers, including those from limited-income or disadvantaged families, RED II shies away from actually delivering on the specifics of realizing the societal value of RECs in practical terms. National Energy and Climate Plans (NECPs) must incorporate each Member State's individual response to the implementation of RED II. So far, only the NECPs of Portugal, Spain, Italy, and Greece connect RECs to energy poverty reduction (Hanke et al, 2021).

Some critics have pointed to a somewhat fantasized storytelling of energy communities that may be disguising gaps in the way, for example, local communities are benefiting from them. Particularly at-risk communities face difficulties in being involved in, or benefiting from, and in developing their own local renewable energy generation. At present, few segments of society have the resources (e.g., financial capacity, time, and knowledge) to engage in RECs and reap the benefits (e.g., via intermediary structures) of the clean energy shift (McGee and Greiner, 2019).

#### **2.4 Similar studies**

Nowadays it is possible to state there is a consensus that the energy transition is not just cost-effective and technologically viable but also a socio-cultural and transformational issue. Such a consensus comes from a number of studies that have covered various experiences in different geographical areas, especially in the European territory. The available literature brings to light the benefits and challenges that affect communities, how such communities have experienced not only the energy transition, but also a transition towards the community as a social organism (Teske et al, 2015)..

Recognized for the strong dissemination of renewable energy technologies since 2000 and by declaring the energy transition (*Energiewende*), Germany accounts for almost 50% of installed renewable energy in the form of citizens' or collective ownership. The case study area of North Frisia (Schleswig-Holstein, Germany) is an exceptional example of renewable energy deployment, with a self-sufficiency rate of around 350%. During the past three decades, the continental parts of North Frisia has evolved from a traditional agricultural economy to a predominantly energy-based economy. The development of renewable energy projects has generally been driven locally, not commercially, by local innovators, local

communities, and local businesses. People have recognized the local opportunities of community renewable energy projects based on a process of engagement and income generation from the project back into the communities (Süsser and Kannen, 2017).

In the municipality of Platanias, in Crete (Greece), the energy community's target was to harness the power of locally available renewable energies, such as solar and solid biomass, while cutting down on the use of fossil fuels. The community has 15 residential flats covering 795 m<sup>2</sup>, which require energy for heating, cooling, lighting, hot water, and appliances and 2 small greenhouses covering 0.33 ha which need energy for heating, cooling, lighting, and equipment operation. The focus centers around employing a decentralized power supply that leverages local renewable energy sources. All renewable energy systems, excluding solar panels, have been produced and implemented by local businesses. The existing energy systems generated 857,877 kWh per year, providing 94.46% of the community's consumption and substantially cutting the community's emissions by 278,494 kg of CO<sub>2</sub> annually. The nearby university played a role in determining their capabilities and specifications (Vourdoubas, 2017).

Magliano Alpi, a small town in province of Cuneo, has successfully established the first Italian renewable energy community, in December 2020, where the local municipality, citizens, and utilities collaborate to produce and exchange energy derived from renewable resources. This organization is a private entity that brings together public institutions and private companies, creating beneficial public-private partnerships (PPP). The Magliano Alpi REC operates a photovoltaic system that generates power distributed among selected municipal buildings, a small artisan business, and three pioneering families who initially volunteered to participate. The expected production is estimated to be 24198 kWh/year, which will supply 46% of the total energy demand or 85% of the daily consumption. This all translates into benefits for the members of the REC corresponding to a reduction in energy bills of approximately 21% and a decrease in emissions of circa 10.5 tCO<sub>2</sub> benefiting the entire community (Olivero et al, 2021).

It is remarkable to observe how the incentives for establishing a REC can vary significantly from one instance to another. Examining communities such as Marstal in Aerø Island, Denmark; Samsø Island, Denmark; and Cloughjordan eco-village in Ireland reveals the multitude of subtle reasons behind their creation. For Marstal, very high oil prices in the 1970s acted as a catalyst; Samsø Island sought to address rampant unemployment and

stimulate economic revival; while in Cloughjordan, the eco-village community's goal was to create a truly sustainable living environment (Heaslip et al, 2016).

At times, the motivations behind RECs can seem unexpected, influenced by their geographical location. While most literature highlights lower energy costs as a primary driver for individuals to participate in such projects, surveys among Portuguese and Spanish REC participants revealed that environmental and climate concerns were the predominant factors for citizens in these two countries (Soeiro and Dias, 2020).

