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Local Energy Projects on Islands: Assessing the Creation and Upscaling of Social Niches

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Abstract: Islands have great potential for renewable energy, and several pilot and experimental projects have been set up on islands globally, aiming to promote clean energy and self-sufficiency. Many of these decentralized energy initiatives oppose the established regimes of centralized electricity generation and introduce new forms of organization and management. Thus, they can be considered social niches. The aim of the present study is to explore the transition potential of renewable energy projects on three islands located in southern Europe. The analysis mobilizes literature on the strategic niche management theory (SNM) with a focus on the role of the various actors and the different management models. Through a systematic analysis of policy documents and the literature, enriched by interviews, the paper identifies different types of renewable energy projects and discusses the potential for scale up. The paper concludes that these projects are currently in the inter-local phase, and decentralization is not only an important innovation for energy production, but also a new form of energy management often dominated by different actors than the established electricity system.

Keywords: local energy; strategic niche management; islands; energy transitions; niches

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1. Introduction

New forms of sustainable energy production are paving the way for a new energy regime away from the traditional centralized fossil fuel system. This new generation of decentralized hybrid power systems can be connected to the main grid or operate in isolation and consist of micro-grids, energy produced from local renewable sources, and storage solutions. These systems are considered a viable alternative for rural areas and small islands, as they can reduce the cost of imported fuel and increase stability and autonomy, while at the same time they offer various economic and social benefits.

Due to their competitive advantage and the clearly defined boundaries, islands are ideal isolated laboratories for sustainability, circular economy, and renewable energy. The high cost of imported oil makes renewable energy sources economically viable in small insular power systems. Additionally, the isolation and need for self-reliance can trigger stronger community involvement, which can create a favorable environment for socio-technical innovations. The European Commission's White Paper on Renewable Energy Sources, the United Nations Conference on Islands and Small Island States, and the European Island Agenda recognize the central role islands can play in the energy transition.

This idea of islands as laboratories for renewable energy technologies has been tested in a number of case study islands in Europe, such as Samsø in Denmark [1], Greek islands [2,3], the Canary islands [4,5], and Faroe islands [6]. Beyond Europe, energy transition and self-sufficiency are now a priority for many islands worldwide, such as Cape Verde [7,8], Reunion island [9], Yong Shu Island in the South China Sea [10], and in the Pacific island countries [11]. Thus, islands with their unique environments are hubs, not only for new technologies, but also for new forms of social organization and governance.

Due to the lack of available funds, the high levels of isolation, and the limited skills and knowledge at a local level, in many of these areas a new business model that includes various actors such as municipalities, universities, private companies, and Non-Governmental Organizations (NGOs) has emerged. This new business model is a response to the challenges energy communities face globally and to a new regulatory environment that undermines their entity (e.g., [12,13]).

In this context, the present article discusses the emergence and development of decentralized renewable energy systems with a hybrid ownership model, as social niches which can push not only for a simple shift in energy generation technology, from fossil to renewable energy sources, but for a social shift in the energy management and consumption system. In the established regulatory and market frameworks in Greece, Spain, and Portugal, and under the interesting opportunities presented by the EU Clean Energy Package and the relevant provisions on citizen participation and energy communities of the Renewable Energy Directive (EU) 2018/2001, various local and regional initiatives are being developed, implementing new structures and challenging the old regimes [14]. In this line, I assume that these decentralized energy initiatives (local or regional) oppose the established regimes of centralized electricity generation, as it is also discussed by other scholars [15]. I take the hypothesis one step further and argue that these niches are currently in the inter-local phase in which projects exchange knowledge and experiences. Applying the Strategic Niche Management (SNM) theory [16], this comparative case study analysis attempts to answer the following research question: *how might some heterogeneous local projects with hybrid ownership contribute to niche development and a deeper change in the overall system of electricity generation, and what is the role of the various actors in the process?*

The rest of the paper proceeds as follows: in the next section Ibriefly analyze the theoretical context, addressing the Strategic Niche Management Theory (SNM) and the role of various actors in the different business models. Section 3 presents the methodology. In Section 4 the three cases are introduced in more detail followed by an analysis. In Section 5 I apply the framework to analyze the case studies and discuss the most important findings. Section 6 concludes.

2. Theoretical Context

2.1. Strategic Niche Management

The Strategic Niche Management (SNM) framework is an evolutionary analytical tool focused on understanding the gap between Research and Development (R&D) and market success regarding new technologies. This phenomenon is related to the "locked-in" socio-technical regimes which define the set of rules according to which, actors such as firms, users, and policymakers act [17,18]. The established regimes are less open to radical technologies that require a change in important system parameters. Thus, for a radical change to happen, innovations must come from outside the regime, and the transformation needs to develop in niches. Niches are protected spaces in which experimentation can take place and new technologies can incubate and mature (e.g., [19,20]). In this line, the SNM aims to analyze the success and failures of niche creations, and to provide a tool for the management of innovations for sustainability. According to the SNM theorists, the development of niches depends on three key elements: (i) expectations; (ii) social networks; and (iii) learning processes [21]. If the formation and the interaction of these internal processes are well-managed, the niche has the potential to influence and transform the regime [22,23].

