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The Role of Energy Communities in the Achievement of a Region's Energy Goals: The Case of a Southeast Mediterranean Region

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Abstract: This study explores the potential of ECs as a conduit for achieving a region's or a country's energy goals. The study focuses on Greece, where roughly 1700 energy communities have been founded since 2018. The methodology adopted is based, initially, on an extensive literature survey, aiming to outline the general energy goals on a regional and national level. On a second stage, focused interviews were accomplished with four of the biggest energy communities in Greece, investigating essential topics, such as their motivations, their business models, the obstacles they have faced, and their achievements. Environmental, economic, and energy security reasons were revealed as the main incentives for the foundation of energy communities in Greece. The major obstacles underlined by the interviewees were the bureaucracy and the changing, often towards a less supportive direction, legal framework. The contribution to a more sustainable energy environment, the reduction of the electricity procurement cost, and the remedy of energy poverty feature as the most important achievements. In the context of the ongoing energy transition in Greece, this article concludes that even though ECs can promote energy transition and mobilise a commonly acknowledged dialogue that can aid a nation's efforts to achieve its energy goals, further investigation is required regarding the proposed policy initiatives, focused on strategies for upscaling the impact of energy communities, thus enabling them to flourish further.

Keywords: energy community; national energy climate plant; renewable energy sources; energy transition; sustainability; cluster; rational use of energy; energy democracy



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1. Introduction

To face the climate crisis and energy-related issues, Europe has been proactive in setting milestones and implementing strategies to save energy and minimize CO₂ emissions. Thereupon, the European Union (EU) has redesigned their approach to energy production and use, based on the milestones presented in Table 1.

These milestones demonstrate Europe's commitment to reducing energy consumption and CO₂ emissions, with a particular focus on the building sector [10] and the integration of renewable energy sources while transitioning to a more sustainable and climate-resilient economy. Table 1 highlights that the EU's milestones are characterised by a multifaceted approach, which includes legislative measures, energy efficiency improvements, and the promotion of renewable energy sources [2,11]. Furthermore, in 2021, the European Commission adopted a series of legislative proposals to achieve climate neutrality in the EU

by 2050, including the intermediate target of at least 55% net reduction in greenhouse gas emissions by 2030, compared to 1990 levels [12].

Table 1. EU milestones on energy-related strategies.

Milestone	Description
Kyoto Protocol (1997)	While not specific to Europe, the Kyoto Protocol sets targets for reducing greenhouse gas emissions, which spurred European countries to take action [1].
EU Climate and Energy Package (2008)	This package sets binding targets for EU Member States to reduce greenhouse gas emissions by 20% levels, increase the share of renewable energy to 20%, and improve energy efficiency by 20% by 2020 with regard to 1990 [2].
EU Energy Efficiency Directive (2012)	This directive established binding measures to help the EU reach its 20% energy efficiency target by 2020 and laid the groundwork for subsequent policies and actions [3].
Paris Agreement (2015)	Building upon the Kyoto Protocol, the Paris Agreement aimed to limit global warming at a maximum of 2 degrees Celsius above pre-industrial levels, with efforts to limit the temperature increase to 1.5 degrees Celsius. The EU, along with its Member States, committed to this agreement, further driving efforts to reduce CO ₂ emissions [4].
European Green Deal (2019)	This is one of the most ambitious milestones ever. It aims to make Europe the first climate-neutral continent by 2050. The Green Deal includes various initiatives, such as the European Climate Law, which legally binds Member States to reach net-zero emissions by 2050, and the European Climate Pact, engaging citizens and stakeholders in the transition [5–7].
Recovery and Resilience Facility (2020)	Part of the EU’s COVID-19 recovery plan, this facility allocates funds to Member States to invest in green and digital transitions, including energy efficiency measures and renewable energy projects [8].
Fit for 55 Package (2021)	This package proposes a set of legislative measures to align EU climate and energy policies with the more ambitious 2030 targets, including increasing the share of renewable energy to 40–45%, improving energy efficiency by 36–39%, and reducing greenhouse gas emissions by at least 55% below 1990 levels by 2030 [9].

Additionally, with the Green Deal, the EU has set an ambitious 32% target for electricity produced by renewable energy sources in the EU’s energy mix by 2030 [13]. If such targets are to be met, the production, supply, distribution and storage of electricity must be treated in an integrated way. Thereupon, the European Climate Pact [14] recognises people’s communities and organisations’ significance to energy transition [15], as they disseminate renewable energy plants’ capabilities and benefit society [16]. A comment made by Ursula von der Leyen (President of the European Commission—9 August 2022) describes vividly this insight: “Regardless of the size and capacity of your city, town or village, regardless of where in Europe you are located: you have a key role to play”.

In this context, renewable energy communities (RECs-renewable energy directive, [15], transposed at the Member State level by 2021) have an important role. Energy communities (ECs) were first referred to in the 2019 “Clean Energy for all Europeans” package. The revised Renewable Energy Directive [15] strengthened the role of renewable self-consumers and renewable energy communities, hence leading RECs to become a part of a common EU legislative framework for a greener Europe. The term “Energy Communities” has been used in a variety of ways in the literature, such as Citizen Energy Communities [17], Sustainable Energy Communities [18], Clean Energy Communities [19], Sustainable Communities [20], Renewable Energy Communities [21], and Low Carbon Communities [22]. According to Frieden et al., ECs are a form of organised collective action in energy sys-

tems [23], while Blasch [24] refers to them as “associations of actors engaged in energy system transformation through collective, participatory and engaging processes, seeking collective outcomes”. Through their real social and environmental implications, which might vary, ECs also address important societal concerns like energy poverty [25].

Nevertheless, the pace of development for ECs can vary significantly across European countries, as it is a complex process influenced by a range of factors [26], such as geographical location, resource availability [27], cultural attitudes towards energy use and production, including efficiency and productivity of renewable energy [28], policy directives, economic growth, technological innovation [29], environmental concerns, and socio-technical dimension [30]. Additionally, the level of communities’ engagement may also play a role in shaping the pace of their development. Furthermore, time has proven that the existence of factors such as environmental and climate goals, economic and social drivers, technological and infrastructure advancements, or legal frameworks may lead some countries to set more supportive policies or regulatory frameworks in place, thus making it easier for communities to form and develop renewable energy projects [31]. For example, countries like Germany and Denmark have been pioneers in the development of energy communities, with strong government support [32] and a culture of community engagement [33] in renewable energy projects.

The explicit aim of current European policy measures is to facilitate the transition to a low-carbon energy system by encouraging the development of community energy projects [34]. This is because both legislative and non-legislative regulations have the potential to stifle community initiatives in the energy sector, as these initiatives are both impacted and driven by developments in this sector [34]. Nonetheless, some countries may be slower to adopt energy community models due to regulatory barriers, political challenges, or a lack of awareness among the public. In such cases, countries that manage to overcome these hurdles and attempt to become the forefront of this transition and a beacon for other nations that face the same difficulties are the spark behind this research. Overall, while the transition to energy communities is a promising trend in Europe’s energy landscape, it is important to recognise that it is not a one-size-fits-all solution, and each country will have its unique journey and challenges along the way. Even though ECs tackle energy matters locally, political measures are necessary to address issues at their roots.

In conclusion, even though ECs are not a new concept, their legal status, as part of the European legislative package “Clean Energy for All Europeans”, has made them more significant in recent years. In this context, this study addresses knowledge gaps and misconceptions about ECs and their connection with the energy scheme in a Southern European country in the East Mediterranean, where Renewable Energy Sources (RES) thrive. Although this article is not the first about ECs in Greece, it is the first of its sort, namely, the first that focuses on ECs’ role in reaching a region’s energy goals. Despite the substantial literature on ECs, as the majority of them are found in Northern Europe (such as Sweden, Germany, and Denmark) with little experience in the Euro-MED region, their comprehensive potential to advance a region’s energy objectives, particularly in developed nations, remains inadequately explored, indicating a research deficiency.

Thereupon, in the context of the ongoing energy transition in Greece, this study seeks to address a knowledge gap about the relationship between ECs (which its members share only electricity) and a region’s or nation’s energy transition objectives, notably focusing on a Southern European region. The article starts with an overview of the relevant literature in Section 2, thus attempting to highlight those critical questions that would allow this study, through qualitative research, to correlate ECs’ impact factor over a region’s energy goals (Section 3). By interviewing the CEO of several ECs in Greece, useful insights into the perspective on energy issues that will eventually define Greece’s sustainable landscape

were investigated (Section 4), and a coherent understanding of the role of ECs in the achievement of Greece's energy goals was acquired (Section 5). This study concludes with the discussion of both phases' findings in Section 6 in correlation with the acquired results addressing the identified gaps from the literature review and the presentation of conclusions in Section 7.

2. Literature Review

As mentioned above, a Renewable Energy Directive revision was released as part of a clean energy package for all Europeans by 2018, setting a target of 32% renewable energy by 2030, which was proposed in 2022 to be increased to 45% by 2030 by the REPowerEU plan, concluding, finally, to a temporary 42.5% with a plan for possible revision if this goal will be too high [35]. Although EU Member States should have complied with RED II by June 2021, the process is still far from a wide exploitation of the community energy concept [30]. Undoubtedly, this challenge calls for well-informed decision-making assistance for improved utility as well as spatial energy planning of various sources, technologies, and sharing concepts, particularly for countries with an abundance of renewable energy resources [36].

Among the energy carriers, electricity is one of the most common, being produced from various primary energy sources such as coal, oil, natural gas, solar, and wind, and can also be converted into other forms of energy very efficiently. Nevertheless, the use of fossil fuels by conventional power plants is reduced, creating the necessity for greater penetration of renewable energy in the sectors of electricity, heating/cooling, and onshore transportation, which account for 51%, 32%, and 17% of the total final energy onshore consumption, respectively [37]. The chart in Figure 1 shows the electricity production percentage from renewable sources over the total gross electricity consumption per EU country in 2022. It can be observed that the percentage ranges with the maximum of Iceland's 99.2% (Norway is excluded as it's above 100%) and the minimum 10.1% in Malta, while Greece is around the middle with 42.4% and very close to the EU average.

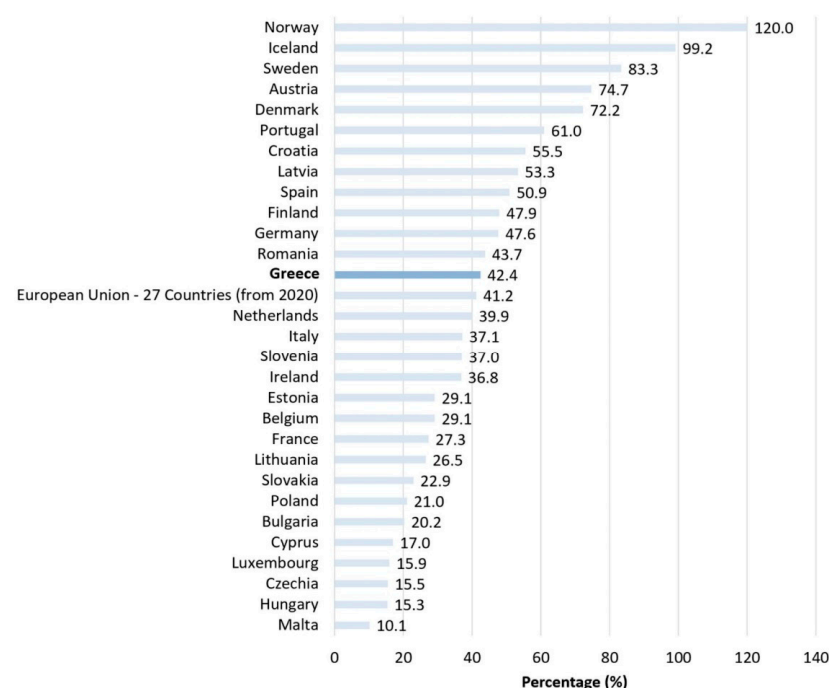


Figure 1. Annual electricity production percentage contribution from renewable energy sources versus the total annual electricity demand in the EU's Member States [38].

