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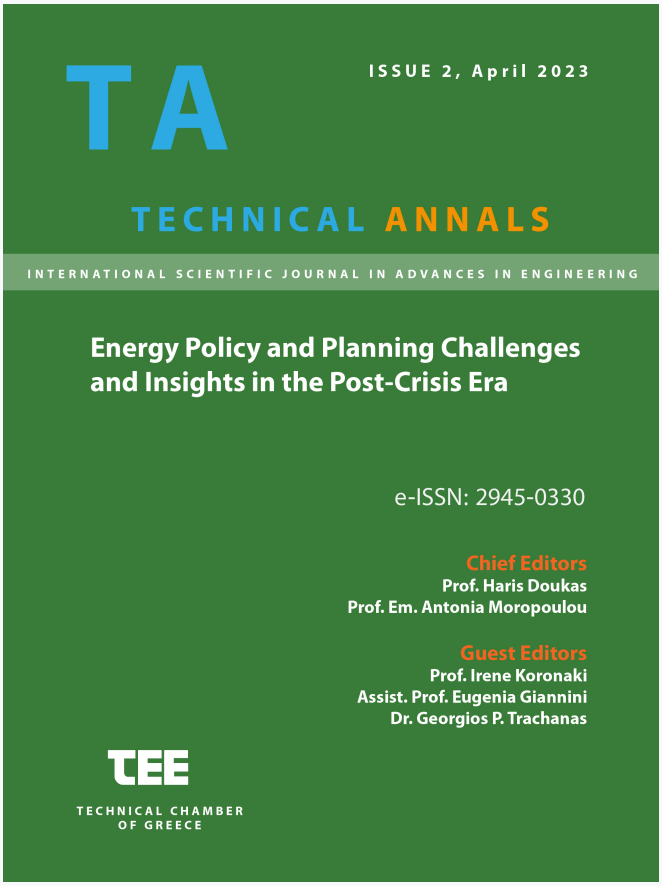

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Georgios Konstantopoulos, Eleni Kanellou, Konstantinos Kontogiannis

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Exploring the energy community actions to alleviate energy poverty in the Greek context

Georgios Konstantopoulos[1[0000-0002-0958-9654]] , Kontogiannis Konstantinos[1] and Eleni Kanellou[1[0000-0002-8538-1644]]

[1] Decision Support Systems Laboratory, School of Electrical and Computer Engineering, National Technical University of Athens, 15780 Athens, Greece
gkonstantopoulos@epu.ntua.gr

Abstract. Energy poverty is a significant problem in Greece, affecting many people and exacerbating social inequality. Lack of access to affordable and reliable energy negatively impacts health, comfort, and economic opportunities. While various initiatives have been implemented to address energy poverty, energy communities are emerging as a promising approach to tackle this issue. Energy communities refer to groups of people who come together to produce, consume, and manage their energy resources collectively. They enable households and communities to reduce their energy bills, improve living conditions, and enhance social and economic resilience. Energy communities can also stimulate local development and promote renewable energy technologies, contributing to a more sustainable and equitable energy system. This paper reviews energy poverty alleviation actions by energy community initiatives across Europe and proposes relevant energy poverty alleviation actions for energy communities in Greece, aiming to contribute to the ongoing debate on how energy communities can alleviate energy poverty.

Keywords: energy poverty, energy communities, collective actions.

1 Introduction

In Greece, a considerable number of people experience energy poverty, which contributes to social inequality. Lack of access to affordable and dependable energy services has adverse effects on people's well-being, quality of life, and economic prospects. As a result, the affected communities suffer from long-term consequences. While various initiatives have been implemented to address energy poverty, more attention has been given to the potential of energy communities as an effective approach to tackle this issue. Energy communities refer to groups of people or organizations who come together to produce, consume, and manage their energy resources collectively. They provide a promising avenue for addressing energy poverty by enabling households and communities to reduce their energy bills, improve their living conditions, and enhance their social and economic resilience. Energy communities can also stimulate local development and promote the adoption of renewable energy technologies, contributing to the transition towards a more sustainable and equitable energy system.

This paper aims to investigate the potential of energy communities and the actions they can take to mitigate energy poverty in Greece. Specifically, the paper starts with presenting the Greek institutional context regarding the alleviation of energy poverty and how it relates to social and environmental justice. Next, it delves into the energy democracy and energy justice concepts in the context of energy poverty to shed light on their relevancies. It also presents the Greek legal framework that governs the establishment and operation of energy communities, reviews the energy poverty alleviation actions led by energy community initiatives across Europe, and it presents some of the existing case studies identifying the six main strategic areas that the relevant actions can be enlisted. A short reference on the main challenges in implementing such actions is also presented.
Finally, the main output of this paper is an extensive exploration and documentation of the relevant energy poverty alleviation actions that can be developed by energy communities acting in the Greek legal and societal context. By doing so, this paper seeks to contribute to the ongoing debate of whether energy communities can contribute in mitigating energy poverty and in what way.