Within the Clean Energy for EU Islands Programme (CE4EU)<sup>6</sup>, local communities are encouraged to take more ownership of their traditional activities by tackling external factors that contribute to high energy and production costs. As a result, six pilot islands have been tasked with creating their own 'Island Clean Energy Transition Agenda', a Strategic Plan for the transition to clean energy. One of these islands is Culatra, a small island in Algarve, Portugal. Culatra is confronted with significant challenges in relation to energy efficiency and self-supply, water depletion, waste treatment and local pollution. With energy representing around 50% of household costs on the island, tackling energy poverty is another major hurdle. The experiences that motivated the Culatra community demonstrated first and foremost that success depends on unique, positive combinations of technology, people, organizations, and location within their particular circumstances - far exceeding the mere power challenges they sought to tackle. The findings reveal that by relying solely on publicly accessible facilities, photovoltaic energy generation can cut grid dependency by a third. In addition, an estimated 85.7% of the electricity generated on the island can be used locally, while the residual 14.4% could be fed into the power network (Pacheco et al, 2022).

## **2.5 The Portuguese regulatory framework**

In 2016, at the Conference of the Parties to the United Nations Framework Convention on Climate Change, Portugal made a commitment to become carbon neutral by 2050. To meet this target, the Roadmap for Carbon Neutrality 2050 (RNC 2050) was approved in July 2019.

On the other hand, and in accordance with Regulation (EU) 2018/1999, concerning the Governance of the Energy and Climate Action Union, it was determined that all Member States should draw up and present to the European Commission an integrated national

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<sup>6</sup> <https://clean-energy-islands.ec.europa.eu/assistance/project-support>

energy and climate plan for the 2021-2030 horizon. In this context, and in articulation with the goals of the RNC 2050, the National Energy and Climate Plan 2030 (PNEC 2030) has been elaborated as the key document of the country's energy and climate strategy for the coming 10-year period to achieve a zero-carbon future, approved in July 2020..

The PNEC 2030 establishes targets and respective strategies and actions regarding the reduction of greenhouse gas emissions, the integration of energy from renewable sources, energy efficiency and security, internal market and research, innovation, and competitiveness, as well as a clear approach for the achievement of those goals and targets.

In the same line, the European Green Deal<sup>7</sup> established the roadmap for reducing emissions by at least 55% by 2030, inducing a profound transformation, particularly in the power model, as noted in Figure 3, with a clear path towards renewable energy, namely on reviewing the current target of 32% of renewables in the EU energy mix by 2030.

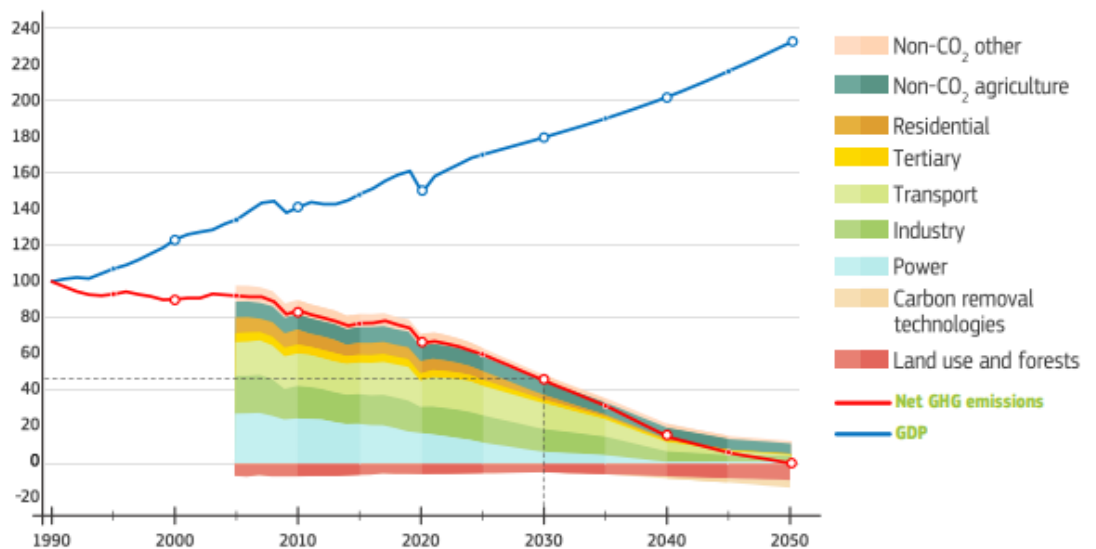


Fig. 3: GHG emissions by 2030 necessary to accomplish with the target of 55%.<sup>8</sup>

