Energy Research & Social Science 81 (2021) 102288

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

"From local island energy to degrowth? Exploring democracy, self-sufficiency, and renewable energy production in Greece and Spain"

Marula Tsagkari [a,*], Jordi Roca [a], Giorgos Kallis [b]

[a] Department of Economics, Faculty of Economics and Business, University of Barcelona, Av. Diagonal, 696, 08034 Barcelona, Spain
[b] ICTA-UAB, Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, Research and Degrowth, Spain

ARTICLE INFO

Keywords:
Local energy
Degrowth
Islands
Southern Europe
Energy transition
Energy democracy

ABSTRACT

The energy sector is at the center of the current economic system, and of literature and activism on degrowth, which questions the sustainability of current models of energy use. Local and small-scale energy systems may have the potential to reduce energy and resource consumption and to advance degrowth-related ideals of energy democracy, self-sufficiency, and local production. In the present paper we link a discussion on degrowth and local energy projects, using two case studies from southern European islands, El Hierro in Spain, and Tilos in Greece. These pioneer local energy initiatives have a complex ownership model that includes various public and private actors, and aspirations that go beyond merely electricity production to other economic and social goals. We look into the promise of these initiatives in transforming insular areas and promoting an alternative way of living, comparing attributes of the processes involved to four degrowth principles. We conclude that despite the degrowth potential of these local energy projects, their prospects are limited to revitalizing local economies and empowering local communities, but not necessarily reducing energy use or creating an alternative to the growth orientation of the islands.

1. Introduction

Climate change demands a radical change in fossil fuel-based energy systems, which are the primary sources of global greenhouse gas (GHG) emissions. The availability and increased access to renewable energy has opened up the possibility for new energy arrangements, like decentralized energy production on a small scale much closer to use. Islands, where access to fuels is scarce and costly, but local conditions like topography and natural resources are often favorable to wind and solar energy, can be ideal laboratories for clean energy transitions. Islands can be considered as micro-worlds of larger topographies, which make them particularly well-suited for demonstration and pilot projects [1]. Many insular areas are lagging behind the mainland economically - especially urban centers – with low incomes, high unemployment rates, lack of opportunities for young people and depopulation/lack of human capital. Dissatisfaction with conventional development has led many islands to look for alternative strategies and local energy (LE) projects, some argue, that can help empower islands economically, culturally, and socially [2].

Economic growth depends on energy use [3]. Many scholars, policymakers, and activists call for a change, not only in energy technologies, but also in the centralized and monopolized energy system, combined with a broader change in the current capitalist system and the predominant lifestyles the latter promotes [4]. The Degrowth Movement, drawing upon the fields of ecological economics and environmental justice, emerged as a response to interrelated socioeconomic and environmental crises. Given their small size, towns, villages, neighbourhoods, and islands offer ideal set-ups for experimenting with – and reflecting upon - ideas of degrowth [5] and clean energy transition [6]. Degrowth points not only to energy efficiency and cleaning/decarbonizing energy supplies, but also to reducing energy use, and thus facilitating the decarbonization of a smaller, rather than larger, energy system [7]. Small-scale, community-owned or local renewable energy projects are, then, interesting studies to investigate from a degrowth perspective, as they combine low-scale energy systems, often with a sufficiency orientation and, potentially, elements of democracy and local control.

Despite this potential, there is still little evidence on how degrowth ideas can relate to local contexts. Along these lines, we link a discussion on degrowth and LE on islands, using two case studies from southern Europe, El Hierro in Spain, and Tilos in Greece. These islands are international examples of energy transition, as they aim to become self-

* Corresponding author.
E-mail address: marula.tsagkari@ub.edu (M. Tsagkari).

https://doi.org/10.1016/j.erss.2021.102288
Received 16 March 2021; Received in revised form 31 August 2021; Accepted 1 September 2021
Available online 11 September 2021

sufficient in terms of their electricity needs using renewable energy technologies. Their aspirations go beyond simple electricity production and include socioeconomic goals, like increased participation from local populations in decision-making, and revival of the local economy through tourism and job creation.

These islands see energy infrastructures as an opportunity to construct new modes of living and new identities. These opportunities, however, come with emerging challenges and dilemmas. New projects are inevitably characterized by uncertainty as "the effects of human actions can never be fully anticipated or predicted, and their outcomes [are] never completely known [8]". Even the best-defined goals of local energy projects are open to interpretation and can have distinct results, which are shaped through negotiations conflict, empowerment, political regimes, cultures and diverse perceptions of past and future change [9]. For this reason, although the goals of the LE projects examined here are not defined in degrowth terms, we argue that such goals can be related to degrowth principles. Thus, in the present paper, we aim to further explore this potential, and to examine the complex relationship between degrowth, islands and local energy. We do this by envisioning whether and how degrowth could emerge in the current arrangements, under what conditions, and what obstacles – evident and hidden – it will encounter.