2 Energy poverty in the Greek context

2.1 Energy Poverty definition and institutional alleviation efforts in Greece

Energy poverty, recognized by Greek Law 4001/11 as a prominent social issue, refers to the inability of consumers with low income, as evidenced in their tax returns, to meet their needs for energy, i.e., electricity or natural gas due to either their professional and marital status, or special health conditions, and other factors. In Greece, financially weak residential customers affected by energy poverty are classified as Vulnerable Customers. The National Action Plan to Combat Energy Poverty (NEPAP, 2021) defines a household as energy poor based on a multi-dimensional indicator calculated from the adjusted net income of the household, the minimum required energy consumption, and the median income of the corresponding population for all households. The country has two pillars of legislation to address energy poverty, the first being protection of vulnerable social groups through reduced energy consumption prices and benefits for the weakest, and the second being the facilitation of access to energy through self-production, both by private RES units and energy cooperatives.
The Greek National Energy and Climate Plan [43] sets an ambitious target of reducing energy poverty by 50% by 2025 and by 75% by 2030, with 2016 as the reference year. Measures and policies to address energy poverty include the Social Residential Tariff (SRT), the allowance for the purchase of heating oil, and the improvement of energy efficiency of buildings, among others. The National Action Plan to Combat Energy Poverty (NEPAP, 2021), implemented through information sharing and education, consumer protection, and development perspectives, aims to improve the Social Residential Tariff and introduce the "energy card" to enable affected households to consume a certain amount of energy products during exceptional times of crisis. The plan also proposes the energy upgrading and installation of renewable energy systems in the buildings of affected households to promote self-consumption and save energy.

However, the lack of a definition of energy poverty [1], contributes to the difficulty of understanding how to tackle the issue at different policy levels. Energy poverty is a complex social phenomenon, and identifying energy-poor households has been based on welfare criteria and indicators rather than a definition. As a result, some households that suffer from energy poverty episodes are difficult to identify and help.

To tackle energy poverty in Greece, it is crucial to identify the factors and characteristics that make up an energy-poor household and quantitatively analyze the affected households' number and spatial distribution. This information can guide specific and locally oriented incentives for the implementation of planned policy measures. Funding for development and fair sharing among affected persons and amendments to the regulatory framework are essential for achieving the goals of the National Energy and Climate Plan [43] and the National Action Plan to Combat Energy Poverty [44].

Tackling energy poverty in Greece requires a multi-faceted approach that targets improving the energy efficiency of homes and changing of the energy model with the uptake of renewable energy sources through the establishment of energy cooperatives. The implementation of specific and locally oriented incentives and the provision of funding are crucial for achieving the goals of legislation and plans aimed at alleviating energy poverty in Greece.

2.2 Linkage between energy poverty and social and environmental justice

Energy poverty is not just an economic issue, but it also intersects with social and environmental justice concerns. Low-income households are more likely to live in poorly insulated homes, which leads to higher energy bills, more greenhouse gas emissions, and poorer air quality [23]. Moreover, the effects of energy poverty disproportionately affect certain social groups, such as the elderly, disabled, and families with young children [11].

Addressing energy poverty can therefore contribute to broader social and environmental justice goals. By improving the energy efficiency of homes and promoting the use of renewable energy sources, not only can energy bills be reduced for low-income households, but also greenhouse gas emissions and air pollution can be decreased, resulting in a healthier environment for all.

Furthermore, promoting access to energy through self-production by energy cooperatives can also lead to a more democratic and participatory energy system, where citizens have a greater say in how their energy is produced and consumed [13]. The linkages between energy poverty and broader social and environmental issues highlight the need for a more holistic approach to energy policy, one that takes into account not only economic concerns but also social and environmental factors.

3 Energy democracy and energy justice in the context of energy poverty

3.1 Defining energy democracy and energy justice

Energy democracy and energy justice are two emerging concepts in the fields of energy policy and environmental justice. Energy democracy refers to the idea that communities should have control over their energy systems and participate in decisions related to energy production, distribution, and consumption [19]. This can involve community ownership of energy infrastructure, cooperative energy models, and participatory decision-making processes. The goal of energy democracy is to create a more decentralized, democratic, and equitable energy system that benefits all members of society.

According to Sovacool and Dworkin [19], energy democracy "refers to a process of democratization of energy production, distribution, and consumption through the greater involvement of communities and individuals in energy decisions and policies." This can take many forms, such as community-owned renewable energy projects, energy cooperatives, and participatory decision-making processes. The goal of energy democracy is to shift the power dynamics of the energy system away from large corporations and towards communities and individuals.

Energy justice, on the other hand, focuses on the equitable distribution of energy resources and services. As defined by Schlosberg et al. [17], energy justice "concerns the fair distribution of the benefits and burdens of energy systems and their impacts on people and the environment." This includes issues such as access to energy services, affordability, and environmental impacts. Energy justice recognizes that certain communities, such as low-income and minority communities, are often disproportionately impacted by energy-related environmental hazards, such as pollution from fossil fuel power plants.

The concepts of energy democracy and energy justice are closely related, as both aim to address the social and environmental injustices associated with the current energy system. By empowering communities to have greater control over their energy systems and ensuring that all members of society have access to sustainable and affordable energy services, these concepts can help to create a more just and equitable energy system.

3.2 Energy democracy and energy justice as necessary elements of the EU energy transition

Energy democracy and energy justice are crucial components of the European Union's (EU) efforts to transition towards a more sustainable and equitable energy system [31], [36], [37].The EU has set ambitious targets for reducing greenhouse gas emissions, increasing the use of renewable energy, and improving energy efficiency. However, these goals cannot be achieved without the participation and engagement of communities and citizens.

The EU's Clean Energy for All Europeans package [32] emphasizes the importance of empowering consumers and communities to participate in the energy transition and promoting the development of community-owned renewable energy projects, thereby promoting energy democracy. Furthermore, energy justice is a critical component of

the EU's Energy Union Strategy, which aims to ensure that all citizens have access to affordable, reliable, and sustainable energy services, while also addressing the environmental impacts of the energy system [32].
By promoting energy democracy and energy justice, the EU can build public support for the energy transition and create a more equitable and sustainable energy system. This can help to address social and environmental injustices associated with the current energy system and ensure that the benefits of the energy transition are shared by all members of society [4].