Within this framework of profound change, Portugal needed to adapt the legal framework of the National Electricity System (SEN) to the needs and challenges posed by these strategic instruments, which will guide the country's energy policy in the coming years. The system must necessarily evolve from a system based on centralized production to a decentralized model that includes local production, self-consumption solutions, active

<sup>7</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0562>

<sup>8</sup> State of the Union 2020, EU Climate Target Plan 2030, Key contributors and policy tools

management of smart grids and ensures the active participation of consumers in the markets. The Decree-Law 15/2022<sup>9</sup> was issued on January 14<sup>th</sup>, 2022, and their introduced amendments can be structured along five fundamental axes, among them the active participation of consumers, in production and in the markets.

Notwithstanding the above, according to the European Federation of Citizen Energy Cooperatives (REScoop.eu)<sup>10</sup>, the Portuguese work of the transposition of the EU legislation on the definition of RECs is considered to have significant shortcomings. The main reason for this classification is explained by the fact that the REC definition (introduced in the law<sup>11</sup> on renewables collective self-consumption) creates confusion as to what potential activities a REC can engage in; despite the fact that almost all provisions on RECs, including the definition, are copied from the EU legislation, there is no specificity and legal clarity as to the concept of RECs and their role in the energy system; the Portuguese legislation also does not address autonomy as well as allows installations to be owned by third parties, thus ignoring one of the core basic concepts of energy communities, which is ownership. As such, the definition of RECs has not been properly transposed and is not in line with the Renewable Energy Directive.

As regards the geographical proximity of RECs, this is used not only for effective control but also for eligibility which is stricter than the Renewables Directive and could significantly limit participation outside the community and the development of RECs over time. While the ability of RECs to take any legal form provides flexibility for their development, there is a high risk of abuse as there is no authority to oversee RECs or their compliance with the definitions. In addition, RECs are not required to have their own production facilities and may be owned by third parties, resulting in REC members having a passive role in their projects, as the primary responsibility could lie with a professional market actor. This is contradiction to the intention of EU legislation to recognize energy communities and distinguish them from other market actors.

The legislation also includes provisions for the development of an enabling framework for RECs, but these provisions do not go into detail over the EU Directives. The Executive has not carried out an assessment of the drivers and barriers to the development

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<sup>9</sup> <https://dre.tretas.org/dre/4772926/decreto-lei-15-2022-de-14-de-janeiro>

<sup>10</sup> <https://www.rescoop.eu/transposition-tracker>

<sup>11</sup> <https://diariodarepublica.pt/dr/detalhe/decreto-lei/162-2019-125692189>

of RECs, despite a regulatory obligation to do so. The government has also some simplified administrative procedures for the approval of smaller projects, but no regulations have been tailored to RECs and there is no specific support mechanism for REC projects.

In summary, while Portugal has transposed definitions for RECs, it has not yet established a consistent or inclusive framework for the development of energy communities. While regulations on collective self-consumption have been adopted, there are a range of shortcomings that will limit the ability of energy communities to fully exercise their full rights under the EU Directives. And it reflects on the number of projects presented for approval before the Directorate-General for Energy and Geology (DGEG) by June 20<sup>th</sup>, 2023: out of the 694 license applications, 665 were for collective self-consumption units and only 29 for renewable energy communities<sup>12</sup>.

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<sup>12</sup> [https://expresso.pt/economia/economia\\_energia/2023-06-22-A-procura-de-um-lugar-ao-sol-comunidades-de-energia-dao-os-primeiros-passos-n%E2%80%A6](https://expresso.pt/economia/economia_energia/2023-06-22-A-procura-de-um-lugar-ao-sol-comunidades-de-energia-dao-os-primeiros-passos-n%E2%80%A6)

### **3. Methodology**

The questionnaire for the structured interviews was based on a categorization according to four aspects: environmental, societal, economic, and planning. The decision to structure around these aspects is holistic and encompasses most of the significant dimensions that shape the success and challenges of these communities. Therefore, each aspect can be emphasized as explained below.