In the next section, we present the concept of LE, followed by a short discussion on four degrowth and LE hypotheses. In Section 4, we explain the methodology for data collection and analysis, and present the two case studies. In Section 5, we report the results, and in Section 6 we discuss our findings. The final section concludes and reflects on the possibilities for degrowth based on our case studies.

2. Background and theory

2.1. Contextualizing local energy

The term Local Energy (LE) is quite broad and encompasses initiatives "involving a range of public, private and community organisations for the benefit of local consumers operating within a defined area" [10]. Devine-Wright [11] uses the term LE to describe the new social arrangements of mixed business models around renewable energy (usually wind, solar, and hydro), that rely mostly on local authorities and local enterprise partnerships with a focus on local needs, like job creation, skills training, new infrastructure, and development of the area.

These initiatives have emerged – and received attention - as a response to centralized energy systems. While huge investments are undertaken in the name of green growth, frontline communities make significant efforts to develop different types of local energy, distributed generation, energy storage systems and demand-side participation through smart grids. However, lack of resources, funding and knowledge often lead local authorities and communities to form partnerships with private organizations and intermediate actors. Such ownership models, known as 'hybrids', can be useful contractual arrangements for islands and small remote communities [12], that can be positioned in the spectrum between a strict capitalist model and alternative economic practices [13].

These types of LE projects become ever more predominant in various countries [11,14], creating a need for further analysis of these new arrangements. Various scholars argue that LE projects are vehicles, not only for an energy transition, but also for a bigger societal transition [4,15]. Others are more skeptical, claiming that, in most cases, these projects function inside the mainstream economy [16,17], making it less likely that they will promote citizen participation and produce strong and cohesive communities, as they prioritize economic growth through investments in clean energy [11].

Many renewable energy projects, despite their local character, may exacerbate inequalities, sustain individualistic materialism and increased material use, as well as contribute to the commodification of labor, local cultures, and land. On the other hand, even though techno-centric projects, positioned within the prevalent capitalist model, can create problems, LE projects can, in certain instances, create "spaces of intersection with non– or post-capitalist projects" [18].

The present study contributes to this debate by analyzing two operating LE projects, evaluating how they work, and assessing to what extent they could contribute to new social arrangements on the islands, beyond economic growth. As a normative vision of societal transformation, we focus on the theory of a degrowth approach, presently gaining attention, which is ideally suited as a framework for thinking – and assessing – the radical potential of the LE projects at stake.

2.2. Degrowth and local energy

Degrowth calls for a socially sustainable downscaling of production and consumption of environmentally- damaging goods in overdeveloped countries to remain within planetary boundaries and enhance human and environmental wellbeing. Although degrowth started as an environmental concern, it soon became a deeper critique of capitalism, modernization and unsustainable growth [19]. The degrowth literature offers empirical and theoretical evidence that challenges assumptions that infinite growth and environmental sustainability can be achieved only through innovative technologies and eco-efficiency as argued from the eco-modernist perspective [20-22].

The transformation of energy is a central point in the degrowth literature, and thus local energy projects and degrowth ideas can be examined in tandem, as some of the social innovations found in the degrowth discourse can also be embodied in LE projects. In past years there have been efforts to define sets of concrete degrowth principles (see [19]) and some attempts to operationalize 'degrowth' especially in alignment with social movements like transition towns, alternative food networks, and eco-housing [18,23,24]. Nonetheless, there are few studies that connect degrowth ideas with energy projects in local contexts.

As an example of this phenomenon, the research of Alarcón Ferrari and colleagues [25] examined how close a local project in Sweden aligned with the broader ideas of degrowth, energy democracy and technology, concluding that the initiative is still very much growth-oriented. In their study, they used a critical discourse analysis approach, but did not engage in-depth with degrowth ideas. Similarly, the research of Kunze and Becker [16] found that small-scale local energy projects have little degrowth potential, as they follow the profit maximization logic enforced by the energy market, and did not envision how a degrowth local energy project would look in their case studies. In a more comprehensive approach, Rommel et al. [26] defined certain "aims" of degrowth that can be applied in the arena of renewable energy, including local production, new business models, equity and fairness, sustainable consumption, convivial use of technology and a strong sense of community. The authors juxtaposed these hypotheses with the German case of the citizen energy movement *Bürgerenergie* and found that only a few initiatives embraced these degrowth ideas.