3.3 Relevancy with community efforts to address energy poverty in Greece

Energy democracy and energy justice can play a crucial role in addressing energy poverty in Greece, which is a significant social and environmental issue. Greece has one of the lowest performances on almost every index of energy poverty in the European Union, indicating that a significant proportion of households unable to afford basic energy services [30].
Energy democracy can empower communities to take control of their energy systems and develop local solutions to energy poverty, such as community-owned renewable energy projects [19]. This can provide households with access to affordable and reliable energy services and reduce their dependence on fossil fuel-based energy sources. One example of energy democracy in action is the establishment of community-owned solar projects in low-income neighborhoods in Athens, which promote local participation and access to affordable renewable energy [19]. An example of energy justice in Greece is the social tariff program, a policy initiative that provides financial support to low-income households for energy bill [38].
Energy justice can also help to address energy poverty by ensuring that all members of society have access to affordable and sustainable energy services [3], [17]. This can be achieved through policies and programs that provide targeted support to low-income households and prioritize the development of renewable energy sources[3].
By promoting energy democracy and energy justice in Greece, policymakers can work towards reducing energy poverty and creating a more equitable and sustainable energy system [7], [10]. This can have important social and environmental benefits, such as improving public health, reducing greenhouse gas emissions, and enhancing energy security [48], [49].

4 Energy communities: a vehicle to energy democracy

4.1 The launch of energy community concept in the Greek legal framework

Energy Cooperatives (EC) in Greece are a new way of self-generation and self-consumption of electricity that allow consumers to become producers and are based on the principles of social and solidarity economy. The term “community” is used instead of “cooperative” and the purpose of each EC can be profitable or not. Members of an EC can be natural persons, legal entities of private and public law, as well as regional and local authorities, with a minimum number of members required. The legislation ensures

that each member has equal participation rights in the General Assembly of the EC. Recent amendments to the legislation abolished the priority examination of grouped applications and increased the limit of virtual net metering. However, some issues still exist, such as the legal framework and the resistance of the traditional monopolistic model of electricity generation.

The establishment of EC in Greece is regulated by Law 4513/2018[40], which defines an EC as a civil cooperative of exclusive purpose that aims to promote innovation in the energy sector, tackle energy poverty, and enhance energy self-sufficiency and security. The law specifies that ECs may include actions to support vulnerable consumers and citizens living below the poverty line and undertake social policy initiatives such as energy upgrade of residences or reducing the energy consumption of buildings. The legislation also encourages the participation of regional and local authorities in ECs, which is of great importance for their financial capital to invest in EC and encourage energy autonomy.

In conclusion, ECs in Greece offer a new way of self-generation and self-consumption of electricity, based on the principles of social and solidarity economy. Although some issues still exist, such as the legal framework and the resistance of the traditional monopolistic model of electricity generation, ECs have the potential to enhance energy self-sufficiency and security, tackle energy poverty, and promote innovation in the energy sector.

4.2 The new regulations of Law 5037/2023 for Energy Communities

The latest regulations outlined in Law 5037/2023 [41] address photovoltaics, self-consumption, and Energy Communities, and they aim to align national legislation with EU Directives 2018/2001 and 2019/944. These Directives emphasize the importance of citizen participation in the energy transition, as part of the "Clean Energy for All" European legislative package, which was finalized in 2019. The harmonization of the Directives with national law represents an essential institutional step to involve citizens in the energy transition fully. This move replaces the 2018 Law 4513/2018[40] on energy communities. However, the use of the energy community institution to satisfy energy needs, as was the case with Law 4513/2018[40], presented certain challenges. Therefore, the integration of the two Directives is an opportunity to strengthen the necessary supporting framework for healthy development and further strengthen the role of local societies in the energy transition.

Under the new law, Law 4513/2018's Energy Communities will be replaced by two new forms of energy cooperatives: Renewable Energy Communities (RECs) and Citizens Energy Communities (CECs). Both new collective ventures require a minimum of 30 members, which is an increase from the five members required under the previous law. The proposed activities of RECs include production, consumption, storage, and sale of electricity from renewable sources, and they can apply virtual -net metering from RES production units to meet their members' energy needs and consumers living below the poverty line.

The CECs must undertake at least one of the following activities: production, self-consumption or sale of electricity from renewable sources, storage, distribution and supply of electricity, cumulative representation, provision of flexibility and balancing, as well

as provision of energy efficiency, charging services for electric vehicles, and other energy services to its members. They will be able to sell, store, distribute, and procure "green" electricity, as well as own, introduce, buy, or lease distribution networks and manage them autonomously. They will also provide other services such as Demand Response, and energy efficiency services.
The new law also provides additional regulations to facilitate the activities of new energy communities, such as the use of public funds for financial support, inclusion of energy communities in the Development Law as a distinct form of cooperative organization, limiting the percentage of profits that can be distributed to members, legislation of electric grid capacity for energy and virtual net-metering projects, the connection of virtual net-metering projects to the High Voltage grid, and the removal of the obligation to belong to the same provider for implementing virtual net metering. Additionally, the new law addresses issues surrounding self-production for apartment buildings, prohibits the transfer of producer certificates and other licenses, and allows energy communities to manage micro-grids autonomously.
The new law apart from providing incentives for the new types of communities, introduces restrictions on the previous law's communities' activities, leading the latter to transition to one of the two new legal forms. Therefore, the new law also provides for transitional provisions to facilitate the transitional period.

5 Energy communities and their potential to alleviate energy poverty

Up until now, efforts to alleviate energy poverty have mainly focused on providing financial assistance, but identifying energy poor individuals or those experiencing energy poverty is challenging due to the multifaceted nature of the issue [3], [7]. Indicators have been developed to better identify them, and social tariffs and subsidies can offer short-term relief but do not fully address the problem [22]. Alternatively, a bottom-up approach can empower energy poor citizens to leverage innovative financing schemes or join energy communities. Small-scale energy efficiency interventions and behavioral changes can also provide temporary relief. Large-scale interventions require specific schemes or innovative financing to fund them. Actions by energy communities, a type of community energy initiatives, can enhance energy democracy [24], and the Clean Energy for all Europeans packages can pave the way for national-level plans to introduce energy communities. Leveraging innovative financing can establish energy communities primarily composed of citizens and local enterprises. Combining both approaches can lead to a fair and inclusive energy transition, addressing energy poverty and enhancing energy democracy by involving citizens in energy production and providing clean and affordable energy to all [47].