To maximise the use of RES among its Member States, the EU designed energy policies and a long-term plan to achieve specific energy targets and has set a vision for being a zero-energy continent in the near future. With its strong territorial aspect, the EU's long-standing cohesion policy encourages integrated territorial and local development strategies to meet the various development needs of Europe's cities and regions while assisting the less developed nations and regions in catching up [39].

Thereupon, the EU spends a substantial part of its budget on the expenditure to support its policy about climate and energy while remaining on the right path to achieve the target of reducing greenhouse gas (GHG) emissions, increasing renewable energy exploitation, and improving energy efficiency. The EU's pursuit of the above led not only to a long-term strategy but also to the dissipation of the acquired knowledge from the Kyoto Protocol, in 1997, to the Paris Agreement, in 2015, on energy efficiency, deployment of renewables, and energy-saving roadmaps. In this way, the EU assigned the energy transition task to its Member States, giving them directives as well as the legislative framework to approach the newly set goals. Therefore, the concept of ECs has emerged, and the EU provided the required legislative flexibility for them to offer to their members reduced electricity costs, the chance to invest in new RES projects for electricity and heat, alleviating, hence, energy poverty, and claiming a new sustainable development pattern.

However, at the European level, there is no unified approach to the development of energy communities, and several different approaches have been developed. The promotion of energy sharing, cost-effective management, inclusive policies, and regulatory issues related to networks and energy markets are all open issues that need to be tackled by each Member State with several choices that might not be shared by others [40]. Consequently, due to various factors, including geographical, cultural, economic, and political differences, countries in Central Europe and those in the Mediterranean region present differences in the development of ECs. Countries like Spain, Italy, Greece, and Portugal have their own unique set of challenges [41] and opportunities when it comes to EC development. While they may have abundant renewable energy resources such as solar and wind, they may also face different regulatory hurdles, economic constraints, and cultural attitudes towards energy ownership and participation. Additionally, factors like climate conditions and population density can influence the feasibility and scale of energy community projects in these regions. In the framework of energy transition to a sustainable future, balanced territorial development is essential [25]. Thereupon, further research is required to achieve environmental sustainability in Greece and in other Southern European countries [42].

2.1. Greece's National Energy Strategy

Governments, in an attempt to comply with some general EU guidelines, implement energy policies providing incentives for the installation of plants for energy production from RES and energy exchange with the national grids. As the target for integrating RES becomes greater, the challenges to overcome their consequent obstacles grow as well [37]. Within this context, the Greek government gave its energy policy a lot of thought due to the Russia–Ukraine war, as the production disruptions could lead to price increases and supply concerns [43], thus leading them towards its transition to a renewable-based system, further strengthening its commitment to move away from fossil fuels and accelerate the clean energy transition. Thus, in 2019 Greece issued the first National Energy and Climate Plan (NECP) in accordance with the 2018 Intergovernmental Panel on Climate Change (IPCC) presented results. Since then, massive changes have taken place in the world, which necessitated the review of the first approved text and the issue of its revision in 2023, within which they will be incorporated.

As the NECP is the country's roadmap for energy transition, it serves three purposes. Firstly, it lays out Greece's general strategy on how the country will achieve climate neutrality by 2050. Secondly, it presents the policies that will facilitate the achievement of the nations' goal, with an emphasis on the intermediate stage of 2030. And, thirdly, it translates the policy in a reference scenario and action plan, offering an understanding of the principal patterns and magnitudes of the major influencing factors. As the RES implementation rate in Greece between 2019 and 2023 has increased significantly in every sector, the revised version of the NECP sets higher quantitative goals than the previous version. Figure 2 summarizes the latest set of energy goals in relation to the NECP's previous version, while Table 2 presents a summary of the newly set energy goals based on the revised version of Greece's NECP, submitted at the end of 2023 and anticipated to be finalized within 2024.

Previous Version of NECP	NECP revision
- RES share in total energy consumption by 2030 to be at least 35% - RES generation in electricity consumption at least 61% by 2030 - RES electricity generation should be 67% of domestic electricity generation by 2030 - RES participation in transport sector 19% - RES development for heating and cooling to be at least 43% by 2030 - GHG emissions reduction (without LULUCF) reduction in relation to 1990 40%	- RES share in total energy consumption by 2030 to be at least 44% - RES generation in electricity consumption at least 80% by 2030 - RES electricity generation should be 82% of domestic electricity generation by 2030 - RES participation in transport sector 29% - RES development for heating and cooling to be at least 46% by 2030 - Energy poverty reduced by 50% in 2025 in relation 2016 and reduced by 75% in 2030 - GHG emissions reduction (without LULUCF) reduction in relation to 1990 54%

Figure 2. Summary of Greece's NECP revision energy goals.

Table 2. Summary of Greece's latest energy goals [44].

No	Target Goal	NECP 2019 (2030 Targets)	NECP 2023 Revision (2025 Targets)	NECP 2023 Revision (2030 Targets)
EG1	Greenhouse Gas (GHG), Land Use, Land Use Change, and Forestry (LULUCF) (change since 1990)	40%	41%	54%
EG2	GHG with LULUCF (change since 1990)	-	44%	57%
EG3	RES penetration percentage over the gross final consumption of energy	35%	31%	44%
EG4	Energy efficiency	0%	4%	5%
EG5	Final land occupation	16.5	16.6	15.4
EG6	RES—electro-production (% of gross electricity consumption)	61%	58%	79%
EG7	RES in heating and cooling	43%	36%	46%
EG8	RES in the transport sector	19%	13%	29%
EG9	Renewable fuels of non-biological origin (RFNBO) (% transport fuels)	0%	0%	1%

Table 2. Cont.

No	Target Goal	NECP 2019 (2030 Targets)	NECP 2023 Revision (2025 Targets)	NECP 2023 Revision (2030 Targets)
EG10	Advanced biofuels (% transport fuels)	1.5%	0%	2.4%
EG11	Conventional biofuels (% transport fuels)—upper limit	1.7%	1.7%	1.7%
EG12	Effort Sharing Regulation (ESR) (% GHG change in non-Emission Trading System (ETS) sectors)	40%	36%	46%
EG13	Reducing energy poverty in relation to 2016 (% reduced number of households meeting the above-mentioned conditions)	-	50%	75%

The reasons behind this percentage increase in specific objectives could be either Greece's commitment to make possible the transition to a climate-neutral economy by 2050 or a strong belief towards specific initiatives and actions that are already being promoted and implemented by the government, like energy communities (ECs) or the attempt to simplify and speed up the licensing framework, ensuring optimal integration of RES in electricity networks, operating energy storage plants, and the promotion of electromobility.

Another important observation is the emergence of a new objective, which is the reduction of energy poverty (EG13), a goal advocated by the ECs. Nonetheless, this new target also points out that the timeline for accomplishing the goals is essentially a technology competition, possibly even across continents, rather than a motivation driven by climate concerns.

Of course, as in the first NECP version, also in the new revised version, the goals presented in Table 2 are further broken down into objectives and priorities. For example, the participation of renewable energy sources in electro-production is further divided and analysed in Table 3.

Table 3. Further analysis in objectives of No. 6 goal from Table 2 [44].

RES Participation in the Electricity Sector	NECP 2019 (2030 Targets)	NECP 2023 Revision (2025 Targets)	NECP 2023 Revision (2030 Targets)
Renewable energy sources, other than hydroelectric (GW)	15.5	14.8	23.5
Wind power (GW)	7.1	6.0	9.5
Solar power (GW)	7.7	8.2	13.4
Other RES (GW)	0.7	0.5	0.6
Hydroelectric (GW)	3.7	3.1	3.8
Electricity storage capacity (GW)	2.7	3.3	5.3
- Batteries	1.25	1.9	3.1
- Pumped storage	1.4	1.4	2.2
Capacity of units with burnt gas (GW)	6.9	6.9	7.7
Power of solid burnt units (GW)	0.3	1.5	0.0
Power of units with burnt liquid (GW)	0.3	1.3	0.7

In the revised version of NECP, it is highlighted that out of the 9.5 GW of wind power goals by 2030, 1.9 GW is related to offshore wind parks. Also within it, the statement that “granted up to July of 2023, the implementation of new RES projects is approximately 13.6 GW for the system and 2.6 GW in the grid, while there is also a significant number of applications submitted

to the operators for the issuing of new connection agreements”, seems to imply that the State has provided tools and means so that the annual figures for electricity production from RES up to 2030 may be considered realistic and achievable. The revision of NECP also states that there will be studies on assessing the risk factors of expanding the current network infrastructure in order to include RES projects after the time mark of 2030.

Thus, mitigating the effects of climate change is a major task for humanity, with Europe and Greece playing their part in this endeavour. The installation of diverse RES to replace fossil fuel consumption is necessary for the eventual shift to a net-zero carbon economy. Greece’s 2023 NECP predicts that until 2050 solar electricity will account for a sizable portion of the nation’s energy mix. This suggests that the adoption of RES will increase quickly in Greece, given the high available potential and the corresponding expressed investment interest [45].

2.2. Energy Communities in Greece

After the introduction of the EU policy for community energy initiatives across its Member States (see Table 1), the challenge lies in the national and regional implementation of this framework [46]. Therefore, Table 4 below presents a summary of the Greek government’s attempts towards the operationalisation of the EU’s enabling framework.

Table 4. Greece’s legislative regulations.

Law	Description
Law 4416 (2016)	Introduction of net metering and virtual net metering targeting farmers and municipalities.
Law 4513 (2018)	Introduction of Energy Communities.
National Energy and Climate Plan (NECP) (2019)	Definition of quantitative targets for energy, reduction of emissions, heating and cooling, and renewable energy until 2030 and 2050.
Law 4643 (2019)	Liberalisation of the energy market, modernisation of Public Power Corporation, further support of RES systems, and privatisation of Public Gas Corporation.
Law 4710 (2020)	Promotion of electro-mobility and more.
YPEN-DAPEEK/74462/2976 (2020)	Definition of the licensing procedure for the installation and connection to the distribution network of small wind turbine stations with an installed capacity up to 60 kW, as well as any other details.
Law 4951 (2022)	Modernisation of the licensing process for renewable energy sources—Phase B of licensing of electricity production and storage framework for the development of pilot marine floating photovoltaic stations and more specific provisions for energy and environmental protection.
Law 4964 (2022)	Provision for the simplification of environmental licensing, establishing a framework for the development of offshore wind farms, dealing with the energy crisis, environmental protection, and other provisions.
Law 5037 (2023)	Renaming the Energy Regulatory Authority to the Waste, Energy, and Water Regulatory Authority, expanding its scope with responsibilities over water services and urban waste management, and strengthening water policy—Modernising the legislation on the use and production of electricity from renewable sources through the incorporation of EU directives 2018/2001 and 2019/944—Changes for energy communities.
National Energy and Climate Plan (NECP) (under development following the 2023 EU’s feedback)	Draft updated NECP 2021–2030

Along with the emergence of initiatives, policies, and new regulatory frameworks aiming at the energy transition in Greece, the one that stood out was Law 4513/2018, which was altered by Law 5037/2023. Based on these two legislative frameworks, EC initiatives can adopt only the legal structure of urban cooperatives, in contrast with the EU, where a wide range of legal forms has been utilised, including partnerships, community interest companies, various types of social enterprises, and associations [47]. Additionally, both

laws deviate from the EU Directive 2019/944, the first based on proximity and the second on whether they operate for profit or non-profit purposes.