Adopting a similar approach for this study, we chose to focus on four degrowth principles related to LE energy projects and their concrete goals, namely: "energy democracy", "energy self-sufficiency", "localized production", and "revitalization of the local economy" without a single emphasis on economic growth. The parallels between each of these degrowth principles and LE is examined below.

2.2.1. Energy self-sufficiency

For degrowth theory, the question is not only how to meet present demands with new technologies, but how to reduce energy demand to a level that could be provided by renewable resources. Efficiency improvements, by themselves, are not enough, as they can also have countereffects and negative externalities [27]. Recent research [28], for example, shows that the tight coupling between GDP and energy use can be explained by economy-wide rebound effects, and that feasible climate mitigation scenarios involve not only decarbonizing energy supply, but

also a dramatic reduction of energy use and a slowing down of economies [21].

Renewable energy and efficiency, in other words, are necessary, but not sufficient if the economy keeps growing at 2 or 3% each year [20]. Decarbonization is easier if economies do not grow or grow slower than they would otherwise would. Furthermore, given the important demand of renewable energies for materials [29], a lower energy use, and, by extension, a slower rate of growth for the economy, are necessary for broader sustainability. This brings into focus the question of sufficiency, over and above that of efficiency. We understand sufficiency here to mean reducing energy use towards the minimum level necessary for meeting basic human needs [30]. Efficiency is welcome, but degrowth postulates, in addition, the goal of sufficiency – a decent living using the minimum amount of energy necessary.

Thus, from a degrowth perspective, any local sustainable energy system should not only pay attention to the supply side, but also to the demand side, as well as to the broader economic transformation that makes wellbeing within limited energy use possible.

2.2.2. Energy democracy

Questions of equity, autonomy and democracy are central in degrowth [31-33]. Local, small-scale and self-sufficient energy systems with hybrid organization and are often seen as potential paths for energy democracy [16,25]. This is because these systems keep workers and users under direct control more easily and allow for broader participation from the local community. Direct participation, through voting and real power to influence decisions and change outcomes, is, according to Arnstein [34], the highest level of citizen empowerment and the core of energy democracy. The energy democracy concept aligns with degrowth ideas as they both require a re-imagining of energy politics, in which authority for decision-making is placed in the hands of the local population, energy consumers become energy citizens and energy a common good, democratically governed [35,36].

2.2.3. Re-localization of production

The importance of localized production has been a central point in the degrowth literature. Re-localization of production can reduce transport costs by minimizing the distance between production and consumption, can increase local control over production and can create community resilience, energy reliability, and self-sufficiency [37,38]. Re-localization implies that many of the stages of the life cycle of energy provisioning happen in the local community. It doesn't mean walling off the community from the outside world, but using local resources, recruiting local workers, serving local consumers/users and becoming less dependent on imports [39]. Various local low-tech ideas, like wood stoves, pedal washing machines, and small wind turbines that can be maintained by non-experts, have been discussed in the degrowth literature as convivial energy tools [40], since they are self-built and have low material and financial cost.

2.2.4. Re-vitalization of the local economy

Many peripheral areas, like the small islands that are of interest here, have not followed the rapid economic growth of mainland cities in the last decades, and have lived through a prolonged "recession" or stagnation period. Food production through unsustainable agriculture and farming, extraction of raw materials, large scale renewable energy projects, or unsustainable mass tourism are some of the forms of exploitation peripheral and insular areas face in the pursuit of economic development [41,42]. Traditional ways of living have been retreating, and land and human relations are being increasingly commodified, ostensibly to catch up economically with the centers of economic activity. However, this is not the only path, and there are good arguments as to why local economies can be "revitalized" without succumbing to "growthism". Revitalization can take the form of new economies that do not reinforce the logic of capital accumulation, but center on sovereignty, self-sufficiency, and well-being. Social and cultural regeneration can lead to rural revivification [43]. The creation of employment in small business and local cooperatives, sustainable and organic agriculture that covers local needs, sustainable and slow tourism, local currencies, and co-housing are some examples.

3. Methodology

3.1. Case study approach

For our analysis, we chose the case study approach, suitable for examining a phenomenon in a real life context [44]. The case studies were not chosen because they were positive examples of projects with degrowth aspirations, but rather, because we were interested in understanding to what extent, and how, as local energy projects, they could follow or contribute to degrowth openings. We believe that social failures can also provide useful insights for energy social science research and, although the two cases represent small and isolated cases, big changes often come from marginalized places [45].