5.1 A review of sectors for community energy actions against energy poverty

In recent years, there has been a growing interest in community energy actions as a potential solution to alleviate energy poverty. However, despite the increasing attention, there are not many examples of successful community energy actions to address

energy poverty. This chapter provides a review of community energy actions that have been implemented to address energy poverty, highlighting the limited number of successful case studies. According to Bode, A.[12], community energy has the potential to address energy poverty, but its impact is limited by a variety of factors such as funding, policies, and regulations. Nonetheless, the few successful examples of community energy actions can serve as inspiring models for other communities facing similar energy poverty challenges. Six categories have been identified in which the community energy actions can be listed (fig.1).

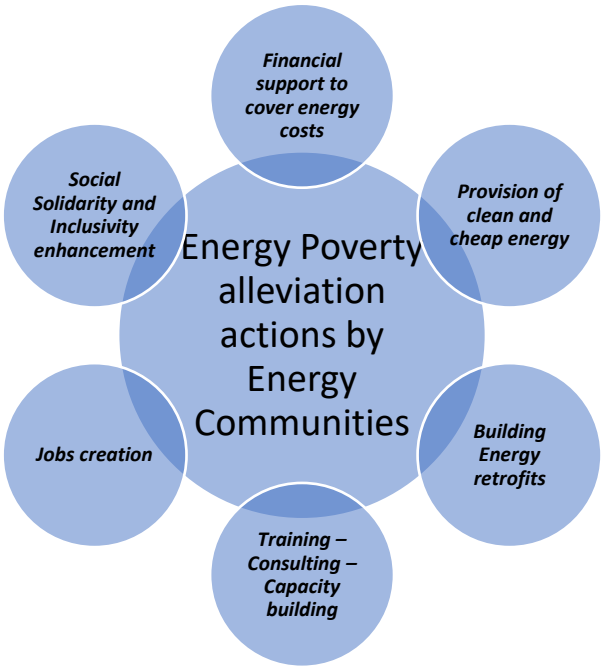

Fig. 1. Identified categories of Energy Poverty alleviation actions promoted by Energy Communities (elaborated by the authors).

Provision of clean and cheap energy

According to the European Commission [34], energy cooperatives (ECs) can provide clean and cheap energy to vulnerable households. For example, in Germany, the EC Energiegewinner produces renewable energy and allocates a portion of it to cover their energy needs [28]. This indirect benefit can result in financial savings for the cooperative's members, including vulnerable households. Moreover, ECs can provide free access to energy for energy-poor households through net metering. For instance, the Belgian EC Ecopower [50] allows its members to produce their own renewable energy and sell excess energy back to the grid. This excess energy can be used to offset the energy bills of energy-poor households in the community, resulting in significant financial savings [27]. Furthermore, ECs acting as energy providers can also benefit energy-poor households by preventing power cuts. For instance, in Spain, the EC Som Energia

supplies electricity to its members, including vulnerable households. As a result, power cuts to energy-poor households who are members of the community can be suspended, providing a reliable source of energy, and reducing financial stress [46].

Building Energy retrofits

According to current literature, Energy Communities are actively promoting initiatives aimed at enhancing the energy efficiency of buildings. These initiatives are often subsidized or supported by financial incentives provided by the community. The economic benefits are frequently prioritized towards energy-poor households or social housing, with the objective of improving their living conditions. Additionally, in collaboration with energy providers, Energy Communities are implementing programs to incentivize the reduction of energy consumption, with the aim of redirecting the funds saved towards energy retrofit projects [2], [39].

Social Solidarity and Inclusivity enhancement

Energy poverty often affects vulnerable and marginalized groups in society, leading to social exclusion and stigmatization (Thomson et al. 2019). However, energy communities can promote social solidarity and inclusivity by providing information and equal participation opportunities to all [5], [6], [8], [9]. For example, the Plymouth Energy Community in the UK engages with local residents through information events and social media, providing a platform for discussion and collaboration on energy issues [20]. This has helped to break down social barriers and improve energy access for vulnerable households [20]. Similarly, the Energiegewinner energy cooperative in Germany provides a network of suppliers and consumers, offering benefits such as discounts and special prices [2], [28]. Within this framework, energy-poor households can have their needs monitored and reported to authorities for immediate support, as demonstrated in Greece [15]. By promoting inclusivity and empowering marginalized groups, energy communities can create a more just and equitable energy system [24].

Financial support to cover energy costs

Within the context of Energy Communities (ECs), various measures are employed to alleviate energy poverty among vulnerable households. One such measure is the provision of discounts, allowances, or the suspension of energy bill payments for a specific period of time [15]. Another approach involves the collection of funds from EC members for direct distribution to energy-poor households or for the implementation of actions aimed at mitigating energy poverty. These funds can be in the form of collective funds, revolving funds, micro-sponsorships of members in paying their electric bills, or crowdfunding campaigns [7]. In addition, some local authorities may temporarily cover the energy debts of vulnerable households to ensure a continuous supply of electricity and energy, with the support of ECs (Selvakkumaran, S., & Ahlgren, E. O., 2017). Finally, vulnerable households often have the opportunity to become members of ECs with a very small amount or free of charge.

Job creation

Energy Communities have developed renewable projects create job opportunities that are accessible to everyone in the local communities [21]. These opportunities range from internships to permanent positions and cater to the needs of the community.