Thereupon, according to recent research [25], Greek ECs' current greatest concern refers to the transitional period between the two legislative frameworks, as there is no provision regarding the future of ongoing community energy projects regarding their connection contracts. Identifying and recording this degree of uncertainty across multiple dimensions for the adaptation of ECs' existing operations to comply with the new legal requirements is a gap that this research will address in an attempt to provide clear guidance for ensuring the smooth evolution of ECs, the continued growth of RES in Greece, and, hence, the achievement of Greece's energy goals.

In December 2023, 1689 ECs were recorded by the official Greek Registry, according to the data presented by The Green Tank [48]. However, not all of them have active RES projects, while, after the alteration of Law 4513/2018 in 2023, sixteen (16) new ECs have been established. Five (5) of them are citizens energy communities (CECs) and eleven (11) are renewable energy communities (RECs), as both types were introduced by Law 5037/2023. The rest of these ECs were established by Law 4513/2018. ECs in Greece account for around 17.5% of the total RES power production in low and mid-voltage [49]. This points out Greek ECs' alignment with the established energy goals that have been set within NECP.

Figure 3 presents a significant increase in the registration of ECs after 2020, while their applications for permits to produce electricity and to connect to the network seem to have been stabilised in the past two years. At the same time, the upward trend of electrified requests highlights that more projects are approved by the grid administrator, despite the lack of the required grid infrastructure and electric space for new producers.

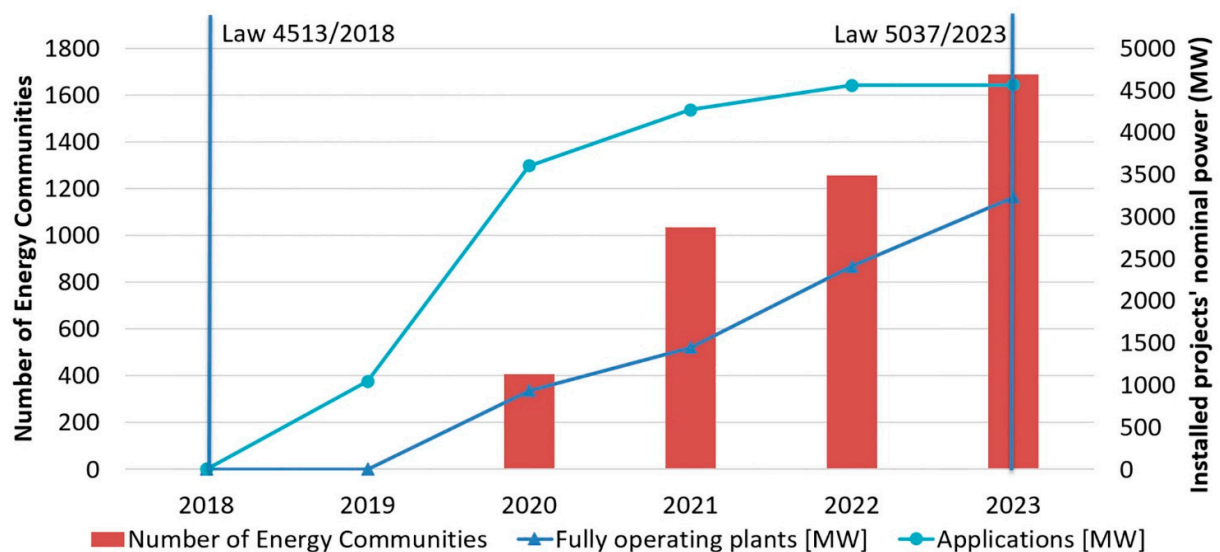


Figure 3. Numbers of Greek ECs and applications for new projects before and after the introduction of the relevant legislative framework (authors' elaboration based on data of [50]).

The Green Tank [48] also recorded the number of ECs within each geographical region along with other significant data regarding the attempt of ECs to establish themselves. Figure 4 presents the outcome of this research.

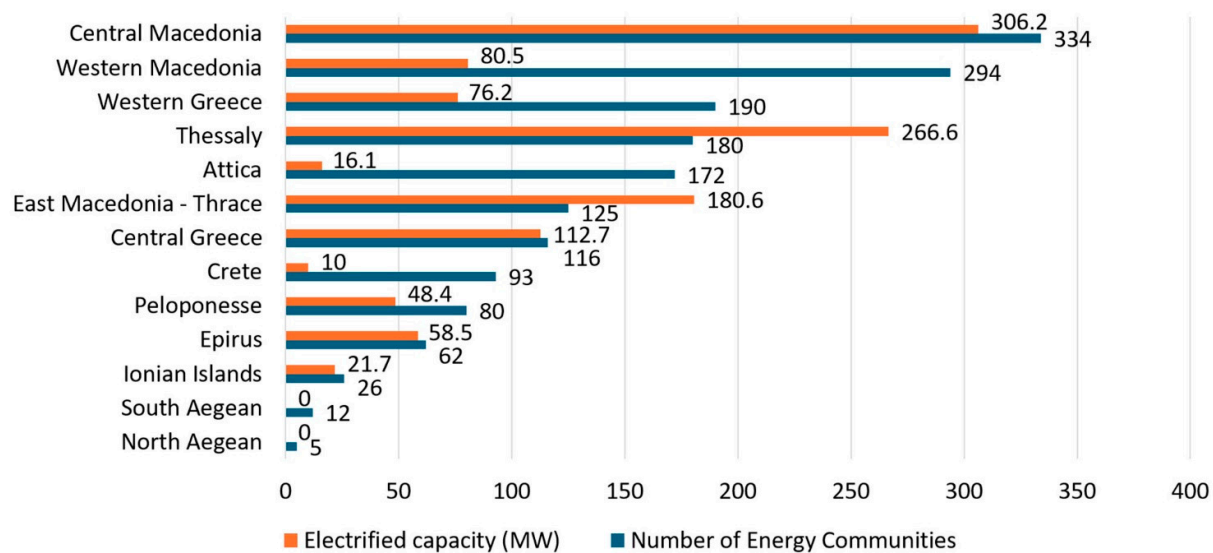


Figure 4. Number of ECs per geographical region and their electrified/installed capacity till December 2023 [51].

The Region of Central Macedonia remains first in the number of ECs with 334, while second is the lignite Region of West Macedonia with 294. The region of Central Macedonia also has the largest electrified power (306.2 MW), while the second is Thessaly (266.6 MW) and the third is Eastern Macedonia and Thrace (180.6 MW). The region of Crete records 93 ECs with projects of just 10 MW. Having presented the electrified/installed capacity of ECs, it was considered important to also present the total electric energy produced in Greece from RES in 2023 in order to attempt estimation. Figure 5 presents the total installed electric capacity from RES (in blue colour) and their total electricity production (in purple colour) during December 2023 per geographical region in the mainland, interconnected grid. Comparing Figures 4 and 5 data with the annual electric energy demand in 2023, which according to IPTO archives [49] was 54.3 TWh, the annual production of electric energy (47.6 TWh) and the annual production of electric energy from RES (21.3 TWh) [52] an idea could be drawn regarding the potential of ECs, which account for almost 17.5% [49] of the total electric production from RES, to reduce the country's primary electric energy consumption. No data were uncovered during the investigation that would enable the authors to document the annual output of electrical energy from ECs.

Thereupon, this study will collect and present secondary data, such as policy papers, data reports, and the existing literature, in conjunction with primary data obtained from a fieldwork survey (public and private sector energy-related organisations). By synthesising various sources, the research will thoroughly examine Greece's energy sector, encompassing trends and contemporary developments. This method ensures a comprehensive understanding of the sector while simultaneously addressing a research need concerning the rising role of energy communities and their regulatory problems in Greece.

Combining the above with qualitative research using interviews, the obtained quantity and depth of information allow for more in-depth examination of the subject matter through follow-up questions, explanations, examples, etc., in contrast to static questionnaires. This is because the interviewee and the researcher engage in real time. As will be further explained and presented in the methodology section by incorporating perspectives from important active EC officials, the study will provide vital and critical insights from within into the practical implications of energy policies and projects. This helps to gain a better understanding of the local energy landscape, thus covering another gap regarding Greece's energy sector's context.

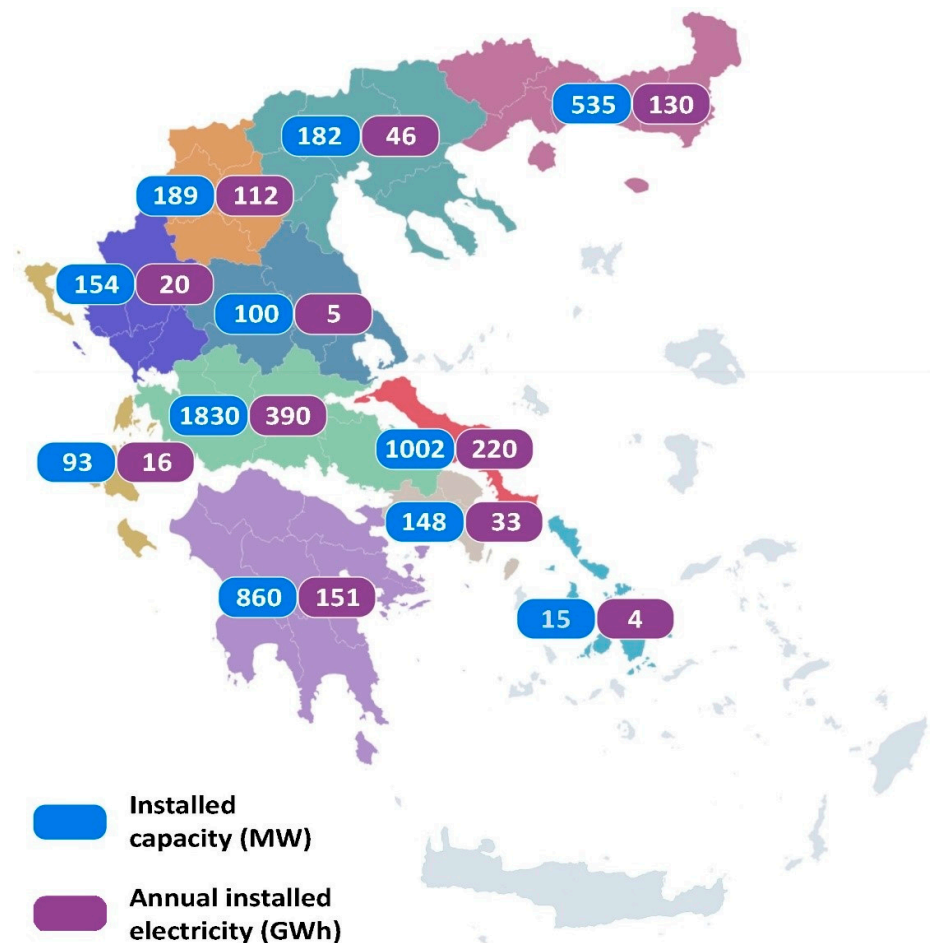


Figure 5. Total installed capacity from RES plants per region and their electricity production (December 2023) in the mainland interconnect grid [49].