While we cannot generalize on the basis of just two cases, they offer sufficient material for an in-depth analysis [46] and confident findings [47]. The two case studies share similarities that allow us to examine them in parallel and to compare insights. For instance, they function within similar policy environments [48], have similar mixed ownership models that include local, corporate, and governmental involvement in project development and ownership [14], they aim to achieve 100% electricity self-sufficiency, and aspire to incorporate social, environmental and locally-oriented values.

3.2. Data collection and analysis

The analysis was based on data obtained through document analysis (energy statistics, public reports, policy papers at national and state level, review of the available scholarly literature and internet sources). The results were supplemented with findings from open-ended conversations with key actors. Between January and May 2020, we conducted 25 interviews with municipality representatives, technical staff, research partners, private companies and representatives of environmental organizations and business owners. We acknolwedge that our results rely on a limited number of interviews, thus some voices may not have been included.

Interviewees were given the opportunity to remain anonymous, however, in Appendix A, we provide information regarding the project and the organization to which they belong. By using a semi-structured methodology and open-ended questions, we gave interviewees space to develop and expand upon topics that were relevant for them and/or the researcher [49].

The main goals and motivations of the projects were identified from a review of relevant documents and reports and were related to the degrowth hypothesis presented in Section 2. In this way, we created four thematic sections that guided the interviews to investigate how much affinity these projects have with degrowth ideas, and how degrowth can be positioned in these initiatives. The main questions asked concerned the performance of LE projects, the role of the local community and the local government in the process, and the socioeconomic benefits of the project. A schema of the general research questions that guided the interviews is presented in Appendix B. All interviews were transcribed and entered into the Atlas.ti software to code the sections and align them with thematic headings for each case. This "template coding" approach [50], where codes are created beforehand, has the advantage of allowing the researcher to filter large areas of data when focusing on a specific research problem [51].

3.3. Island presentation

3.3.1. El Hierro

The island of "El Hierro" is located on the Atlantic Ocean seaboard

and is the smaller of the Canary Islands with an area of 268.7 km^2. The island has a total population of 10.162 people living in three municipalities. Prior to the implementation of the renewable energy system, the island imported about 40,000 barrels of oil annually and was dependent on nine diesel units located in the Llanos Blancos to cover the local electricity demand. Due to isolation, this system was one of the most expensive in the Canary Islands and highly polluting. Currently, there are no plans for connecting the system with other islands. The annual electricity demand of El Hierro is about 44 GWh (2018), with a daily peak of around 7 MW. Most of this demand is for domestic needs and water desalination. Throughout the year, more than 20.000 tourists visit the island, as can be seen on Fig. 1, there are small peaks in energy demand during the summer months.

In 1997, the island Council adopted the "El Hierro Sustainability Plan", aimed at making El Hierro the first island in the world to be completely powered by renewable energy sources, and, at the same time, to improve the quality of life for local people, revitalize the local economy, and preserve its cultural and natural heritage. In 2014, a hydro-wind plant (total power 11.3 MW) started operation. The project combines a wind farm and a pumped-storage hydroelectric power station. The water is stored in an upper reservoir and can be used when there is no wind to switch on the turbines or to generate electricity to cover demand [52-54]. The project is managed by a mixed private–public company, "Gorona del Viento El Hierro S.A", founded in 2004. The majority of shares are publicly-owned through the Island Council of El Hierro (Cabildo of El Hierro) (65,82%), the Canary Islands Government (3,23%) and the Technological Institute of the Canary Islands (7,74%). Corporate participation includes the private electric utility company Endesa (23,21%). This public–private partnership is unique for the Spanish energy system. After 50 years, the company will become solely public, with the Cabildo of El Hierro as the only shareholder.

The initial investment was covered by the Spanish Government through the Institute for Diversification and Energy Saving (IDEA) (35 M€), while the Cabildo de El Hierro, the Ministry of Industry of the Government of the Canary Islands and Endesa contributed 20 M€ as stakeholders. A bank loan of 25,6 million euros was obtained and repaid after three years of operation. The economic gains resulted from selling energy in the wholesale electricity market and from guaranteed capacity payments ("garantia de potencia"), a subsidy payment to ensure that the facility would be paid off in time. These subsidies are calculated annually taking into account various parameters, such as the initial investment cost and the cost of operation and maintenance, defined in Order IET/1711/2013 (see also [48]). These subsidies are paid indirectly by consumers throughout Spanish territory.