Through the involvement of experts, vulnerable members of society are trained to secure a stable income while also contributing to society by actively participating in these Energy Communities.

Training – Consulting – Capacity building

Energy Communities often provide support to vulnerable members by offering free energy audits and energy certificates, along with recommendations for improvements. These services are often accompanied by free studies for the installation of renewable energy systems and energy upgrades in energy-poor [33]. To help households adopt more energy-efficient behaviors, Energy Communities also organize training seminars, energy efficiency workshops, and offer technological tools for personalized energy-saving tips [10]. Some Energy Communities even have specially trained consultants, such as municipal employees, who provide information on participation in Energy Communities, as well as advice on improving domestic energy behavior and implementing beneficial energy actions in energy-poor households.

5.2 Successful examples of energy poverty alleviation efforts by collective energy initiatives and communities across Europe

Collective energy initiatives and communities have emerged as a promising solution to this problem, with many successful examples of energy poverty alleviation efforts across Europe. Some successful examples of EC that have developed energy poverty alleviation actions are:

Coopérnico, Portugal [25]: Coopérnico is a Portuguese energy cooperative based in Lisbon, established in 2013 with the primary objective of alleviating energy poverty through the development of renewable energy projects. With a membership of over 1,400 , Coopérnico [42] focuses on developing community-owned renewable energy projects, including solar PV, wind power, and energy storage solutions, while collaborating closely with local communities. By generating revenue from these projects, the cooperative provides low-cost energy to low-income households and offers energy efficiency advice to further reduce energy bills. Coopérnico's efforts in reducing energy poverty not only benefit the community but also promote the transition to a sustainable energy system, which aligns with the cooperative's goal of developing 100% renewable energy projects owned and controlled by local communities. Coopérnico serves as a successful example of how energy communities can combat energy poverty by utilizing renewable energy sources and involving local communities in the process [25], [26], [42].

Energy Local, UK [29]: The main objective of Energy Local is to help communities develop local energy projects that generate renewable energy and provide low-cost energy to residents. The initiative achieves this by working with local communities to identify suitable locations for renewable energy projects and helping to secure funding and support for these projects. Once the renewable energy projects are developed, Energy Local helps to establish a local energy trading network that enables residents to buy and sell energy at a fair price. The initiative also provides energy efficiency advice and support to low-income households to help them reduce their energy bills. Energy Local has been successful in reducing energy bills for thousands of households in the UK. For example, in Bethesda, Wales, a community-owned hydroelectric project

developed with the help of Energy Local has provided low-cost energy to local residents, reducing their energy bills by up to 50% (Energy Local case study on the Bethesda community-owned hydroelectric project).
Energiegewinner, Germany[28]: Energiegewinner is a German energy cooperative that was founded in 2011 with the goal of promoting the development of renewable energy projects and supporting the energy transition in Germany. The cooperative is based in the city of Cologne and has around 2,000 members. One of the main objectives of Energiegewinner is to reduce energy poverty by providing low-cost energy to low-income households. The cooperative achieves this by developing community-owned renewable energy projects and using the revenue generated to provide low-cost energy to its members. Energiegewinner also provides energy efficiency advice and support to low-income households to help them reduce their energy bills. The renewable energy projects developed by Energiegewinner include solar PV, wind power, and biomass projects, as well as energy storage solutions. The cooperative works closely with local communities to identify suitable locations for its projects and involves local residents in the planning and implementation of the projects.
Ecopower, Belgium [50]: The Ecopower Energy Community in Belgium is a cooperative organization that focuses on promoting renewable energy production and tackling energy poverty. Founded in 1991, it emerged as a grassroots movement driven by the desire to shift towards sustainable energy sources and democratize energy ownership. The community's main goals include developing, owning, and operating renewable energy projects, as well as empowering local communities to actively participate in the energy transition. Ecopower engages in various actions, such as investing in wind, solar, and hydropower projects, providing affordable and locally-produced green energy to its members, and advocating for renewable energy policies. One of its key initiatives to alleviate energy poverty is through its social fund, which provides financial assistance to vulnerable households for their energy bills. By promoting renewable energy, community ownership, and social solidarity, Ecopower aims to create a more sustainable and equitable energy system in Belgium, while actively addressing energy poverty and promoting energy justice.

5.3 Actions that Greek Energy Communities can develop to Fight Energy Poverty

In this part, the actions, that energy communities in Greece can take to help fight energy poverty, are identified, and categorized in the six categories described above. These proposed actions are in alignment with the current legal framework and can serve as a blueprint for the Greek energy communities who make efforts against the phenomenon. The following list is not exhaustive and strictly defined, as the proposed actions need to be customized to each local context that may be implemented.

Table 1. List of actions that Greek Energy Communities can develop to Fight Energy Poverty

Energy Communities actions to mitigate Energy Poverty		
Category	Type of action	Detailed description
Clean and cheap energy supply	Excess energy provision	Offering support to energy-poor households by providing surplus generated energy (usually through energy credits) in cases where surplus energy has been produced.
	Disposition of part of the generated energy	Disposition of part of the generated energy of the cooperative to energy-poor households.
	Uninterrupted power supply	Suspension of power cuts for energy-poor households that are members of the cooperative. This action can only be taken if the energy cooperative operates as an energy provider for its members.
Buildings' Energy retrofits	Energy retrofits in homes	Implementation of energy retrofits actions in homes. Providing financial resources from the energy community to promote energy upgrade or savings projects in energy-vulnerable households.
	Energy retrofits in social housing buildings	Implementation of energy retrofits actions in social housing complexes. Providing financial resources from the energy community to promote energy upgrade or savings projects in social housing complexes.
	Partnerships with electricity providers for funding energy upgrades	Providing incentives to reduce energy consumption in order to use the saved funds for financing energy retrofits works.
Social Solidarity and Inclusivity enhancement	Addressing social exclusion	Encouraging participation of energy-poor households (which are usually economically vulnerable) in collective schemes and community actions, empowering them to seek networking, participation, and employment opportunities.
	Empowerment for participation in a fair energy transition	Participation in decision-making and planning bodies/committees of the energy community, thus fostering the energy democracy.