3. Energy Communities Contribution to a Nation's Energy Goals

In recent years an increasing number of studies have analysed energy communities to investigate various elements, such as their political and regulatory framework and its evolution, their economic and environmental benefits, their adopted RES technologies, their successful start-up and management, the motivation of individuals to participate, their social role and community planning, and their business models [53]. At the same time, various case studies have been carried out researching their barriers and shortcomings [54]. Nonetheless, accurate and up-to-date statistics on energy communities are hard to find and often not easily comparable across countries [55]. According to a study by Wierling [56], by the end of 2022, there were more than 9250 energy communities in 29 European countries, 26 of which are Member States. RESCoop.eu gathers around 2450 renewable energy cooperatives with around 1.5 million individual members [57], although the same source estimates that these are only half of the active renewable energy cooperatives in Europe. Other sources report that more than 3500 cooperatives have been established across Europe as of 2020 [58].

Yet, creating and operating ECs is often complex. In addition to an appropriate regulatory framework, they require investments, legislative knowledge (and often a lot of work to address barriers to unfavourable legislation), proximity to sites with high RES potential, a cohesive and committed group of stakeholders, and participation of local administrations. Examples of ECs are largely concentrated in Northern Europe (e.g., Sweden, Germany, Denmark), with limited experiences in the Euro-MED area. Despite the extensive literature concerning energy communities [16], their holistic potential to

support a region's energy goals, especially within developed countries, has not been fully examined, revealing, hence, a research gap.

Even though energy communities are usually deployed at the neighbourhood scale within EU countries, since the proximity facilitates governance [16], this is not the case within Greece. The different locations and area's morphology differentiate their operation and investment decisions. Therefore, this research also sheds some light both on Greek ECs and the transformation of Greece's energy sector.

According to the literature, ECs' main objectives are the production, supply, distribution, sharing, and consumption of renewable energy carried out collectively by citizens, often partnering with small and medium-sized enterprises and public authorities [59], using the different goals that stakeholders have related to ECs [60] as a way forward. Following that, this figure also highlights the different connections that may cause interference or contribute to the energy transformation path. Particularly regarding the Greek insular country, there is a small number of ECs in the islands of Crete, Sifnos, and Chalki that have undertaken the ambitious project of making their islands totally green and energy democratic and independent [61–63].

ECs, thus, are legal entities that are controlled by a community of formerly passive consumers and in which participation is open and voluntary. In an ideal scenario, an EC brings public, private, research, and economic actors together to take control of energy production and supply. EC, as a revised form of cluster, is an altered way to organise collective energy actions around open democratic participation and governance and to provide social, environmental, and economic benefits to its members and the local community [64] and to assist a sector and a region to adopt innovation [65]. As summarised by the EU Smart Cities Information System [66]:

- The environmental aspect of ECs refers to the expected increase in renewable energy share;
- The social dimension of ECs relates to the collaboration and organisation between members of the energy community, as well as the principles that guide such cooperation;
- The economic dimension of ECs relates to the variety of activities energy communities might exercise to match consumption and production at the community level.

At the same time, ECs can assist the transition from a centralised to a decentralised energy production system, a more effective exploitation of renewables [67], the reduction of energy costs and dependency on imported energy sources, and the citizens' involvement in a prosumer role [68]. Ideally, they can help mobilise private capital [69], enhance flexibility in the energy market [70], and lower public resistance against the energy transition [71]. Summarising all of the above, Table 5 attempts to examine how ECs' activities align with national and global energy goals, drawing insights from the literature and correlating them with Greece's energy goals (EGs), as presented in the draft version of NECP.

Table 5. ECs' activities correlation with NECP's energy goals [66].

ECs' Activities	Activity Analysis	Energy Goals
Collective self-consumption	Collective self-consumption implies the instantaneous or near-instantaneous matching of production and consumption within a geographically confined area and between multiple consumers.	EG1, EG3, EG6, EG13
Production	Production is often the primary activity of energy communities. This activity either stands alone or is combined with other activities, such as supply.	EG2, EG3, EG6, EG7 EG1 (indirectly), EG9, EG10, EG11 (perhaps in the future)

Table 5. *Cont.*

ECs' Activities	Activity Analysis	Energy Goals
Supply	In the Clean Energy Package, the concept of multiple suppliers on a single metering point is depicted. This enables the supply of locally produced energy within the energy community while simultaneously allowing the consumer to select a conventional supplier for the energy that cannot be supplied by the community.	EG13
Distribution	The Electricity Market Directive leaves open the option for member states to allow CECs to take over the distribution of electricity. There is no single right answer to whether this should be allowed or not.	Not applicable for NECP
Aggregation	Energy communities can aggregate the electricity produced by the production plants owned by the community, the consumption profiles of their participants and/or external customers, as well as the energy flexibility of their assets, and offer these aggregated loads collectively for purchase or auction in any electricity market.	EG12
Sharing of electricity	The new directives enable energy sharing between the members of an EC. That implies that excess energy produced by one member or energy produced by a common asset can be used to supply other members. The conditions under which this will be allowed depend on the country and the rules agreed upon in the specific energy community.	EG12
Energy-related services	Energy-related services can also be provided to the members of an EC, including the services of an EV charging card, a shopping guide for energy-efficient appliances, a mobile application to save energy, rental of power meters, subsidies for insulation and replacement or installation of heat pumps, consultancy services, energy auditing, consumption monitoring, energy monitoring, and management for network operations, etc.	EG1, EG4, EG7, EG8
Tackle energy poverty	Energy communities can be an important way to meet the increasing electricity demand and alleviate energy-vulnerable or poor households by matching local production and demand, resulting in reduced electricity prices.	EG13

Thus, it becomes evident that ECs collectively manage energy production, distribution, and consumption, often focusing on renewable energy sources, which could therefore be seen as a key strategic means for achieving national and global energy goals, including sustainability, energy supply security, and economic development.

3.1. Key Insights for the Achievement of a Country's Energy Goals

A multidimensional strategy that takes into account social, political, economic, and technical factors is needed to achieve a nation's or a region's energy goals. Thereupon, this section presents the key insights that, according to recent studies' findings, successfully support the achievement of these goals.

Table 6 highlights that a comprehensive strategy that incorporates local policy actions, population density considerations, economic conditions, investment attractiveness, environmental regulations, innovation efficiency, technical and total factor energy efficiency, and effective energy management is needed to achieve regional energy goals. Regions can improve their overall economic growth, sustainability, and energy efficiency by tackling these concerns. Additionally, local authorities can integrate all available resources, projects,

or programs with determination, consistency, and continuity to improve their competitiveness while simultaneously achieving environmental sustainability and promoting energy awareness within their jurisdiction [72]. Thus, this study's major question derives from the interrelation of the aforementioned key factors (KFs) with the effects of the ECs within a nation and consequently within a region.

Table 6. Key factors for the achievement of a region's energy goals.

No	Key Factor	Analysis	Source
1	Policy and Governance	To accurately forecast energy demand and guarantee sustainable energy usage, policymakers must create energy plans that take the Sustainable Development Goals (SDGs) into account.	[73,74]
		The creation and execution of renewable energy projects require robust energy regulations and efficient governance.	[75]
		Local authorities should adopt approaches that enable decision and policy makers to formulate optimal energy-related programs and concentrate on appropriate financial resources, considering the most suitable tools and anticipated impacts on the techno-economic performance of proposed projects.	[76]
2	Local policy and discourse networks	Local authorities ought to facilitate regional growth and job-creating investments, prioritising energy efficiency and sustainability, through the implementation of effective instruments by their technical departments.	[77]
		The success of energy transitions is heavily influenced by discursive network structure and local policy initiatives. Discourse differences between urban and rural areas impact the advancement of energy efficiency and renewable energy initiatives.	[78]
3	Population Density and Energy Intensity	Improvements in energy intensity are impacted by population density. A higher density of city residents increases energy intensity, though population dispersion in rural areas decreases it.	[79]
		Reducing CO ₂ emissions and promoting sustainable energy practices are two goals addressed by education and investment.	[80]
4	Firm-Level Energy-Saving Efforts	The attributes of fixed assets and firm-level variables like energy-saving initiatives are important in reaching energy-saving targets. Businesses with larger resource stockpiles are more effective at conserving energy.	[81]
5	Economic Conditions and Energy Management	Energy management strategies are influenced by economic factors, such as fluctuating and high energy prices. Technical hazards, financial constraints, and organisational priorities are some of the barriers. Collaboration, ongoing energy accounting, and energy-efficiency initiatives are success elements.	[82]
		Carbon emissions, energy consumption, and economic growth are all related; in developing countries, energy use has a major influence on carbon emissions.	[83]
6	Investment Attractiveness and Energy Access	Energy accessibility and efficient energy management make agricultural businesses more interested in investing in a region, lowering risks, and improving sustainability.	[84]
7	Environmental Regulations	The effects of environmental laws on energy efficiency vary. Regulations drive a transition to cleaner energy in more developed areas and may encourage resource extraction in less developed ones.	[85]
8	Innovation Efficiency	Green productivity gains considerably from innovation efficiency. This connection is negatively impacted by financial constraints, indicating that strategies should be centred on developing green finance and increasing innovation efficiency.	[86]
		Collaborative innovation efforts could be further reinforced by appropriate TRL approaches that would allow their enhancement by mitigating observed shortcomings.	[87]

Table 6. Cont.

No	Key Factor	Analysis	Source
9	Technical and Total Factor Energy Efficiency—Sustainability	Higher levels of technological and energy efficiency are found in the EU's more developed regions. Innovation and human capital are essential for raising ecological performance and regional efficiency.	[88]
		Energy efficiency is essential in reducing greenhouse gas emissions.	[89]
		Export diversification in OECD countries helps improve energy efficiency and reduce energy intensity.	[90]
		To guarantee energy security and sustainability, it is necessary to establish a balance between the utilisation of renewable resources and energy consumption.	[91]
10	Sustainable Development Goals (SDGs) and Energy Demand	To address the increased demand for energy, countries must incorporate the SDG targets into their energy planning.	[74,92]
11	Renewable Energy Development	Renewable energy adoption significantly reduces CO ₂ emissions, contributing to environmental sustainability.	[80,89]
		Public acceptance, investments in the environment, and financial gains are important catalysts for the production of renewable energy; on the other hand, poor governance and insufficient government policies act as roadblocks.	[75]
		A region should assess their optimal solutions, taking into consideration their special needs and future perspectives, as a sustainable strategy against possible future energy crises and relative price instability that will influence their economic profitability. Therefore, the implementation of algorithms for the use of batteries in order to minimise the capital expenditure (CAPEX) could ensure a sufficient percentage of self-sufficiency.	[93]

3.2. Energy Communities Impact Within a Region

As mentioned in the previous sections, ECs' impact is addressed in three dimensions: environmental, social, and economic. Throughout the literature, ECs are often presented as a unique opportunity to alter a country's energy system [25] and secure energy and electricity in times of crisis [7], to adopt and implement innovation [94], to engage the community with energy issues [33], and further educate through experience [46], even though awareness alone seems insufficient without the power to truly enact change and redistribute power. Table 7 below presents ECs' impact according to the three dimensions summarised by the EU Smart Cities Information System [66] and based on this study's literature review [55,58,95–102].