Part of the economic gains is distributed among the shareholders. The local government is the majority shareholder, and thus receives the largest share of Goronás profits. As the price of electricity in Spain is regulated through a unified price system, meaning that the price of electricity is unified over the country to avoid inequalities, the residents of El Hierro have not seen a reduction in their monthly electricity bill. However, the local government re-invests the financial gains in social projects for the islanders, such as subsidies for LED lights and campaigns to reduce plastic bag use and promote recycling, while a part is used to subsidize electricity costs of the most vulnerable households, or to contribute to actions to improve the energy efficiency of buildings.

3.3.2. Tilos

The island of Tilos is located in the southeast Aegean sea, with a total area of 61.49 km^2 and a population of 780 people. The island is part of the Kos-Kalymnos autonomous grid system that consists of 9 islands in total. In past years electricity demand was covered by two oil stations of 120 MW, one in Kos (102 MW) and one in Kalymnos (18 MW), supplying Tilos via an underwater cable. This connection is rather unstable, with many regular and long-term blackouts, especially during the summer months. Due to the island's small size and the distance from the mainland, there are currently no plans for further interconnection. The total annual electricity consumption remained steady over recent years at around 3GWh, of which 300 MWh emanate from public use (e.g., streetlights and water pumps). The remaining consumption is residential and commercial use, mostly for heating and cooling [55]. The cost of imported fuel corresponds to 75% of the total expenditures for the Kos-Kalymnos system. The average electricity price in 2019 was 153 €/MWh, significantly higher than the mainland where the cost was 58.2 €/MWh [56].

In 2015, the local government decided to develop and operate an innovative renewable energy project as part of the island's sustainability plan. The energy plan has become the main strategy against unemployment, migration, stagnant economic growth, degrading of common identity and mass tourism. The system is a hybrid photovoltaic/wind/storage energy system that consists of a wind turbine (800 kW), a PV park (60 kW), distributed heat storage to control domestic electrical water heaters, and smart meters that monitor and regulate residential and community energy loads [57]. NaNiCl2 batteries (2MWh) are used to store excess energy to ensure security of supply and ancillary services. The battery storage system can provide up to 12 h of energy autonomy for Tilos without any other electricity source. By switching to renewable energy, the project will reduce annual CO_2 emission by almost 1.5 kilo tons (-0.39%) in the non-interconnected islands and is expected to reduce the electricity price in the system by 350.000€ annually. In contrast with El Hierro, the island of Tilos has a shorter tourist season, and the arrival of about 1000 tourists between June and August increases the energy demand almost threefold (Fig. 2). During these peaks, the project will be able to cover about 80% of energy demand, while the remaining energy requirements will be imported from Kos. In contrast, the expectation is that during windy and sunny days with less demand, excess power could be passed to Kos.

The project is a multinational European demonstration and research project engaging 13 participants (4 industrial partners, 7 academic and research partners, 2 distribution system operators and 1 non-

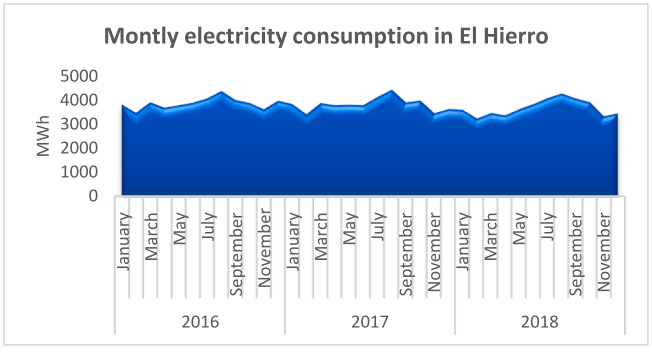

Fig. 1. Profile of monthly energy consumption on El Hierro (Jan 2016-Dec 2018). (Source: Instituto Estadistico de Canarias, 2021).