Concrete and well-defined expectations, which are shared by many actors and are successfully substantiated by the project, are a crucial element in the niche formation process. Expectations that are robust, realistic and credible can provide the groundwork for an effective learning mechanism [19,21,23]. Learning processes focus on generating knowledge and changing the cognitive framework to overcome barriers and constraints of innovation. During this learning process, various niche actors reflect on the niche development and adapt their views and expectations. Some scholars (e.g., [19,24]) distinguish between first- and the second-order learning. First-order learning refers to the design of a cognitive framework based on the gathered information regarding technology, policy, infrastructure, etc., while second-order learning is applied when the initial cognitive frame is reshaped and adapted, for example, during changes in the technological design and modification of the network [24]. Networking refers to knowledge transfer and coordination among the actors. A variety of actors can better support the social niches and can create a deeper network. Generally, a broader network that includes various actors from incumbents to challengers and intermediary actors can be more effective [25].

Another important aspect discussed broadly in the relevant literature is the scaling up of niches and the factors that can motivate it. Scaling up is the process of moving from "from experimentation to mainstream" [26]. In order for a global niche to emerge, local projects need to pass from the local phase of independent projects to the inter-local phase, in which knowledge, actors, and visions are shared among various local projects, and then to the trans-local phase in which knowledge is fed into the regime, to end up in the global phase in which the knowledge becomes established and institutionalized [19]. The scaling up of the local niches can happen either through fit and comfort, meaning that the niches coexist and integrate with the present regime without bringing too much change, or through stretch and transform, meaning that the niches push for a change and a reform of the regime [26]. Social innovations can change the established regime in three ways: through replication of local projects at the niche level, though scaling up of existing projects, and through a stimulation process in which ideas of the niche are being transferred to the mainstream regime [27].

The SNM theory has often been criticized for seeing the niches as "unrealistically homogenous" [27] and for failing to acknowledge the important role of different actors and the quality and type of their interactions [18]. As a response to these criticisms, the present work focuses on the role of various actors and their interactions. While indeed a lot of the previous work focused on a single project [28], in the past years there is an increased interest in the interaction among projects and how multiple projects interact and influence each other while forming a "global niche". In this line, our study uses a cross case research approach.

2.2. Actors

Actors working in a project can vary from civil participants, to local and national governments, and private sector organizations, such as energy companies and external consultants. During the niche formation process, these actors have different roles which can foster or deter the transition. For instance, certain actors such as civil societies can initiate the transition and advocate for the benefit of the local society, leading to conflicts with incumbent actors which have an established position within the regime and advocate for private interests [29]. Other important actors are the intermediary actors, who facilitate learning and the exchange of knowledge among projects, as well as the cooperation between incumbent actors and challengers [23,30,31]. They are often charged with the role to create networks and to enable relationships and learning between similar niches. Their contribution to energy transitions and more concretely the niche empowering process has been the topic of various research [30,32].

2.3. Organizational Types

The idea of a "business model" has gained increasing attention the past years in the literature of SNM [32–35]. Business model innovation is considered an important element for the formation and upscaling of niches. Additionally, "appropriately designed business models are an important opportunity to overcome some of the key barriers to the market diffusion of sustainable energy technologies" [36].

The most common organizational models are public, private, and community based. Recently a new hybrid model has emerged, in which "societal roots of shared responsibility and environmental concerns are combined with market tasks such as energy profitability, security and access and governmental responsibilities" [37]. In the energy sector it can have the format of private–public agreements or of local government projects with citizen participation. In these new model, key actors such as the state, private sector, and community work in cooperation through the various stages of the niche formation. Despite the criticisms [12], these new arrangements offer more flexibility and a more democratic and pluralistic approach. Especially for small rural areas and islands, with limited access to funds, and lack of knowledge and capacity, this hybrid ownership model can be proven ideal for the energy transition through the availability of public land and the release of funds from private investors [38,39].

In technological innovation, technological arrangements are the main focus of the niche analysis, while in social innovation, the social arrangements are the focal point [27]. In the cases analyzed here, the renewable energy technology itself is mature and established on the market; however, this new social arrangement that includes a broad network, secures public acceptance, pushes for policy changes, and promotes the dissemination of knowledge among various actors is part of the social innovation. These new social arrangements are a "continuum" between grassroots initiatives, driven by ideological motives and market-based initiatives driven mostly by profit [23].

Thus, I argue that this model can favor the local renewable energy niches on islands to pass from the local to the trans-local phase through the incorporation of various actors with strong common visions that create a robust network. I also examine the role of these actors through the niche formation and scaling up process. This approach allows us to analyze sustainability transitions, not only through technological aspects, but also through social organizations and the actors behind them.