	Consumer cooperative	Creating a local network of consumers and suppliers aiming for local discounts on businesses, individuals, and communities, indirectly contributing both to the reduction of energy costs and energy efficient products, as well as the revival of the local economy.
	Partnerships with local organizations and government agencies to provide a solidarity safety net	Knowledge of the specific needs of the EC energy-poor members, thus providing complete information to the public authorities to act more quickly and intensely against energy poverty when needed
Financial support to cover energy costs	Reduced energy prices	Reduced or low prices for the energy supply to energy poor households, when the energy community acts as an energy provider, or collectively procures electricity for its members.
	Financial support through the collective fund	Offering money directly to cover energy costs for energy-poor individuals, or directly covering part or all of their energy bill, through the energy cooperative fund or another specialized fund dedicated to mitigating energy poverty.
	Financial support through microgrants	Periodic collection of funds through microgrants from members of the energy community or non-members, to contribute to covering the emergent energy costs of energy-poor households.
	Payment Suspension	Providing the option of suspending payment of energy bills for vulnerable households for a period of time, when the energy community operates as an electricity provider or collectively supplies energy to its members.
	Partial coverage of energy costs through partnerships with local authorities	Providing support to local authorities (municipalities, regions) in cases where the local authorities themselves undertake the support of energy-poor households, usually by temporarily covering the energy debts of these households and ensuring the provision of energy regardless of their energy debts.

	Free or low-cost participation in the energy community	Coverage of participation expenses (shares, subscription, etc.) in the energy community for low-income households, so that they can benefit from the broader advantages that members of a community have, such as collective procurement of energy products at preferential prices, consultation etc.
	Crowdfunding campaigns	Development of crowdfunding campaigns aimed at raising funds for actions and projects (e.g., renewable energy units for virtual energy aggregation) specifically focused on mitigating energy poverty.
	Revolving funds	Creation of special revolving funds to finance actions and projects that will generate revenue, which will be partially channeled towards new projects (that will yield new revenues) and partially towards mitigating energy poverty.
Jobs creation	Internships	Offering internships to members of energy-poor households
	Permanent jobs	Offering permanent job positions to members of energy-poor households.
Training – Consulting – Capacity building-awareness raising	Development of education, information, and decision-making tools.	Development of tools aimed at supporting members to reduce energy consumption. The tools provide capabilities for measuring consumption and understanding it and reducing energy consumption while maintaining the same level of comfort through customized advice provided through the software.
	Educational sessions and user meetings	Educational sessions, seminars, and user meetings, either in-person or online

	Energy audits	Offering free energy audits and energy certificates to vulnerable households, accompanied by proposals for improvements and energy efficiency measures.
	Maturation of new RES projects or energy efficiency measures in homes	Free preparation of studies for the installation of RES and energy upgrading of buildings in energy-poor households.
	Customized Household consultation	Information on energy actions or financing tools in which household members can participate. Personalized support for choosing an electricity provider based on the household's needs.
	Information and transparency in participation terms.	Development of a safe and transparent framework for the terms of contracts provided by an energy community as a supplier and providing detailed information on those terms.
	Training of municipal staff to address energy poverty.	Training of municipality staff to provide energy-saving advice and support to energy-poor households, or the establishment of an energy poverty alleviation office.
	Mapping the local context	Identification of the specific needs the energy poor households face in a specific area, thus removing barriers and challenges for participating in an energy community and receiving customized support by local authorities.
	Awareness raising	open educational campaigns, workshops, and events to help society understand the causes and consequences of energy poverty, and empower them to take action to address this issue through collective efforts and community-based solutions

5.4 Challenges to implement energy poverty alleviation actions

While energy communities offer a promising path towards a more sustainable energy future, they face several barriers and challenges. In this response, the most significant barriers energy communities face in incorporating energy poverty mitigation actions in their activities, include lack of funding, regulatory barriers, technical expertise, lack of community engagement, scale, and political will. Understanding these barriers is critical for developing effective policies and programs that can support and enable the growth of energy communities:

Lack of funding: One of the biggest barriers to energy communities is the lack of funding. Many energy communities are community-led initiatives that rely on volunteers

and donations, which can make it difficult to secure the necessary funding to implement energy poverty alleviation programs [5].
Regulatory barriers: Regulatory barriers includes issues with permits and licenses, grid access, and energy market rules. These barriers can make it difficult for energy communities to generate and distribute renewable energy or access affordable energy sources to energy poor households [6].
Technical expertise: Many energy communities lack the technical expertise needed to implement energy poverty alleviation programs. This includes knowledge of energy efficiency measures, renewable energy technologies, and energy management systems. Without this expertise, it can be difficult to design and implement effective programs [20].
Lack of community engagement: Community engagement is essential for energy communities, but it can be challenging to get people on board. This includes issues with communication, outreach, and engagement. Some communities may not be aware of the benefits of energy poverty alleviation programs or may be resistant to change [11].
Scale: Energy communities often operate on a small scale, which can limit their impact on energy poverty. Scaling up these initiatives can be challenging and require significant resources and expertise [14].
Lack of Political will: Finally, political will can be a barrier to energy communities addressing energy poverty. Government policies and programs can have a significant impact on energy poverty, but they may not always prioritize community-led initiatives. Without support from policymakers, it can be difficult for energy communities to have a significant impact [16].
In Greece, similar problems are arising [45], despite the positive aspects of the legal framework. There are still several ambiguities, many possibilities are described, but it has not yet been determined how they can be implemented in practice. Additionally, financing is not easily accessible for energy communities, as there are no available banking programs for cooperatives, especially for a recently established organization that does not own property. The expansion of the framework for the self-consumption of renewable energy sources at a collective level beyond energy cooperatives should be examined, including unions, etc.