Table 7. Impacts of ECs within a region (authors' elaboration based on the literature).

No	Environmental Dimension	Social Dimension	Economic Dimension
1	Increase Renewable Energy Deployment	Community's welfare	Decrease energy production costs
2	Optimization of Resources	Community's empowerment	Enhanced grid flexibility
3	Responsible use of resources by society	Community's education	Sustain economic efficiency
4	Greenhouse gas emissions reduction	Addressing health and safety issues	Creating new infrastructure/jobs
5	Environmental sustainability	Energy Democratization	Increase community's income
6	Local energy storage/Energy adequacy	Energy equity	Attract local investments—Business opportunities
7	Improve Resource efficiency ENV.D	Social cohesion S.D	Mitigate energy supply costs EC.D

Therefore, according to the previously presented literature review, on which Tables 5 and 6 were constructed, this study researched the correlation of EC outcomes (some of them presented in Table 7) with the key factors for the achievement of a region's energy goals (several of them presented in Table 6). The methodology of this research was designed bearing also in mind both the difficulties that field research would face, due to the lack of a unified registry of Greek ECs, and the fact that most energy communities are currently still in the development phase.

4. Methodology

Based on the theoretical foundations established in the previous sections, this section presents the research methodology adopted to explore the role that ECs play in the achievement of a region's energy goals. As there are various types of research, such as quantitative and qualitative, it was decided to combine the existing secondary data (deductive approach) for the creation of the structure of the in-depth interviews (qualitative method). According to Saunders, Lewis, and Thornhill [103], a researcher should avoid falling into the trap of thinking that one research approach is better than another: “they are better at doing different things and it all depends on the research purpose and questions”. Therefore, after taking into consideration both the literature review's findings and the Greek context within which ECs are established, the authors decided to follow the research process presented in Table 8.

Table 8. Phases of the research method.

Phase	Preliminary		Fieldwork
Source	Literature Review	Chambers of Commerce	Interviews
Purpose	To comprehend previous research's findings and to locate preliminary evidence regarding the research question	To retrieve available data that would support this study's second phase	To explore the validity and reliability of the obtained by the previous phase information and to expand them further if possible
Method	Secondary data		In-depth interviews

This study used phase one for the extraction of indicative trends and the elicitation of key factors (presented in Table 6), which were later included in the fieldwork and the design of the in-depth interviews. Although field research is more commonly used in the social sciences, such as anthropology and the health professions [2], as in these fields it is vital to create a bridge between theory and practice, it is nevertheless an important fact-finding object, and in other scientific fields, (i) in order to identify the environment of their subjects and to understand their interconnections, and (ii) when there is a lack of data on a particular topic, field research can be used to fill information gaps that can only be filled through in-depth primary research.

One of the field research methods is qualitative research, which aims to collect and analyse non-numerical (descriptive) data to understand the social reality of individuals, including understanding their attitudes, beliefs, and motivations. This type of research usually involves interviews, focus groups, case studies, and/or observations to collect detailed data. Qualitative research is often used to investigate complex phenomena or to study and record people's experiences, perspectives, beliefs, and attitudes about a particular topic. It is particularly useful when researchers want to understand the meaning that people attribute to their experiences or when they want to uncover the underlying reasons behind a subject [104]. In qualitative research, the interview is a conversation between the researcher and the interviewee, where questions are asked to elicit information. The biggest advantage

of qualitative research through interviews is the amount of information and in-depth analysis that can be obtained. Another advantage of the interview is the flexibility it offers the researcher. In contrast, for example, to static questionnaires, the dynamic nature of an interview, through the interaction of the researcher and the interviewee in real time, allows for further analysis of the topic at hand through, for example, follow-up questions, explanations, examples, etc. [105]. The interview approach also has some drawbacks. It requires time, both for conducting the interviews and for their subsequent analysis, while good coordination between the researcher and the interviewee is a prerequisite. In addition, the researcher should ideally be well-trained and properly prepared for each interview to collect the necessary information. Finally, as the interview is about recording the experiences, knowledge, attitudes, beliefs, etc., of a specific individual, the derived results cannot always be generalised [106].

Thereupon, before proceeding with our research, it should be mentioned that due to the small number of functional ECs, the respondents were strategically sampled across various regions in Greece to ensure the validity of our data in terms of spatial distribution, but also in an attempt to ensure the representation of diverse geographical areas. By reviewing ECs not from all over Greece, our research attempts to offer a comprehensive picture that takes into account regional and geographical variations and dynamics on ECs' energy-related experiences and attitudes. The sampling's regional stratification enhances the significance of our findings [107] and provides a solid foundation for researching the path towards the achievement of Greece's energy goals by capturing and assessing the current state of ECs' potentials within the Greek context. Acknowledging that ECs and Greece's energy sector are interrelated and reinforcing, this research aims to investigate ECs' possible role and present the Greek reality of the sector's alterations.

The research was initiated in the second trimester of 2023 by a thorough literature review for the identification of the primary objectives based on other nations' case studies, followed by an analysis of Greece's relevant legislative documents, like the energy laws N4414/2016, N4513/2018, and N5037/2023, along with related regulations, policy documents, and reports, to establish the essential academic, legal, and policy context of this research. Then, through a meticulously designed interview survey, the authors aimed to obtain the essential data and to gather opinions on the various matters related to the achievement of energy goals for the ECs and, thus, for the region of their establishment. By discussing with the CEO of the ECs, valuable insights into the perspective on energy issues that will eventually shape Greece's sustainable landscape were investigated, and an attempt to build a coherent understanding of the role of ECs in the achievement of Greece's energy goals was made. The research was concluded in the second trimester of 2024.

Given the previously mentioned framework, this study aims to fill a knowledge gap regarding the interconnection of ECs with a region's/nation's energy goals and, more specifically, with a Southern European region. A spatial analysis of energy communities is pertinent for a wider context, as energy transitions are shaped by local socio-economic, political, and environmental factors [2,25]. Nonetheless, the ideas obtained may possess broader applicability in many contexts, such as transferability of best practices, scalability and adaptability, policy and regulatory insights, etc. [2,25,108]. Extracting universal insights from a localised study can motivate and enlighten extensive dialogues regarding decentralised energy systems, community resilience, and global sustainability transitions.

The literature surveys pointed out that researchers have shown interest in ECs' versatile objectives, which usually aim at improving the self-consumption or self-production of renewable electricity. The authors present and analyse qualitative data to provide a comprehensive picture of the current state within ECs in Greece, contributing thus to the broader conversation on how to assist a nation in achieving its energy goals. A significant

novelty in comparison to other studies examining ECs regards the fact that those that presented state-of-the-art did not include a nation's attempt to transform its' legislative framework after realising the pivotal role that its implementation played in integrating principles of fairness and inclusivity that might eventually guide the energy sector [109] to a transformation.

4.1. Preliminary Phase

In the pursuit of a sustainable energy future, various energy goals were set by the EU for its Member States. Thus, in order to comply with the EU directives, Greece has adhered to the dynamics and trends of 2024, concentrating on unalienable policies to reduce emissions by 2030, while also considering the bigger picture of achieving climate neutrality by 2050. Since the first NECP in 2019, Greece has achieved significant milestones within the energy sector.

On 7 October 2022, the Greek electricity system achieved a major milestone, as RES covered 100% of electricity demand for five consecutive hours (based on data from Independent Power Transmission Operator (IPTO)—https://www.linkedin.com/posts/ipto-admie_res-clean (accessed on 30 August 2024), while Greece has exceeded the target of reducing natural gas consumption set by the EU for the period from August 2022 to March 2023. According to the analysis conducted by The Green Tank [48,50], natural gas consumption decreased by 31.8% compared to the corresponding period of the previous year and by 20.9% compared to the average of the corresponding eight months of the previous five years. This achievement exceeded the European Commission's target of −15% by almost 6 percentage points.

Additionally, according to the first data of IPTO for electricity production in the period January–June of 2023 (May–June data have not been certified), RES (wind, photovoltaic, and hydroelectric) covered 58.1% of electricity production while the rest was covered by the natural gas (35.6%) and lignite (6.2%) plants [110]. This year's (2024) performance is close to the levels of 2023, when RES accounted for 58.8% of production, despite the fact that in the meantime tens of megawatts of new RES, mainly photovoltaics, have been added to the country's production capacity. Specifically for ECs, the installed energy production technologies are one thousand five hundred eighty-five (1585) photovoltaic parks, two (2) wind parks, and one (1) biogas station. As can be seen in Figure 6, this increase coincides with a similar increase in RES projects by ECs.

Despite the first observation, one can also notice a decrease in ECs' applications after 2020, which could be due to both the legislation alterations and the limited available electrical space. The observed decline in electrified projects (meaning forth on constructed projects that are active) and the notable discrepancy between applications and completed projects could be attributed to this second factor in addition to financial challenges. The significance of this discrepancy was noticed by the Greek State, leading, hence, in September 2023, to the publication of an investment invitation with the aim of strengthening self-production by ECs.

However, ECs' projects are divided into commercial projects and those addressing citizens' needs. Figure 7 presents the applications and the electrified projects of ECs that adopt the primary goal of their creation and are created by the citizens for the citizens.

Furthermore, Figure 7 demonstrates unequivocally the increase in energy production from ECs, addressing, thus, the attempt for the accomplishment of Greece's energy targets in general and the most recent NECP's EG4, EG6, and EG13 in particular.

Before proceeding with the qualitative approach, the authors decided to construct a map of the ECs as derived from the partial records retrieved from the regional Commercial Registry in order to have a comparison with the acquired preliminary data from The Green

Tank. Figure 8 presents the registered ECs located in Greece according to their registry address. The different colours refer to the different Greek regions.