3. Methods

The research used a multiple case study approach based on data from an in depth-literature review, enriched with interviews. The comparative case study approach was chosen to bring into view the differences and similarities between these initiatives, to illustrate their heterogeneity regarding their locations, size, technologies, organization, and motivations, to examine the niche formation in real life context, and to discuss replication [40].

The three case studies selected are pioneer projects and are characterized by a hybrid ownership model that includes corporate and governmental and public involvement. Due to their innovative character in terms of management and technology, they can be considered representative cases of a sociotechnical niche emergence with new social institutions, values, and aims that do not form part of the mainstream regime. A full list of the criteria used to choose the case studies is presented in Table A1. I was especially interested in studying established projects with innovative technologies and a hybrid ownership model in countries that have not yet been studied well. The three cases are in southern Europe, namely, in Spain, Portugal and Greece that have a huge renewable energy potential which remains unexplored to a certain degree, especially in insular areas.

The analysis is based on key concepts of the SNM framework (presented in Section 2), with a special focus on the role of various actors in the niche formation process. Data were obtained through a review of the available scholarly literature and internet sources (public reports, policy papers, official websites) and from online interviews conducted with key actors between November 2019 and January 2020. These actors were identified from the preliminary document analysis. The participants were given the right to remain anonymous, but information regarding their role is provided in Table A2.

The open-ended questions were guided by the key processes of the SNM and covered among others, the motivation for participating in a joint project, the expected outcomes, the relationship with the other partners, the organization, and the knowledge they acquired (Table A3). The program Atlas.ti (Scientific Software Development GmbH, Berlin, Germany) was used to code the sections and to structure the verbal material from the interviews under the themes of the SNM (motivation/expectations, learning, and networking). [19]. The same categories were used for the primary documents.

By analyzing the aforementioned themes, I examined how the decentralized energy projects on isolated islands emerged, to what extent they might be contributing to niche development, and the role of the various actors in this new organizational model. The present research focuses on the heterogeneity of the actors and the design, assuming that a combination of specific structural and organizational forms and adequate policies can help new projects and can contribute to a change in the overall system of electricity generation on isolated islands.

4. Results

The three case studies chosen are the islands of Hierro (Spain), Tilos (Greece), and Graciosa (Portugal). The three projects have different forms of ownership and incorporate various forms of renewable energy.

4.1. El Hierro

El Hierro island is located in the Canary archipelago and has a population of 11,154 people. Currently, five wind turbines (total 11.5 MW) and a hydro plant (11.32 MW) supply about 80% of the island's energy demand. This flagship project is managed by Gorona del Viento El Hierro S. A. that consists of the El Hierro Island Council (65.82%), Endesa (23.21%), the Technological Institute of the Canary Islands (ITC) (7.74%), and the Autonomous Community of the Canary Islands (3.23%). The pilot program was inaugurated in 2015 to substitute the polluting diesel oil used in the Llanos Blancos thermal station. The project gained widespread recognition and in 2019, members of the International Energy Association visited the island to overview the progress and discuss the challenges. Gorona del Viento has inspired similar initiatives on other Canary Islands and worldwide and is currently expanding to include the use of electric vehicles and water desalination.

The project has a small but deep network. Incumbents such as the private company Endesa and the public company Red Electrica de España (REE) form part of the network, which proved to be very stable. All the interviewees highlighted the trust and good cooperation among the members of the network. The municipality played a key role, not only in envisioning the project, but also throughout the implementation. Several interviewees acknowledged that without the aspiration and guidance of the local government the project would not have been realized. The expectations and motivations were clearly articulated from the beginning and shared among all the actors. These include environmental benefits—mostly carbon dioxide (CO_2) emissions reduction, financial, such as a lower cost of electricity, and social, such as new income and job opportunities. An important vision shared by several interviewees was the energy self-sufficiency of the island and the avoidance of electricity blackouts, which prior to the project, were common on stormy days.

However, despite the initial expectations, the underperformance and the high costs led many to question the idea, as expectations are still not confirmed by tangible results. Many claim that self-sufficiency cannot be achieved under the present design and call for a reconsideration of the expectations and the outcomes. This, combined with the elevated costs of the project, has raised doubts among the experts regarding the economic feasibility. The expectations have been re-evaluated and the new target is lower than the initial 100%. Gorona del Viento is expected to cover about 55% of the annual demand at the moment.

Learning was essential for the project as there are no other similar experiences worldwide. The experiment showed that some of the technologies do not function properly and the design had several flaws. For instance, the size of the upper reservoir was not sufficient and there were gird stability issues. This failure produced important technical knowledge, leading to reflexive learning. This knowledge resulted in various publications and presentations in conferences and world forums. Recently, the project opened internship to students from universities, aiming to disseminate the acquired knowledge. Information was also disseminated through the website of Gorona del Viento. Social knowledge was a quite important element and was achieved through discussions with the local community, brochures, workshops, seminars and exhibitions, and training organized by the Red Cross [41]. Overall, the learning process was broad and reflexive.