#### **3.1 Environmental**

In a global context, with the undeniable urgency of climate change, transitioning to renewable energy sources is vital for a sustainable future. RECs exemplify decentralized models that reduce carbon footprints and lessen dependence on fossil fuels. Besides reducing greenhouse gas emissions, renewable energy also minimizes local environmental degradation like air pollution, water usage, and habitat destruction that's often associated with non-renewable energy sources. Holistically, environment directly impacts public health, with better air and water quality leading to fewer health problems.

Thus, the questions on this topic were:

- 1) What are some of the renewable energy sources that your REC utilizes to generate climate-friendly energy? And how do you ensure that they operate efficiently while minimizing their impact on the environment?
- 2) How do people perceive the presence of solar panels in their local environment? And what factors influence their level of acceptance or resistance towards them?
- 3) Do community renewables impact the way people perceive and shape their local environment? If yes, how?
- 4) What are the main drivers for the development of community-based renewable energy projects at the grass-roots level?

#### **3.2 Societal**

**Empowerment & Ownership:** RECs offer members an opportunity to take charge of their energy production, creating a sense of ownership and accountability. As well, the social cohesion is increased, since collaborating to establish and maintain a community-based energy system can foster stronger societal bonds, mutual respect, and collective action. These

communities become real-world examples, enlightening the broader public about the benefits and challenges of renewable energy.

Thus, the questions on this topic were:

- 1) What role do you think it plays in promoting a sense of togetherness among the community?
- 2) How can the implementation of the REC make municipalities/neighborhoods more attractive to people and increase social diversity?
- 3) What impact does this have on the types of jobs available in these areas?
- 4) How do the REC enable social support for education and families?
- 5) What role do they play in improving the budgetary situation of each member of community?
- 6) Does it cause any impact on people's social lives and daily routines for taking part in a REC? If yes, what kind of impact?
- 7) What strategies the REC developers use to ensure that their projects align with the needs and wants of local communities?
- 8) How can they effectively communicate the benefits of energy autonomy and security to the communities?
- 9) What are some effective strategies for promoting communication and collaboration between experts, developers, and local community in the early stages of REC projects? Are public meetings used to address concerns and build trust among stakeholders?
- 10) What role do key influencers (for example, journalists, public figures, etc.) play in promoting the development and acceptance of REC projects? How can REC developers effectively identify and engage with these influencers to build support for their projects?

### **3.3 Economic**

Transitioning to renewable sources creates jobs in manufacturing, installation, and maintenance sectors, benefiting local economies. Over time, renewable energy often proves

to be cost-effective by reducing energy bills and providing stable energy prices. Renewable energy infrastructure, though having an upfront cost, is a long-term investment that offers more predictable returns and resilience against fluctuating fossil fuel prices.

Thus, the questions on this topic were:

- 1) What type of economic benefits the REC brings for the local affected community?
- 2) Do you think that economic security and job opportunities play a role in addressing the issue of outmigration of young people from the community?
- 3) Does the concept of the REC ensure benefits to all members? How it could be guaranteed?
- 4) How does the concept of REC help to keep money within the region (municipality/neighborhood) and prevent it from going to big business companies? What impact does this have on promoting local economic growth and development?
- 5) How do REC impacts tourism in region? What challenges do municipality/neighborhood face in balancing their role as an energy community with their role as a tourism community?
- 6) What measures are being taken to address issues of underproduction and overproduction in the REC?
- 7) What do you think are the main factors that drove the success of the project? Did the community's need for economic recovery contribute to its development and implementation?
- 8) What financing models are most effective for ensuring the long-term success of the REC project? Can mixed financing be used to support these projects?
- 9) What role does financial motivation play in driving the development of REC projects?
- 10) How can REC developers effectively communicate their financial goals to local communities?

### **3.4 Planning**

Proper planning is imperative to ensure the efficient use and distribution of energy, adequate storage facilities, and smooth grid integration. Properly planned projects can serve as successful models, allowing other communities to adopt or adapt as per their needs. As technology and societal needs evolve, a well-planned renewable energy community will be better equipped to incorporate new advancements and respond to challenges.