6 Conclusion

Energy communities contribute significantly to the energy transition by promoting the use of clean energy sources and reducing reliance on fossil fuels. Energy communities also play a vital role in advancing energy democracy by empowering individuals and local communities to take control of their energy supply. By generating clean energy locally, energy communities also contribute to environmental protection and reduce greenhouse gas emissions. Additionally, energy communities can help alleviate energy poverty by providing affordable and accessible energy to underserved communities. Overall, energy communities are a promising model for achieving a sustainable and equitable energy future.

Regarding energy poverty, an Energy Community can take actions to support energy-vulnerable households of a specific area. In this paper, various relevant successful cases across Europe were explored, and feasible actions for the Greek context were identified and categorized. Briefly, Ecs in Greece can contribute a) Financially (distribution of a percentage of funds collected through various means and their allocation to energy-poor residents or the development of projects that support them), b) Energy-related (provision of part of the energy produced to cover the energy needs of vulnerable residents), c) Professionally (new job positions, practical training), d) Consulting-training (seminars, workshops, personalized advice, meetings, etc.), e) Technologically (tools to increase energy efficiency or improve energy behavior, building retrofits) and f) Socially (sense of belonging, solidarity, participation, support for vulnerable households in the social context)

However, energy communities face various obstacles, such as inadequate funding, technical know-how, regulatory restrictions, and community participation. Policymakers and stakeholders can help overcome these challenges by supporting energy communities through favorable policies, technical support, and funding opportunities. Collaboration between various stakeholders, including energy communities, local authorities, and NGOs, can also help overcome these barriers and implement effective energy poverty alleviation programs.

Overall, the study emphasizes the potential of energy communities in mitigating energy poverty in Greece and suggests ways they can take action to address the issue. By working together with the local communities, energy communities can promote sustainable development, tackle energy poverty, and create a fairer and more robust energy system.

References

1. Arsenopoulos, A., Marinakis, V., Koasidis, K., Stavrakaki, A., & Psarras, J. (2020). Assessing resilience to energy poverty in Europe through a multi-criteria analysis framework. Sustainability, 12(12), 4899.
2. Biresselioglu, M. E., Limoncuoglu, S. A., Demir, M. H., Reichl, J., Burgstaller, K., Sciullo, A., & Ferrero, E. (2021). Legal provisions and market conditions for energy communities in Austria, Germany, Greece, Italy, Spain, and Turkey: A comparative assessment. Sustainability, 13(20), 11212.
3. Bouzarovski, S., Thomson, H., & Cornelis, M. (2021). Confronting energy poverty in Europe: A research and policy agenda. Energies, 14(4), 858.
4. Burke M.J, Stephens J.C., (2017). Energy democracy: Goals and policy instruments for sociotechnical transitions, Energy Research & Social Science, Volume 33, Pages 35-48, ISSN 2214-6296
5. Caramizaru, A., & Uihlein, A. (2020). Energy communities: an overview of energy and social innovation (Vol. 30083). Luxembourg: Publications Office of the European Union.
6. Dall-Orsoletta, A., Cunha, J., Araújo, M., & Ferreira, P. (2022). A systematic review of social innovation and community energy transitions. Energy Research & Social Science, 88, 102625.
7. Doukas, H., & Marinakis, V. (2020). Energy poverty alleviation: Effective policies, best practices and innovative schemes. Energy Sources, Part B: Economics, Planning, and Policy, 15(2), 45-48.