4.2. Tilos

The small Greek island of Tilos is located in the Southeast Aegean Sea and has a population of 780 people. The island belongs to the electric system of Kos-Kalymnos that is powered with fuels from a thermal station located in Kos. The unstable connection, with frequent blackouts, led to the conception of the idea of the TILOS Project (Technology Innovation for the Local Scale Optimum Integration of Battery Energy Storage). The idea, which involves a wind turbine (800 kW), a photovoltaic park (160 kW), battery storage (2.4 MWh/800 kW $NaNiCl_2$ FIAMM), and smart meters, is coordinated mainly by the University of West Attica (former Technological Education Institute of Piraeus), the private Greek Energy Company EUNICE, the Hellenic Electricity Distribution Network Operator (HEDNO), the World Wide Fund for Nature (WWF), the municipality, and a number of other supporting partners worldwide. The project was named the best energy island project in 2018 and received two EU Sustainable Energy Awards.

The initiative pushed for institutional transformations, including policy changes regarding the hybrid systems on islands that are not connected to the mainland grid and the use of batteries as storage solutions. The energy supplier and the grid operator, despite their established role in the incumbent regime, played a crucial role in the project development. The wide range of different partners from local to national created a broad network and knowledge was disseminated among the actors through meetings and forums. The process of learning was essential and multi-dimensional. The project design and the outcomes resulted in various publications, and details are available on the website of the project. Additionally, an annual summer school was organized. The universities brought knowledge about innovative technological solutions, while the energy firms brought their experience from other projects. During the design and implementation, special focus was placed on the social dimension of learning, with organizations such as the WWF being responsible for the dissemination of knowledge among local people. Learning also occurred through exchange with other projects. Most interviewees when they were asked to mention other similar projects, named El Hierro, Samsø or other Greek cases, indicting an exchange of knowledge and experience. This strengthens the hypothesis that these niches do not operate in isolation but form a trans-local network.

The articulation of motivations and expectations was clear from the beginning. Self-sufficiency, environmental, and economic motives were the most important aspirations shared among the actors. However, some legislative barriers led to a change in the initial expectations. The original design included elements to push for the island's autonomy from the existing power grid, but this has not worked in practice, as there are conflicting provisions in the Greek legislation.

Nonetheless, self-sufficiency and energy autonomy are still the most dominant visions among the interviewees. All the participants associate the project with a more reliable power supply system and fewer power cuts. For some of them, the TILOS project falls into their broader view of a more decentralized power system that allows further autonomy and flexibility. Three interviewees referred to economic motives and assume that the project will bring economic benefits on the island such as new jobs and increased tourism.

The project shed light on the legal limitations regarding decentralized energy, including the pricing system, the licensing process, as well as numerous technical difficulties such as the grid stability [14]. Currently Greece has opened a public consultation regarding the regulation of hybrid power plants. The knowledge acquired from the TILOS project has proven viable in the public discussion, pushing for regulatory changes to allow replication on other islands (e.g., Gaudos, Fournoi, Othonoi).

Regarding the actors involved, the municipality played a key role, not only during the design of the project, but also as a manager of the process, especially in licensing and legislative issues. The figure of a green mayor has been acknowledged as an important asset for the niche formation and the case of Tilos confirms this. Several interviewees referred to the past and present mayors as leading figures in the energy transition of the island. Another interesting aspect is the role of intermediaries and more concretely of WWF and of the University of West Attica, which appeared to play an important role in fostering the communication among actors and the transfer of knowledge.

4.3. Graciosa

Graciosa, a small island in northern Azores with a population of 4777 people, has also initiated a journey towards a 100% renewable energy future. The Graciolica project combines solar (1 MW) and wind generation (4.5 MW) with lithium-ion batteries for storage. The project is led by Graciolica Ltd., a subsidiary of the private company Younicos (Berln, Germany), and the main stakeholder is the Dutch company Recharge A/S owning 50.1% stake in the €24 million investment. The project was delayed due to disagreements among the stakeholders, but it 2019 the Azores Regional Directorate of Energy allowed the injection of the renewable energy produced by Graciolica into the grid. Before the implementation of the project the island was heavily dependent on fuel imports of about 3.3 million liters of diesel per year.

The network consists mainly of partners from industry such as Younicos, Leclanché SA (Yverdon-les-Bains, Switzerland), and Wärtsilä (Helsinki, Finland). There was limited involvement from public organizations (Eletricidade dos Açores-EDA) and research institutes (Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência–INESCTEC) and no involvement from non-governmental organizations. Thus, the Graciolica project is strongly business oriented and the network is not overly broad or deep. Mostly, partners from the private sector worked together to mobilize resources and provide technical assistance. However, a "deadlock" in the renewable energy project occurred due to a disagreement between the shareholders of Graciólica, leading to a change in the composition and the incorporation of a new partner, the company Green Smith. The network in this case was not stable and there was lack of continuation, leading to significant delays and a loss of money for EDA.