Thus, the questions on this topic were:

- 1) Since local participation in the planning and operation of the REC provide social and economic benefits, what role does it play in maintaining local control and ensuring that private interests are represented?
- 2) Does planning law influence the possibility of the future expansion of the REC? How do designate priority areas impact their growth and development?
- 3) What role do lobby groups play in shaping the political landscape around the REC, and how do their interests align or conflict with those of local communities and other stakeholders?

The interviews were undertaken with a representative of Agência de Energia do Porto (AdEPORTO), responsible for the REC Agra do Amial, the first REC in the city of Porto; (ii) a representative of Coopernico, the first renewable energy cooperative to commercialize electricity in Portugal; and (iii) a representative of the REC Telheiras, a local partnership between Telheiras and the Lumiar local council, in the city of Lisbon.

#### 4. Results and discussion

According to the analysis of the interviews, despite the differences between the sizes of the RECs - which are related to the number of people involved, the estimated production and the investment applied - all of them produce their energy from a photovoltaic source (Table 2), installed on the roofs of buildings in order to minimize the environmental impact and to be efficient from a maintenance point of view. In addition, the lifespan of the system (around 25 years) without the need for replacement and the absence of waste generation were other characteristics cited for justifying this choice.

Table 2. Profile of RECs studied during the work

	Agra do Amial, Porto (Portugal)	Telheiras, Lisbon (Portugal)	Vila Boa do Bispo, Marco de Canaveses (Portugal)
Community involvement	181 dwellings and an elementary school	16 dwellings and a public building	Fire station, sports pavilion and other two public buildings
Electricity	100% photovoltaic	100% photovoltaic	100% photovoltaic
Estimated production	160 MWh/year	11,5 MWh/year	23 MWh/year
Initial investment	Not informed <sup>1</sup>	EUR 10,300	EUR 32,000

<sup>1</sup> The REC is part of a wider project (Asprela + Sustentável) which has received EUR 1 million in EU funding.

On the environmental aspect, the analysis shows that RECs certainly create a higher level of awareness of energy issues than is currently the case. Local people ultimately feel that they are directly involved in a common goal within the community, with equal rights, and that this will have an impact on their daily behavior and habits in terms of how they use energy. It was also mentioned that there might be a tendency for people to shift their electricity consumption to the daytime, i.e., to make the most of sunlight. As far as the installation of the panels is concerned, the news was well received and there was no question of any impact they might have, either visually or through the installation of equipment necessary for the operation of the building's communal areas. As this was a project for the benefit of the community, there was no opposition to their installation.

Table 3. Environmental findings: people's perception and shaping of their local environment

	Agra do Amial, Porto (Portugal)	Telheiras, Lisbon (Portugal)	Vila Boa do Bispo, Marco de Canaveses (Portugal)
People's perception and shaping of their local environment	1) Create higher levels of awareness of energy issues 2) Impact on their daily behaviour and habits in terms of how they use energy	1) Environmental component of producing emissions is important 2) The aspect of being a local project	Members of the cooperative are more concerned about the environment

In the social sphere, the search for clean and fair energy at affordable prices to combat energy poverty is a relevant factor. In certain communities, the average monthly energy bill is more than two or three times the rent, which has a huge impact on family budgets. However, social participation varies according to the way in which the REC is promoted, i.e., whether the REC is promoted by a public body or by a group of citizens using their own financial resources. In general terms, the implementation of RECs can make neighborhoods more attractive, because in order to promote a concept such as RECs, the neighborhood must be urbanized and in a position to receive this type of equipment. However, it is not yet possible to say that a REC can maximize the social diversity of the community.

The communication aspect is another important point brought up by all the interviewees. From the research it can be concluded that there is an unofficial roadmap that starts with informing people about what a REC is (on measures, financing and regulation); educating everyone about the importance of the REC for the community, raising energy literacy; training participants to be agents, as it should be; taking action, i.e. looking for the best alternatives to carry out the project; and finally implementing the REC.