8. Esteves, A. M., Genus, A., Henfrey, T., Penha-Lopes, G., & East, M. (2021). Sustainable entrepreneurship and the Sustainable Development Goals: Community-led initiatives, the social solidarity economy and commons ecologies. Business Strategy and the Environment, 30(3), 1423-1435.
9. Gui E.M., MacGill I (2018). Typology of future clean energy communities: An exploratory structure, opportunities, and challenges, Energy Research & Social Science, Volume 35, Pages 94-107, ISSN 2214-6296,
10. Hanke, F., Guyet, R., & Feenstra, M. (2021). Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases. Energy Research & Social Science, 80, 102244.
11. Hewitt, R. J., Bradley, N., Baggio Compagnucci, A., Barlagne, C., Ceglarz, A., Cremades, R., … & Slee, B. (2019). Social innovation in community energy in Europe: A review of the evidence. Frontiers in Energy Research, 7, 31.
12. Bode, A. (2022). To what extent can community energy mitigate energy poverty in Germany?
13. Markard J., Raven R., Truffer B. (2012). Sustainability transitions: An emerging field of research and its prospects, Research Policy, Volume 41, Issue 6, 2012, Pages 955-967,ISSN 0048-7333,
14. Mirzania, P., Ford, A., Andrews, D., Ofori, G., & Maidment, G. (2019). The impact of policy changes: The opportunities of Community Renewable Energy projects in the UK and the barriers they face. Energy Policy, 129, 1282-1296.
15. Papada L., Kaliampakos D. (2016). Measuring energy poverty in Greece, Energy Policy, Volume 94, 2016, Pages 157-165, ISSN 0301-4215,
16. Roby, H., & Dibb, S. (2019). Future pathways to mainstreaming community energy. Energy Policy, 135, 111020.
17. Schlosberg, D., Dryzek, J. S., & Norgaard, R. B. (2017). Climate justice and energy justice. Oxford Research Encyclopedia of Climate Science.
18. Simcock, N., Thomson, H., Petrova, S., & Bouzarovski, S. (Eds.). (2017). Energy Poverty and Vulnerability: A Global Perspective (1st ed.). Routledge. https://doi.org/10.4324/9781315231518
19. Sovacool B.K., Dworkin M.K. (2015), Energy justice: Conceptual insights and practical applications, Applied Energy, Volume 142, 2015, Pages 435-444, ISSN 0306-2619,
20. Sovacool, B. K., Hess, D. J., & Cantoni, R. (2021). Energy transitions from the cradle to the grave: a meta-theoretical framework integrating responsible innovation, social practices, and energy justice. Energy Research & Social Science, 75, 102027.
21. Stainforth, T., Gore, T., & Urios Culiañez, J. (2021) 'The socio-economic impacts of renewable energy in EU regions' Institute for European Environmental Policy
22. Streimikiene, D., & Kyriakopoulos, G. L. (2023). Energy Poverty and Low Carbon Energy Transition. Energies, 16(2), 610.
23. Thomson, H., Simcock, N., Bouzarovski, S., & Petrova, S. (2019). Energy poverty and indoor cooling: An overlooked issue in Europe. Energy and Buildings, 196, 21-29.
24. Wahlund, M., & Palm, J. (2022). The role of energy democracy and energy citizenship for participatory energy transitions: A comprehensive review. Energy Research & Social Science, 87, 102482.
25. "Community Power in Portugal: Coopérnico and Enercoop." REScoop.eu. Accessed April 8, 2023. https://www.rescoop.eu/community-power-portugal-coopernico-and-enercoop.
26. "Coopérnico: The Portuguese Renewable Energy Cooperative Fighting Energy Poverty." IRENA. Accessed April 8, 2023. https://www.irena.org/newsroom/articles/2022/May/Coopernico-the-Portuguese-Renewable-Energy-Cooperative-Fighting-Energy-Poverty.

27. Ecopower. (n.d.). What is net metering? https://www.ecopower.be/english/about-ecopower/what-is-net-metering
28. Energiegewinner. (n.d.). About us. https://energiegewinner.de/en/about-us/
29. Energy Local case study on the Bethesda community-owned hydroelectric project: https://energylocal.co.uk/bethesda/
30. Energy Poverty Advisory Hub (2022). National indicators. https://energy-poverty.ec.europa.eu/observing-energy-poverty/national-indicators_en, https://www.energiegewinner.de/
31. European Commission (2020b) "A European Green Deal: Striving to be the First Climate-Neutral Continent", 12 April 2021, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
32. European Commission (2019). "Clean energy for all Europeans package". Accessed April 8, 2023. https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en
33. European Commission. (2021). Energy poverty. Retrieved from https://ec.europa.eu/energy/topics/energy-poverty_en
34. European Commission. (2020c). The role of community-led energy transitions in the EU's economic recovery. Retrieved from https://ec.europa.eu/info/sites/default/files/1_en_act_part1_v11.pdf
35. European Commission. (2020a, September 4). Energy Communities: The next step in the energy transition. https://ec.europa.eu/info/news/energy-communities-next-step-energy-transition-2020-sep-04_en
36. European Commission. (2016). Clean Energy for All Europeans. Retrieved from https://ec.europa.eu/energy/sites/default/files/2016_11_30_communication_-_clean_energy_for_all_europeans.pdf
37. European Commission. (2015). Energy Union Strategy. Retrieved from https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/energy-union
38. HEDNO (2018). Accessed 1/04/2023. https://deddie.gr/en/upiresies/eidika-timologia/koinwniko-oikiako-timologio/
39. International Energy Agency. (2021). Energy communities. Retrieved from https://www.iea.org/topics/energy-communities
40. Law 4513/2018 (FEK 9/A` 23.1.2018) Energy communities and other issues
41. Law 5037/2023 (FEK 58/A` 28.3.2023) SECTION B Modernization of the legislation on the use and production of electricity from renewable sources incorporation of the 2018 EU directives.
42. Lopes, João Pedro. "Coopérnico: Combining Energy Democracy and Social Justice in Portugal." Open Democracy. Accessed April 8, 2023. https://www. opendemocracy.net/en/oureconomy/coopernico-combining-energy-democracy-and-social-justice-portugal/ .
43. National Energy and Climate Plan of 2019, Decision 4/23.12.2019, FEK 4893/B/31-12-2019, https://ypen.gov.gr/wp-content/uploads/2020/11/%CE%A6%CE%95%CE%9A-%CE%92-4893.2019.pdf
44. National Energy Poverty Alleviation Plan of 2021, Decision PEN /GDE/ 89335/5599/2021 FEK 4447/B/28-9-2021, https://bit.ly/3J7cTU6
45. Greenpeace Greece, WWF, Electra Energy and REScoop.eu (2021). Development of energy communities in Greece: Challenges and recommendations. https://www.rescoop.eu/news-and-events/news/executive-summary-development-of-community-energy-in-greece-under-pressure

46. Som Energia. (n.d.). What is Som Energia? https://www.somenergia.coop/en/who-we-are/what-is-som-energia/
47. United Nations Development Programme (UNDP) (2020). Access to Clean Energy for Rural and Peri-Urban Communities: Practical Insights from a Global Review of Project Experiences. New York: UNDP.
48. United Nations Development Programme (UNDP) (2019). Human Development Report 2019: Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century. New York, NY: United Nations Development Programme.
49. World Health Organization (WHO) (2018). Health and sustainable development: Health in the 2030 Agenda for Sustainable Development. Retrieved from https://www.who.int/sustainable-development/health-sector/health-in-2030-agenda/en/
50. Ecopower Energy Community https://www.ecopower.be/