The role of the local government in the project was less important than in the previous cases and as one of the interviewees stated: "*I don't think the government played a major role apart of "showing" its support towards a successful completion. Hard to say if the government involvement could have been different*". This statement highlights the limited role and influence local governments have in business-oriented projects. Similarly, in this project, the local community had a rather invisible role, but there were no complaints or local opposition. Intermediary organizations were not clearly defined, and the municipality was identified as the only connecting actor between the local people and the project partners.

The only available research regarding the project is a comprehensive Life Cycle Analysis by [42], who concluded that the new hybrid system will reduce the environmental impacts by 43%. The partners signed a disclosure agreement, and as a result, limited knowledge was available to the public, apart from some technical reports from involved partners, available online. There was also limited exchange of knowledge with other projects during the design and implementation. This is partly due to the unique character of the project, but also because the main partners such as Younicos and Leclanché had significant experience in the field of renewable energy production.

Throughout the process, the experiment produced knowledge on various domains. It revealed technical weaknesses regarding grid stability and the use of batteries. Social learning focused on the energy users and more concretely on the demand side of management. In the policy domain, the experiment highlighted various legal gaps and the inadequate subsidy mechanism. All these lessons are very important for the replication and scaling up of the project, which at the moment is expanding to include the use of electric vehicles.

The expectations were articulated well among partners and included economic benefits, the ambition to make their project a reference in the industry, and to prove to investors that storage solutions can work. Secondary motivation included social and environmental benefits. However, during the implementation phase, technical differences, and more concretely the software and the equipment, led to significant delays. There was no initial vision about how to scale up the project or which partners are prepared to invest resources in a next phase. Many of the partners are currently implementing the acquired knowledge in other similar projects around the world.

5. Discussion

5.1. Articulation of Visions and Expectations

The main collective drivers and goals for each project were extracted from the official documents reviewed and from the interviews and are presented in Table 1. All three cases had clear visions and well-defined goals and objectives, which were well substantiated by the projects' design and the outcomes. Common drivers and motivations include self-sufficiency, reduced energy cost, increased grid stability, and reduction of CO_2 emissions.

Table 1. The main priorities of the decentralized renewable energy projects examined (authors own elaboration).

Priorities/Motivation	El Hierro	Tilos	Graciosa
Maximizations of RES penetration	√	√	√
Grid stability	√	√	
Tourism	√	√	
Indirect economic benefits	√	√	
Reduced electricity cost	√	√	√
Reduced CO_2 emissions	√	√	√
Self sufficiency	√	√	√

Note: √ indicates that a certain priority/motivation is applied to the respective project.

The importance of self-sufficiency for isolated communities which depend on local diesel generators or fossil fuel imports is being highlighted in various studies, for example, in the work of [43] in Canada and of [44] in the Netherlands. In a broader context, the ability to be independent of energy providers and to achieve energy autarky is an important driving factor [45–47] for energy transition and can fulfill psychological parameters such as the need for self-determination and a sense of control [48,49]. The emphasis on self-sufficiency shown in the present three case studies provides further evidence for the importance of autarky and how it can influence the development of decentralized energy supply systems, especially in these isolated areas which have a high sense of belonging. Overall, the vision of a decentralized renewable energy system was shared among several interviewees as a response to the current problematic and unreliable centralized system.

The environmental benefits were clearly mentioned in all three cases and were often measured by CO_2 emissions reduction. Despite the emphasis on climate change mitigation, there was no mention of other environmental impacts such as water use, land use, and biodiversity. The secondary environmental benefits were not addressed in any of the cases. This is in contrast with the findings of [50], who questioned and interviewed the participants in a sustainable energy community in the UK and found that the most frequently mentioned reason for becoming involved with the project was environmental awareness.

The economic motive is another important driver. Funding from a local budget or from external corporations increases the pressure for economic viability. Overall, profit orientation is a main motive both for the communities and the corporations that deal with the energy supply. In the case of Tilos, the community considers the idea to export excess energy to the island of Kos in order to increase the profits, while on El Hierro, the community is already experiencing economic benefits from selling the energy and investing the gains in other social projects. On Graciosa, the electricity generated is also sold by Graciolica to the local utility.

Despite the extensive focus on the direct economic benefits due to the reduction in the cost of energy, in all cases there was a specific mention of the indirect economic benefits, such as job creation and new income sources. Tourism, as a sector that can be beneficiated, was explicitly mentioned only in the cases of Tilos and El Hierro. The interconnection by local renewable energy sources and sustainable tourism has been the subject of various studies [51], and renewable energy projects can serve as promotional tools to advertise the islands and increase tourist arrivals.

5.1.1. Initiating

When it comes to energy transitions, communities are often mobilized by endogenous actors such as local governments as seen in El Hierro and Tilos. In both cases, "green mayors" envisioned and initiated the projects. On the contrary, in the case of Graciosa, an exogenous actor (Younicos) played the role of the driving force.