Table 4. Societal insights: local community engagement and dialogue

	Agra do Amial, Porto (Portugal)	Telheiras, Lisbon (Portugal)	Vila Boa do Bispo, Marco de Canaveses (Portugal)
Local community involvement and communication	Low level of involvement, as the only promoter of the project is the city council	Strong community involvement, focusing on environmental and social rather than economic benefits	Medium level of involvement due to the status of the beneficiaries

An important point that has been highlighted is that Portuguese legislation has allowed companies to control some RECs without correctly distinguishing their projects from what is a true renewable energy community and what is collective self-consumption, while the participants remain as customers of an energy supplier, without any proactive participation. In simple words, it is just another signed contract or a fake REC, as can be interpreted from the following statement:

The energy community is not just about producing and selling energy, there's a whole movement of people around an energy community. These companies are entering the market and using the term energy community for things that are collective self-consumption because it sounds better, you see?

The economic benefits to the community are mainly in the form of lower energy bills, as members receive part of their energy from local photovoltaic production at lower prices, and, where the REC is sponsored by a public body, without the need for investment or risk associated with operating the equipment, as operation and maintenance is the responsibility of the sponsor. In the case of cooperatives, members have the opportunity to monetize their savings in collective investments, which has helped to democratize investment in renewable energy. The investments have a fixed duration (on average between 10 and 12 years) and an estimated return of between 3% and 4% per annum.

Table 5 . Economic findings: local community economic benefits

	Agra do Amial, Porto (Portugal)	Telheiras, Lisbon (Portugal)	Vila Boa do Bispo, Marco de Canaveses (Portugal)
Local community economic benefits	Reducing the value of energy bills	It's an investment with a positive re- turn, rather than the issue of electricity bills	Knowing where your savings are going because it's still the real, renewable economy

Another element emphasized by the survey respondents is the importance of maintaining local control, which they believe is essential to ensure that members benefit from the main objectives of these projects, i.e., improving social and economic conditions. While in projects promoted by public bodies, these should be actors with an active role and greater control, on the other hand, private interests must also be safeguarded so that the offer is realistic and meets needs. For this reason, each project must have a clear business model for all stakeholders. Among the planning formalities mentioned is the importance of drawing up detailed rules of procedure, setting out, for example, types of members and their rights and obligations, access requirements for members, withdrawal of members, how electricity is shared, payment of tariffs due, destination of surpluses, meetings, and method of deliberation, etc.

Table 6 . Planning findings: local participation in the planning and operation of the REC

	Agra do Amial, Porto (Portugal)	Telheiras, Lisbon (Portugal)	Vila Boa do Bispo, Marco de Canaveses (Portugal)
Local participation in the planning and op- eration of the REC	Maintaining local control is essential to ensure that members benefit from the main objectives of these projects, which are to improve social and economic conditions.	The REC is not just about producing and selling energy, there is a whole movement of people around an energy community	General meetings, albeit with very low attendance

## 5. Conclusion

The European experience already allows us to say that RECs are a real revolution in a market as arid and sometimes inhospitable to ordinary citizens as the energy production market. In Portugal, however, this revolution is still in its embryonic stages. It's important to reiterate certain aspects of RECs to ensure that their benefits are immense in the face of today's needs, where people's energy security is at risk. RECs promote cost reduction by allowing participants to share the costs of investing in renewable energy infrastructure, such as solar panels or wind turbines, which can result in lower costs for everyone. As noted above, the issue of energy security is important because by producing and storing their own renewable energy, RECs become less dependent on the conventional electricity grid and therefore more resilient to energy disruptions. From an environmental perspective, we see the positive impact on the environment because by producing and consuming renewable energy, RECs contribute to the reduction of greenhouse gas emissions and the use of clean, renewable energy sources. Last but not least, community involvement should be emphasized: RECs can be a grassroots initiative that involves the local community in the production and consumption of renewable energy, encouraging active participation and civic involvement. In Portugal, although solar energy is experiencing strong growth and data from the Directorate-General for Energy and Geology (DGEG) shows that 2022 was the best year in the historical series for the expansion of distributed generation, the length of time it takes to obtain permits for projects is not only a concern for REC project developers, but also reflects the low installed capacity in the country compared to the most advanced European countries in the field, which have already been cited throughout this study. The lack of human resources to deal with the growing demand for licenses, whether for large projects or small units that need to go through the state entity, is a bottleneck for which there is still no visible solution.

And despite the fact that there are several projects awaiting approval, it can be said that the country is still facing a high level of energy illiteracy among a significant part of local society. As this is still a new concept in Portugal, unlike in many European countries, there is a need for more information about the economic and social benefits of building a renewable energy community and which path to take.

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