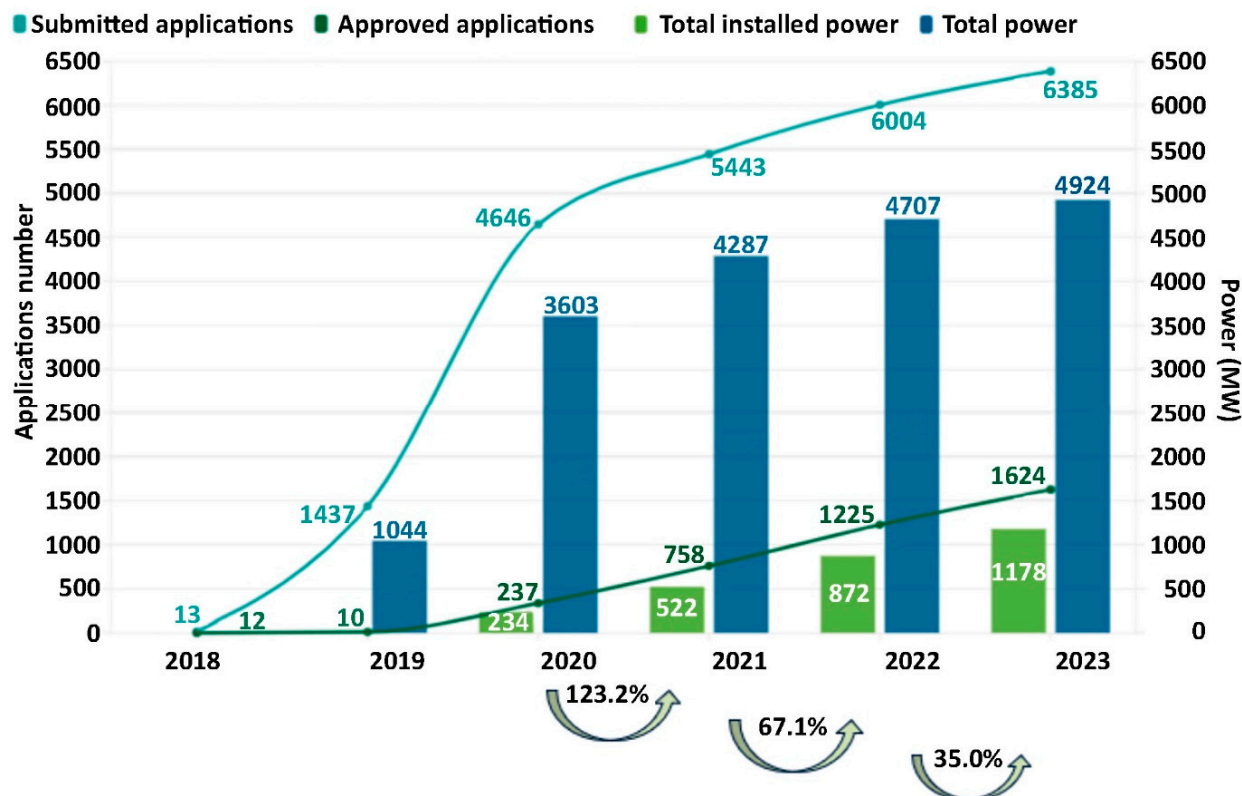


Figure 6. Evolution of the Greek Energy Communities' amount and the total nominal power of their operating RES projects during the 2018–2023 period [51].

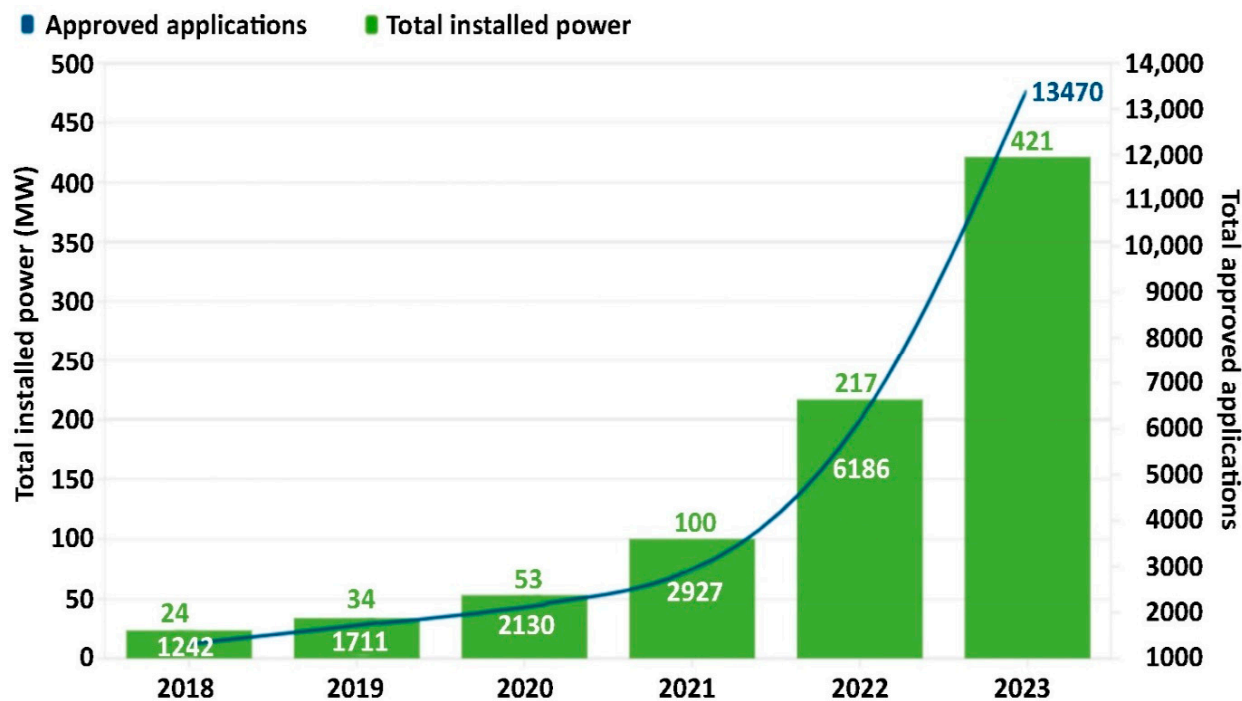


Figure 7. Number and power of self-generation projects (energy offset and virtual energy offset, 2018–2023) by citizens and energy communities [51].



Figure 8. The geographical allocation of ECs in Greece (excluding Crete).

Hence, a new map was constructed, not only presenting the administration address of each EC but also further information (in Greek) regarding the specific EC with the placement of the cursor on the dot of the EC.

Figure 9 presents the Cretan ECs as monitored based on the authors' research and in alignment with The Green Tank #5 data. On the relevant Google Earth folder when the cursor is placed on one of them, its name, region, prefecture, address of the headquarters, operational status, and legal form appears. The authors aim to add further information in the near future.



Figure 9. ECs in Crete based on The Green Tank #5 data (in the table) and based on the authors' research (on the map).

Even though during the time of the study the number of registered ECs was impressive, it was soon realised that only a few of them were truly functional. Of the 1,689 registered ECs, only 558 of them have actual electrified projects (see Table 9).

Table 9. Analysis of ECs and their electrified projects.

Region	Total Number of ECs	Electrified Commercial Projects	Electrified Self-Production Projects	ECs with Electrified Projects
Region of Attica	172	21	1	17
Region of Central Greece	116	151	1	52
Region of Central Macedonia	334	400	3	155
Region of Crete	93	0	15	5
Region of Eastern Macedonia and Thrace	125	254	3	67
Region of Epirus	62	86	2	28
Region of Ionian Islands	26	30	0	11
Region of North Aegean	5	0	0	0
Region of Peloponnese	80	70	18	33
Region of Southern Aegean	12	0	0	0
Region of Thessaly	180	327	0	86
Region of Western Greece	190	122	0	58
Region of Western Macedonia	294	127	1	46
Total:	1689	1588	44	558

As can be observed from the above table, the majority of ECs (more than 68%) seem to exist in paperwork based on the fact that they do not have any constructed projects, which implies that until the moment of this study, they are not truly operational. This observation further strengthens the authors' decision to proceed with the interview method in order to collect the raw data from those who not only participated in ECs' establishment but are also engaged in their operation and, thus, their future.

Another noteworthy finding that has been documented is that, even within fully functional ECs, less than 3% of self-consumption initiatives exist. This made the authors wonder about the final purpose behind the creation of these ECs. Also, it is worth mentioning the fact that in the region of Crete, not even one of the electrified projects is commercial. Could this mean that within Crete the functional ECs derive from the people for the people? This remains to be seen in the next section.

4.2. Fieldwork

After the completion of the first phase and having established this study's context, followed by a thorough literature review that provided a more comprehensive understanding regarding the variables that may influence a nation's energy goals, the authors decided to integrate Tables 2 and 5–7 within the interview in order to identify any links between the impacts of an EC's activity in a region and the essential elements (KFs) needed to achieve its energy goals.

The interview questions were based on previously presented bibliographical analysis and had the structure presented in Table 10. Table 10 also presents the correlation of Table 6's key factors for the achievement of a region's energy goals and the derived interview structure.

As mentioned previously, it was decided to incorporate the interviewed ECs from different regions in Greece, both mainland and islands, each with distinct member morphology. This was chosen to guarantee representation of diverse geographic areas and thus features such as their member types (citizens or public authorities), their size, their projects,

etc., in an attempt to unveil ECs' impact on Greece's energy goals. By doing so, the authors also aimed at this study's added value enhancement.

Table 10. Comparison of the interview structure with the literature findings.

Interview Structure		KFs
1.	EC general information in order to understand the diverse backgrounds and contexts of the participants	2, 3, 5, 6, 11
2.	Goals and motives of both the EC as a unit and also of its members	2, 4, 5, 6
3.	Information regarding their members and stakeholders	2, 3
4.	Discussion regarding their establishment procedures	1, 2, 6
5.	Information regarding their finance and investment actions	2, 3, 5, 6
6.	Energy production cost, resource efficiency	4, 5, 6
7.	Degree of community engagement, energy equity	2, 3,
8.	Networking and further community empowerment and education	2, 3, 9,
9.	Discussion regarding the legislative framework	1, 2, 7, 8, 10
10.	Future goals, Regional Sustainability	3, 4, 9, 11

The reviewed ECs were established from 2019 to 2021 and thus based on law 4513/2018. One of them has been established by public bodies (specifically, according to the legislative framework, by seven public organisations from the same region), while the other three are by citizens (all three of them with more than 100 members). More so, one out of the three is gender-oriented as its members are only women. Table 11 below presents a general profile of the interviewed ECs.

Table 11. ECs general profiles.

Profile	Region	Members	Activity
EC1	Central Macedonia	Citizens/Women	One Electrified Project
EC2	Western Macedonia	Public Authorities	One Electrified Project
EC3	Southern Aegean	Citizens	One Electrified Project
EC4	Crete	Citizens	Two Electrified Projects

The authors chose for interviews the four ECs presented in Table 11 in an attempt to cover different regions of Greece which have electrified projects and are connected to the national grid (EC1 and EC2); or semi-connected (EC4); or not connected at all (EC3). Whose members are from different institutional frameworks (public or private) and even gender oriented (EC1). By selecting ECs operating across different contexts this study can assess how these regional differences influence not only their functions but also their future planning while allowing the identification of common patterns and region-specific challenges. Additionally, by including these ECs', with different legal and institutional frameworks, the policies that may enhance or hinder their contributions to Greece's energy goals can be explored. The diverse status of their members allows for drawing insights regarding their impact to financial stability, governance and engagement levels.

This evident diversity of the interviewed ECs aims to ensure that findings are not limited to one type of EC and therefore enhances the reliability of conclusions and makes

them more applicable across different contexts. Moreover, by highlighting differences and similarities more nuanced and adaptable recommendations can be provided rather than one-size solutions. It is also important to mention that even though all of them had at least one electrified project, their respondents (CEOs) mentioned that they are currently and constantly investigating ways to expand or increase the number of their projects. Therefore, best practices could be revealed by this study, while the identification of common barriers faced by different communities could provide policymakers and stakeholders with vital information about effective support mechanisms.