In all three cases the initial face of the project included incentives from exogenous organizations. The incentives are typically in the form of loans or grants to support the preparation and implementation of the project. Although the incentives came from national or international entities, the response to the opportunity was taken up at the local level mostly by local organizations and the local government in Tilos and El Hierro. These results highlight the importance of exogenous organizations as providers of the funding source and the technical capacity especially in small, isolated areas with limited municipal funds. The initiative of the local community and the local authorities is supported by those external organizations that have a catalytic role in helping the community overcome the initial budget and knowledge limitations. Thus, cooperation among the various endogenous and exogenous actors is important at this stage.

5.1.2. Learning & Networking

Intermediate actors, such as NGOs and universities often provide the required technological knowledge but are also responsible for networking and sharing experiences. Intermediaries can design channels and events that can bring together initiatives from local, regional, and national levels. Growing niches depend on the expansion of these networks and on the network-building activities of the participating actors.

Although learning and networking are important common elements among the three cases, there are some significant differences. In the case of Tilos, the role of educating the public and reducing conflicts was carried out by the non-governmental organization WWF. The University of West Attica was responsible for sharing the learning with other energy intermediaries, for networking, as well as for the project coordination. Similarly, in the case of El Hierro, the knowledge aggregation was also carried out by the Technological Institute of Canarias (ITC) and training of the local population was implemented by the Red Cross. Interestingly, in the case of Graciosa, an external corporation, Tractebel, was the project manager, but not with a clearly defined role of networking and learning. This role was partially taken up by the municipality. The role of universities as intermediaries was strong in two out of the three cases examined. The importance of these institutions in promoting social innovation niches, also highlighted in previous research [52,53], is strengthened further by our observations.

The local energy providers are key actors that serve various interests, have a balancing role, and work closely with other partners such as municipalities (e.g., El Hierro, Tilos) and international corporations (e.g., Graciosa). In all three cases the projects have contracts for selling energy to the energy providers. In this context, the energy providers participate actively in the management of the demand and supply.

There is an informal network among the three case studies available to exchange knowledge and expertise (Figure 1). This network is quite diverse and includes the participation of various actors. The company Younicos that financed the project on Graciosa is a consortium member in the Tilos project. Similarly, ITC participates in both the El Hierro and Tilos projects. Those are the "bridging organizations" of the network that create an inter-local phase in the scaling up process [54].

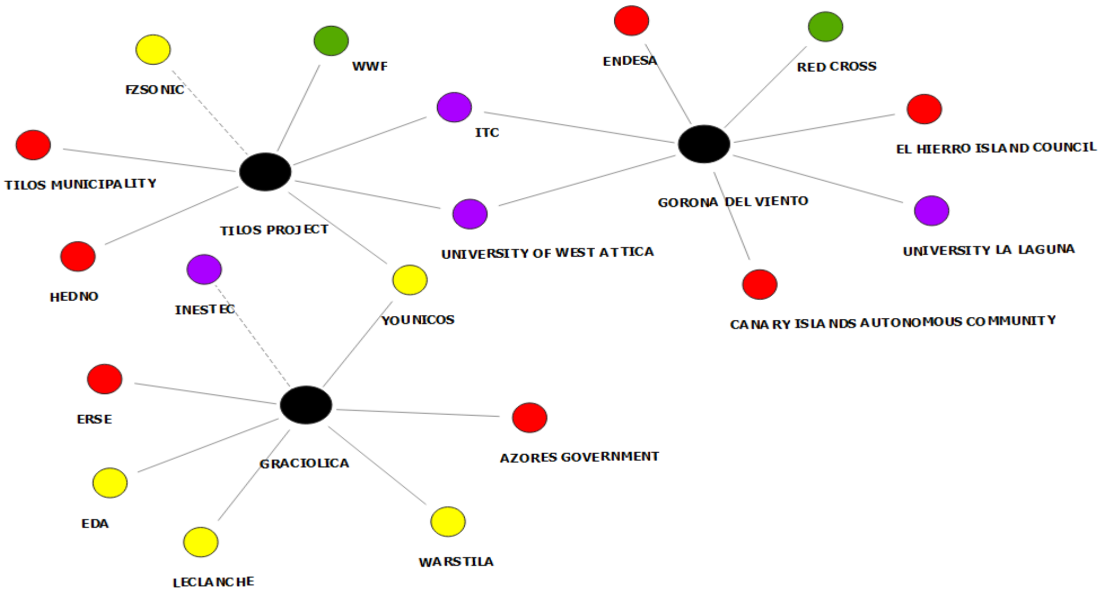

Figure 1. Illustration of the networks for the three projects including public actors (**red color**), private actors (**yellow color**), NGOs (**green color**), and universities (**purple color**).

5.1.3. Management

Moving from the envisioning of the project to management, the three projects can be divided according to their central institutions and their guiding principles into community oriented, state oriented, and market oriented [38,55]. Based on that, the most community-oriented project is El Hierro where the municipality holds the majority of the shares and has the leading role in the management. Graciosa is a more market-oriented system as the owners and managers are private entities. Tilos is a mix of the state and market project due to the strong presence of public organizations, such as the University of West Attica and HEDNO combined with the presence of Eunice. This can be related to the various political systems in the three countries. While in Spain the governmental system is more decentralized and the autonomous communities and municipalities have more financial means and independence for policy design, the Greek system is highly centralized [56].

5.1.4. Funding

When it comes to resources, these seem to come from all the levels of government (local, regional, national, and European) and vary from grant funding to price-support schemes. Overall, external funding is a crucial factor for the vitality of the project especially during the initial stages. Similar to what was observed in the study of [57], the funding worked as an "interssesment device" to further boost the cooperation among the various partners and to strengthen the ties among the participating actors.

5.1.5. Actors

In all three cases, the electricity distribution is a monopoly that has been well established the past years despite that the energy providers participated to different extents in the local initiative. The low levels of resistance can be explained due to the fact that energy providers, through contracts, buy the renewable energy and thus, are not being excluded from the new regime. Our results are in line with the findings of [58], who pointed out that the increased competition increases pressure to invest and thus often the incumbent actors get involved in new technologies. This is often through collaboration in order to limit the risks and costs [59], as is also observed in our cases. These "cooperation strategies" are often mutually favorable for the challengers and the incumbents [60]. Additionally, the energy providers are in a position of power as in all of the cases examined the local communities do not aim to disconnect completely from the grid. On the contrary, they need to have an energy backup in place to deal with the problem of intermittency of the renewable energy sources and the lack of affordable energy storage technologies. This makes the distribution operators crucial actors in the process.

5.1.6. Emergence of a Global Niche

There are indications that the three projects are moving beyond the niche phase into the inter-local and the trans-local phases. Our results suggest that the projects are growing and expanding, including new partners and approaches (e.g., electric vehicles, waste management, and water desalination). I also observed a significant exchange of information among the projects, the presence of weak tiers, and project-to-project links. The initiatives have influenced the regime mainly by pushing for regulatory changes; however, this influence is still marginal. For instance, in the Canary Islands, the El Hierro project highlighted the need for the "Decreto Eólico 6" that simplifies the process of wind farm authorization on the islands. Similarly, in Greece, the Tilos project paved the way for other similar projects and pushed for regulatory changes with the introduction of law no. 4495/2017. The Younicos Company is in charge in both the Tilos and Graciosa projects, allowing the exchange of information while at the same time designing similar projects on other islands (e.g., Lanai and Maui), indicating replication. Similarly, the University of West Attica is also involved in similar projects on other Greek islands, using the knowledge gained from Tilos. Similar new projects inspired by the cases presented here are also emerging all around the world under the prospects of the EU Clean Energy Package. These elements of replication, scaling up, and stimulation further enhance our hypothesis that the cases discussed here are pushing for a reform of the established regime and for a deeper change in the overall system of electricity generation

6. Conclusions

In this paper I used the Strategic Niche Management (SNM) theory and examined the role of various actors in order to analyze three decentralized renewable energy projects on isolated islands with a hybrid ownership model. The projects demonstrated high levels of heterogeneity, but all had some common denominators including clear motives, strong intermediary actors, and support from the local energy providers and the community. Additionally, the results indicate that three key factors from the SNM theory (building networks, managing motivations, and facilitation of learning), as well as the participation of concrete actors in these processes, are of great importance for all three cases. As one can observe from Table 2, in the three projects, the various actors played different roles during the niche formation process, highlighting the variation and complexity of the hybrid ownership model as well as the importance of cooperation among the various partners.

Decentralization is not only an important innovation for energy production, but also a new form of energy management often dominated by different actors other than the dominant ones in the established electricity system. In this line, a heterogeneous group of actors that are less visible in the established regime play an important role in the various niche-nursing stages, such as mayors, universities, and NGOs. On the contrary, incumbent actors can hold new roles in the new decentralized management (e.g., energy providers) and cooperate with the new actors. This can be beneficial for the incumbent and reduces the lines of conflict among challengers and incumbents. In this line, the hybrid management model can be highly efficient if it includes a deep and stable network with clear articulation of expectations and motivations.

Table 2. The main actors participating in the stages of the niche-formation process.

Actors	Initiating			Learning			Networking			Funding			Managing		
	El Hierro	**Tilos**	**Graciosa**	**El Hierro**	**Tilos**	**Graciosa**	**El Hierro**	**Tilos**	**Graciosa**	**El Hierro**	**Tilos**	**Graciosa**	**El Hierro**	**Tilos**	**Graciosa**
National Government					+			+			+	+			
Municipality	+	+		+	+	+	+	+				+	+	+	
National corporations										+			+		
International corporations			+		+	+		+	+		+	+		+	+
Electricity distribution operators													+	+	+
European Union							+	+	+	+	+	+			
Universities		+		+	+		+	+						+	
Non-governmental organizations					+			+							
Citizens	+	+		+	+	+									
Utilities				+						+			+		+

Note: + indicates participation of the partner in the respective stage.