Each interview lasted almost one hour, while some of the respondents were willing to share more of their time. All of the respondents were part of the founding committee, which was also made clear during the conversation, when their praise for an EC's accomplishments gave way to remarks about the challenges they encountered when the EC was first formed.

5. Results

After outlining the research methodology, this section summarises the findings extracted from the overall research. This study utilised inferential statistics for analysis, incorporating unique, proprietary datasets and perspectives to summarise and present key characteristics derived from the correlation of the literature and the experiences of individuals operating an EC's steering wheel, while also offering insights into complex information to improve the accessibility and clarity of the survey's findings. The authors decided that a more effective approach to displaying the findings was through spider charts.

In the first section of the interview, the reasons behind the creation of the EC were investigated. The results are presented in Figure 10. It is evident from the charts presented in Figure 10 that as the overall answers differed, so did the initial motivation behind their embarkation for the establishment of an EC. One could argue that the primary goal ought to be protecting the environment and reducing the use of fossil fuels at the same time. Within the context of the discussion, it is significant to highlight that two interviewees' responses, "For personal reasons", relate to their desire to protect the local environment and scenery. As the discussion moved further to the objectives of their business planning, it became clear that their first aim was to unite the local community.

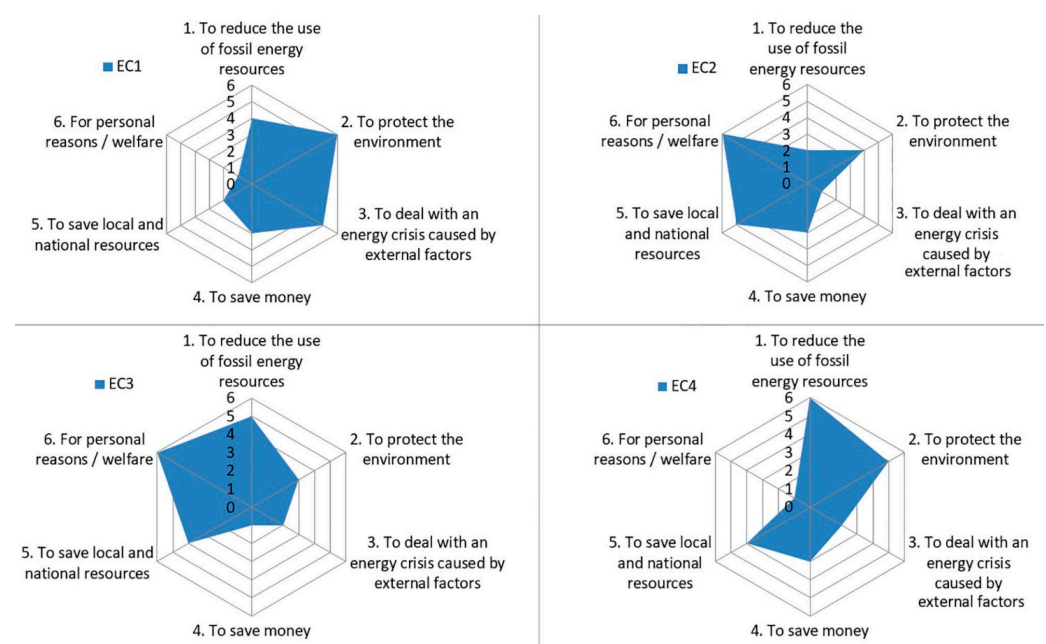


Figure 10. The context behind the creation of an EC according to the CEO.

Based on their responses, their secondary priority differed, and, as a result, so did their strategy for the accomplishment of their objectives. This is depicted in Figure 11, which presents the results regarding the ECs' initial business planning objectives. While EC4's primary goals were to draw investors to the area, EC1 and EC2 were more concerned with developing a sense of community inside the community. Involving their local government and local stakeholders' engagement was EC3's second priority, as enabling the local population to participate in the implementation and management of energy policies seems, according to their opinion, to improve energy efficiency.

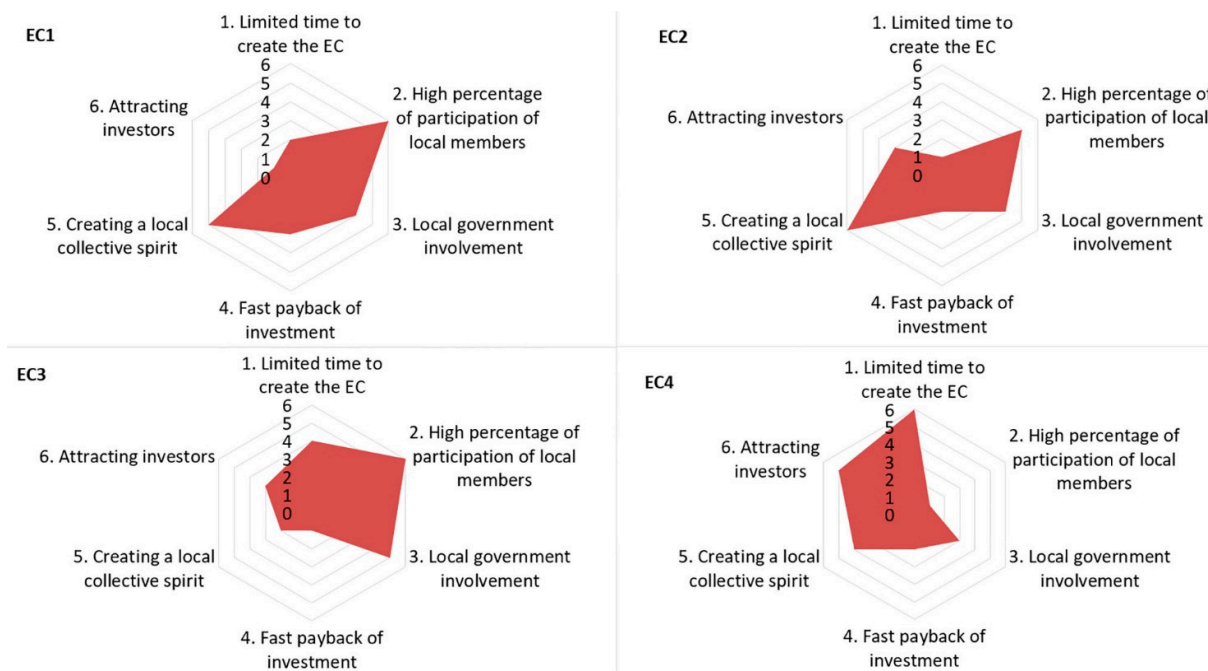


Figure 11. Initial business planning objectives.

But, as in every business planning, investments and funds are also crucial for the ECs. Two of them were funded by private companies and their members, one by its members but mainly by the regional authority, and one by an investment project, funded by the EU and the regional authority.

However, even with the achievement of finding the required funds for the creation of RES projects, ECs have to overcome more than one obstacle. The results from a relevant question are given in Figure 12. During the creation of their projects, one EC faced unique challenges due to its location. Firstly, the transportation of the required technological infrastructure was difficult due to the island's isolation. Secondly, the community was hesitant to join the EC, even after the project's construction. Nevertheless, once they started realising that being a member of the EC mitigated the members' cost for electricity, more people wanted to join.

It was also interesting to observe that all of them agreed that the Greek legislative model only partly covers their goals. This indicates that adhering to Law 5037/2023, there is still room for improvement in the legislative framework. For example, the Law 5037/2023 altered the way EC1 intended to construct their next project, as a modification in their statute was required. Apart from the resulting bureaucracy due to legislation alterations, three of the respondents mentioned that they also faced slow administrative procedures, understaffed public services and unclear county circulars. Only one EC mentioned that they had more difficulties locating investment capital for their projects than they did while dealing with bureaucracy obstacles. They also reported having trouble procuring

grid space. Even so, according to EC4, the transition to smart energy communities will further be essential for building efficient and sustainable energy systems. The presented spider charts in Figure 12 further analyse the recorded obstacles in six operational phases of the ECs.

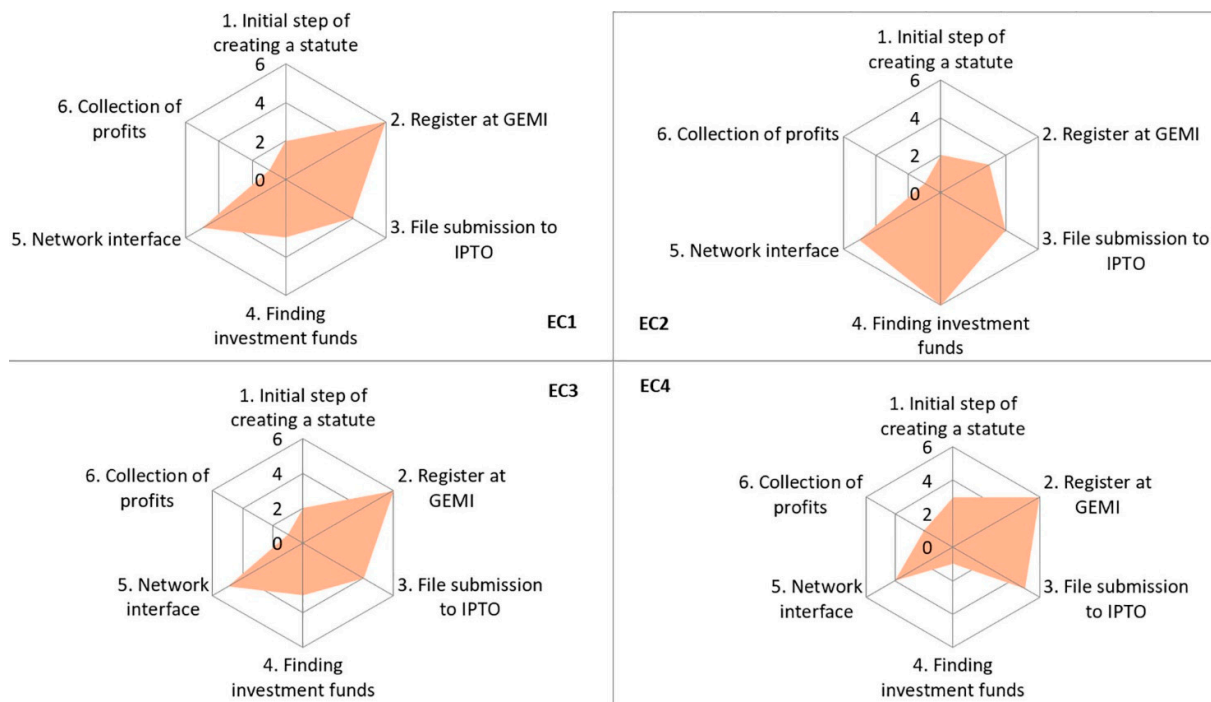


Figure 12. Recorded obstacles during the ECs' operational phases.

According to the responses, the strongest bureaucratic barrier was at the phase of registering at the Greek National Registry (GEMI). Even though their regions differ, they seem to have faced the exact same problems. This could perhaps reflect a lack of a clear process roadmap to follow for establishing an EC. Furthermore, one EC specifically emphasised the need for a solid understanding of the legislative framework to acquire the necessary licenses and to establish an EC. It was also stated that some of the public services were understaffed, which could also explain the slow bureaucratic processes.