Our paper started with the assumption that the decentralized renewable energy initiatives studied here are pioneers in the efforts to change the electricity supply system in their respective countries. Indeed, one can conclude they can be considered important niches for innovation that have created a new policy and structural regime, enforced new institutions, and designed new ambitions. At the same time, they have introduced an alternative management model for local energy projects.

Given the diversity of actors involved, strategies developed, and organizational forms established, one can talk about a heterogeneous emerging field that is not yet stabilized, but with great potential for upscaling. The EU Clean Energy Package paved the way for renewable energy communities, local energy projects, and other forms of citizen's initiatives. So far, these initiatives have shown their potential as active players in the electricity system and have raised hopes regarding the achievement of the binding 32% EU target for RES.

Nonetheless, a future expansion of the niches requires more support for the experiments, especially from intermediary organizations that can promote networking and learning. By creating and maintaining an environment in which expectations are well articulated and reflexive learning processes take place, the niches can expand and be scaled. Another important implication is the need for further collaboration and lobbying to achieve further change in the institutional environment. Significant reforms to national legislation and regulation are still needed in order to provide space for social innovation.

The heterogeneity and the local character of the cases do not allow generalizability. Nonetheless, the present study has theoretical implications that go beyond the particular places. It can offer useful insights for similar projects that are still in the initial stage (e.g., Menorca [61]) and serve as an example for islands with similar characteristics and potential (e.g., Lampedusa [62], Fournoi [63]). In this way it can enhance the creation of new networks and the exchange of knowledge. The business model and governance concept behind these projects can be replicated and applied in multiple arenas.

Building on the present analysis, it would be appropriate to collect further data and to expand the discussion on other initiatives and emerging networks. The new hybrid ownership model is becoming more predominant in many countries and various settings and thus, further research is needed to investigate the potential of this model in other particular spaces and landscapes, but also its endurance over time.

Insofar, it is difficult to say which of the analyzed cases will survive, to what extent they will achieve their aims, and the influence they will have on the overall energy transition nationally and globally. Various challenges will have to be overcome as the projects move from the trans-local to the global phase, but there are indications that this transition is already happening in the countries of southern Europe. The initiatives discussed here offer a promising alternative to the established regime and with the required attention and support can have the potential to contribute to a shift on the energy generation field.

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Appendix A

Table A1. List of criteria for the selection of the case studies.

1.	Located on islands in southern European countries
2.	Not connected to the main grid; thus, they are good examples of decentralized energy systems
3.	They aim to achieve 100% electricity self sufficiency
4.	Are considered pioneers
5.	Include participation of the local communities, but they represent various forms of ownership, different spatial contexts, and receive funding from different sources
6.	Eco-villages—consisting of people who moved to a certain place voluntarily—have been excluded as they often include religious, ideological, spiritual communities, and/or have other aspirations that go beyond the aim of this research
7.	Energy cooperatives were excluded as often the members are not directly related to the community (e.g., Somenergia or Retenergie)
8.	Projects that are still in the very initial stage, have vague ambitions, and lack concrete planning were excluded

Table A2. List of participants and their affiliations.

Reference	Project	Organization
I1	El Hierro	University
I2	El Hierro	Gorona del Viento
I3	El Hierro	Gorona del Viento
I4	El Hierro	Local government
I5	El Hierro	Endesa
I6	Tilos	NGO
I7	Tilos	Eunice
I8	Tilos	Municipality
I9	Tilos	HEDNO
I10	Tilos	University
I11	Tilos	University
I12	Graciosa	Graciolica
I13	Graciosa	Graciolica
I14	Graciosa	Younicos
I15	Graciosa	Leclanché SA

Table A3. Sample of open-ended questions.

Theme	Questions
General	What was your role in the project?
	What was the goal of the project?
	What were the main obstacles during the implementation of the project?
	To what extent are current national policies in line with the development of the project? Do you think there are legal gaps?
	Did you encounter any opposition from the residents or from energy companies?
Motivation and expectations	What was the initial motivation and inspiration for the project?
	Has this changed during the implementation? If yes, why?
	How did the expectations of the various partners influence the project and its upscaling?

Table A3. *Cont.*

Theme	Questions
Networking	In your opinion, who were the most important actors (key actors) in the project (in design and implementation)?
	How was the interaction among the partners?
	What was the role of the local government?
	Did the partners change? Were new partners added to the project?
Learning	How was knowledge disseminated among the institutions and the various project partners?
	Was there an exchange of knowledge with other similar projects? If so, indicate with whom and how the knowledge exchange was carried out.
	What type of learning occurred in the project? How was it organized?

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