Alterations within the local community regarding the ECs' added value to the region were also mentioned, since, by integrating citizen science with energy community initiatives, an increase of public engagement and scientific literacy is expected [111], while advancing SDGs including clean and cheap energy, sustainable cities, climate action, and goal partnerships.

Regarding their achieved goals (see Figure 13), the level of ECs' impact on the regional key factors regarding their energy sector varies in terms of both dimensions (referring to ENV.D, S.D, and EC.D. as mentioned in Table 12) and on their magnitude. Specifically, according to the EC1 representative, they feel that they have succeeded mainly in protecting the environment and their vulnerable citizens (this translates into a direct impact of KF7, KF8, KF11, and KF3, KF5 of their region's goals). Moreover, EC2 strongly pointed out that they have successfully and positively impacted policy and governance factors (KF1), along with local policy and discourse networks (KF2), through the social dimension and policy and governance and renewable energy development (KF11), through the economic dimension. EC3 and EC4 appear to present similar effects in all three dimensions. The key difference between them is that EC3 focuses more on the economic dimension and thus directly renewable energy development (KF11) and investment attractiveness and energy

access (KF6), while EC4 has a bigger impact on environmental dimension, on top of saving members money.

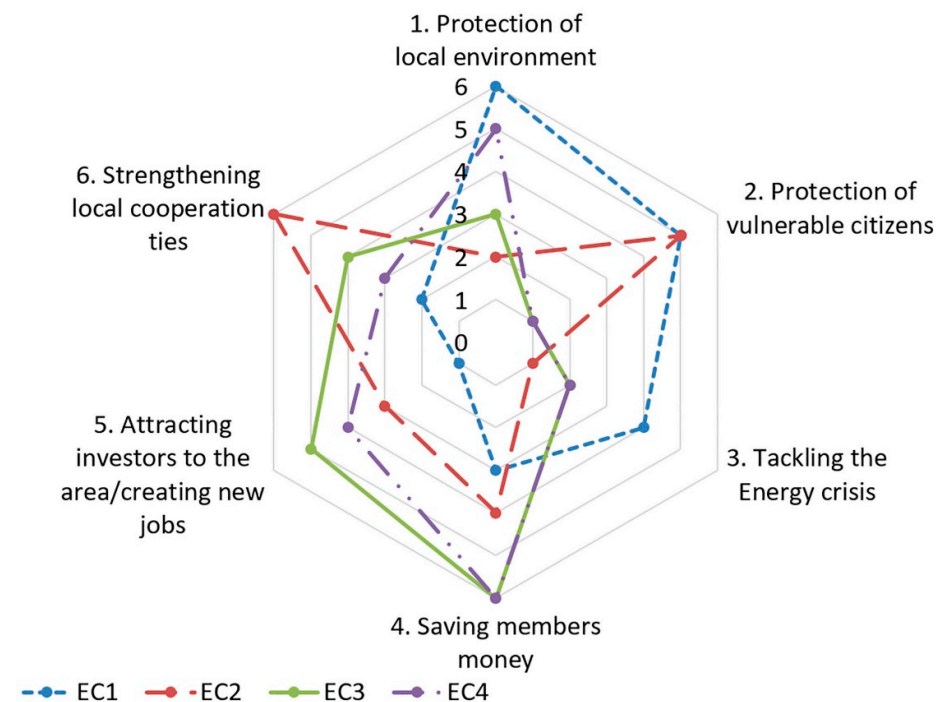


Figure 13. ECs' achieved goals since their creation.

Table 12. Correlating key factors for a region's energy goals achievement with ECs' impacts within a region.

KFs	ENV.D	KFs	S.D	KFs	EC.D
KF1, KF11	1	KF3, KF5	1	KF5, KF10	1
KF9	2	KF6	2	KF9	2
KF3, KF4	3	KF1, KF2	3	KF3, KF5	3
KF11, KF9, KF7	4	KF3, KF5	4	KF11	4
KF7, KF11	5	KF1, KF2	5	KF5	5
KF5, KF9	6	KF1, KF2	6	KF6, KF11	6
KF9	7	KF1, KF2	7	KF11, KF3	7

Several questions were made for comprehending ECs' impacts both on the local community and the region's energy sector transformation. All of the interviewed energy communities provided strong arguments of their belief that ECs will significantly assist the national energy transition, as ECs' interventions within the energy sector could help a region to define its vision, mission, and strategy for energy saving and sustainability, as well as the best practices and methods for its implementation. According to the reviews, their localized actions could not only promote immediate sustainability efforts but also act as basic templates for extensive policy reform. Moreover, ECs may serve as microcosms for broader transformations. Thus, ECs can influence national policy and inspire replication in other regions by exhibiting best practices in governance, finance, and technical implementation. Furthermore, their focus on community-driven techniques guarantees that transitions are socially inclusive and responsive to local demands. Bottom-up influence can close gaps in national energy policies, making transitions more robust and successful. Prioritizing low renewable energy sources over waste to energy technologies would further benefit a region's both energy and environmental goals.

They also agreed that ECs' initiatives' success is significantly influenced by a country's institutional and legal framework. Hence, based on their knowledge, countries with supportive policies present more successful EC case studies than those with less supportive frameworks. Thereupon, they feel that the government should further reinforce by:

- Supportive policy and regulatory frameworks such as grid access and fair compensation for energy produced by ECs.
- Providing grants, low-interest loans, and tax incentives for EC formation and expansion.
- Fund research and pilot projects to test innovative energy solutions.
- Support local workshops, training programs, and school initiatives to educate communities on sustainable energy practices.
- Encourage collaborations between ECs, municipalities, businesses, and universities to share best practices.

The crucial role of localised initiatives in the transition towards sustainable energy practices and to assist them in promoting their potentials to the public along with the long list of benefits that ECs offer to their members.

Although further research is necessary to confirm a definitive causal relationship and measure the impact, evidence indicates that energy communities can significantly contribute to national energy objectives, especially in advancing renewable energy, enhancing energy efficiency, and fostering public participation.

6. Discussion

According to the European Electricity Review [112], the transition from fossil fuels was postponed due to the dual crises in Europe's electrical system in 2022. Coinciding with major unanticipated outages of French nuclear plants as German nuclear units were being decommissioned, Europe experienced an unprecedented drought, resulting in the lowest hydroelectric power levels since at least 2000. *'This created a large 185 TWh gap in energy production, equal to 7% of Europe's total electricity demand in 2022. Five-sixths of the gap was made up by more wind and solar generation and a fall in electricity demand. But the remaining sixth was met by increased fossil generation. Since coal was less expensive than gas, coal accounted for the majority of the increase, rising 7% (+28 TWh) in 2022, compared to 2021. As a result, EU power sector emissions rose by 3.9% (+26 MtCO₂) in 2022 compared to 2021'*. Since gas was already priced higher than coal in 2021, there was no further transfer from gas to coal in 2022, and gas generation remained essentially steady (+0.8%) [113]. The situation could have been even more adverse; however, wind and solar energy, along with a decline in electricity demand, mitigated a more substantial reversion to coal.

One important instrument for effective policy-making in both the energy transition and territorial development domains appears to be the integration of ECs into these plans, as they would stimulate local energy production capacity on an individual as well as a cooperative basis [25]. Although the concept of energy communities is not new, in recent years it has gained more importance due to the legal status it acquired with the European legislative package "Clean Energy for All Europeans". Within this context, this study, even though it is not the first related to ECs in Greece, is the first of its kind regarding ECs' role in a region's energy goals achievement, uncovering knowledge gaps and misconceptions about ECs and the energy scheme in a Southern European nation located in the East Mediterranean, where RES thrive.

As mentioned in the first sections, the idea behind ECs is to support cooperative energy projects that prioritise transparent democratic governance and participation. In accordance with the literature [114], this study's results highlighted that delivering advantages and improving resilience for the people in legal communities is one of their main objectives. At the same time, effective governance strategies and policies are required that will prioritise

the social, economic, and environmental aspects of ECs. In this manner, ECs may play a transformative role in the development of both the national and territorial energy sectors, as well as in promoting innovative energy-saving initiatives within a community through their engagement. Nonetheless, the overall benefits of a fully functioning EC are not limited to their members; they also automatically contribute to the mitigation of fossil fuels and, as a result, the reduction of carbon emissions by providing green energy while strengthening community cohesion and energy democracy.

Within this study, inferential statistics were used for the analysis and included distinct and non-publicly available datasets and beliefs. The presented perspectives add value to the possibilities for coordinating development plans with energy-saving and energy-transformation concepts, promoting a comprehensive strategy for inclusive and sustainable energy practices at the local level. By presenting the connections of ECs' impacts with the key factors that influence a nation's energy goals, this study attempts to provide the required background that will help a nation to formulate local strategies that will further assist the development of ECs creating thus a feedback loop. For every nation, a balanced territorial development is crucial, since it incorporates the idea of comprehensive and integrated energy and development strategies that take into account the unique characteristics, resources and needs of a given region or territory. Consequently, the existence of an alternative action for regional sustainable development that can be replicated and expanded in various regions is of great importance.

7. Conclusions

The continuation of Greece's much-publicised advance in the green transition in electricity production, which is a reality but at a great cost to the national economy, cannot be continued in the other energy sectors without sacrifices in the nation's social policy. Compliance with the NECP would end up suffocating to the detriment of development, and therefore, its revision. The introduction of EG13, a goal for reducing energy poverty, is a goal advocated by ECs. However, this new goal also highlights that, rather than being motivated by climate concerns, the timescale for achieving the energy targets is also connected with benefiting the communities, and it is essentially not only a technical competition but also a social-based project across continents.

This study shows that ECs provide enormous potential benefits for the environment, economic growth, and social cohesion, despite certain difficulties within specific nations, as energy transition requires the production of green energy. Such initiatives can have a greater impact and help create a more just and sustainable energy future if they are in line with more general sustainable development goals. By integrating renewable energy sources, fostering socio-economic development, and enhancing energy democracy, ECs are essential in the pursuit of national energy objectives. Nonetheless, their success is largely dependent on supportive policy frameworks and institutional arrangements. Hence, this study points out that institutional enablers can foster an atmosphere conducive to the flourishing of ECs, enabling them to make significant contributions to a just and sustainable energy transition, by:

- Streamlining the processes for ECs to secure permits and licenses, recognising their distinct characteristics and challenges;
- Establishing or modifying financial incentives and subsidies and offering mechanisms to facilitate access to affordable financing for renewable projects;
- Investing in grid upgrading to facilitate the incorporation of decentralised renewable energy sources from energy communities;
- Establishing a knowledge-sharing platform for ECs to exchange experiences, technical expertise, and best practices;

- Promoting knowledge of the social and environmental advantages of ECs.

ECs can promote energy transition and mobilise a commonly acknowledged dialogue that can aid a nation's efforts for achieving its energy goals; however, further investigation is required regarding policy initiatives, as mentioned above, focused on regional strategies for upscaling the impact of energy communities, thus enabling them to flourish further by overcoming their obstacles. Therefore, the existence of studies that would assist Mediterranean regions to face different regulatory hurdles, economic constraints, and cultural attitudes towards energy ownership and participation is of great significance in the ongoing struggle for the energy sector's transition.

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