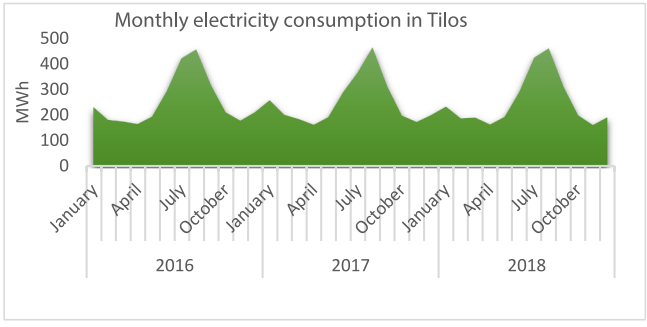

Fig. 2. Profile of monthly energy consumption in Tilos (Jan 2016-Dec 2018). (Source: HEDNO).

governmental organization). Tilos has the first contract for the sale of electricity from a hybrid station in Greece signed by the Hellenic Electricity Distribution Network Operator (HEDNO) and the private energy group Eunice Energy Group (EEG), which operates the project. The project was funded with 11 m€ from Horizon 2020, and 4 m€ from private funds. According to Law 3468/2006, 3% of the total net gain from selling energy to HEDNO returns to the municipality. A third of this is deducted from the bill to cover the residents on the island. For the first year of operation. this amount was 2.055,66 euros [58]. The remaining two-thirds are allocated to the municipality and are dedicated to other projects on the island, that will improve the quality of life of the islanders (books for the library, improvement of the community center, new infrastructure, recycling etc.).

4. Analysis

The two LE projects share similar broad goals and aspirations. These are not inherently aligned or against degrowth, but depending on the design and implementation model, they could fulfill certain degrowth principles, as discussed in Section 2. The two projects, then, can serve as tools for envisioning a potential degrowth path in small communities, similar to those assessed here. This conceptual framework is presented on Table 1. By connecting degrowth to the goals of the projects in the conceptual framework, we seek to embrace the plasticity of the degrowth concept and to explore realistic degrowth pathways. Note that the table below is intended as an example of a potential path adopted for these specific cases, but one need not assume that this is the only degrowth path.

4.1. Energy democracy

The TILOS and Gorona del Viento projects have been praised for the high involvement of local populations [59,60]. They offer alternatives to the centralized energy system within which local communities had no voice, and, as a result, both the reported projects are characterized by high levels of community acceptance (with no opposition or complaints reported). However, these characteristics are not enough to ensure a democratic project, especially under a hybrid ownership model where various actors interact, compete, and negotiate towards shared goals.

In Tilos, the community participated in the design of the project through direct public consultations. As a result, there was a change in the location of the windmill to a less favorable one to protect an endemic bird species, and so as to not disrupt the soil close to agricultural land by the installation of the concrete bucket. Information about the project was disseminated through leaflets, brochures, and the project's webpage. A T.I.L.O.S-info kiosk was installed and equipped with a small PV-roof system. Meetings between all project partners were held every six months, including workshops and roundtables. Moreover, educational projects were organized for schools, and training for adults on issues of environmental awareness and energy savings. Nonetheless, there was only a small core of about 50 people from the island who participated actively in the project design through the public consultation and the remaining population did not have an active role. Many of the discussions among the local people about the project occurred in informal settings, such as the public square and the neighborhoods. These discussions were then transferred to the municipal meetings through the small core of active residents.

Table 1
Potential degrowth paths.

Projects' goals	Potential degrowth paths
Active engagement of users	Energy democracy
Self-sufficiency and energy reliability	Reduction in energy consumption and increased energy efficiency
Re-localization of electricity production and energy autonomy	Low-tech and locally-produced alternatives for electricity production
Re-vitalization of the local economy	Support of small businesses, cooperatives, slow tourism, etc.

During the installation of the smart meters, people showed an increased interest as they felt that they were part of the project. By using smart meters, they believed they could control their consumption, adopt energy saving behaviors and see a decrease in their monthly electricity bills. The option to be notified to turn off unnecessary devices to avoid a blackout was one of the bigger motivations for the local people to install smart meters, and this gave them agency over their own consumption patterns. In some cases, there were concerns regarding the criteria upon which it was decided which households would get meters. In the next step, more smart meters will be installed to avoid discrimination. The next phase also includes the installation of photovoltaics on private houses in order to not only increase the use of renewable sources, but also to further create space for the participation of the local population in the project. Initial ideas for open assemblies and for organizing the project through an energy cooperative were not fulfilled in the first stage due to the requirements of EU funding, however, the creation of a cooperative in the upcoming months is expected to enhance a more democratic model of governance.

For Gorona del Viento transparency is an important aspect of the project. All information, as well as official documents, are available on the webpage of the project. The local population was involved from the very beginning, with a first public consultation held in 2004 during the design phase. Many worries expressed by the local population were considered during the design process. However, according to the local environmental organizations (I8) "*The interest of the local people at the beginning was high, however bureaucratic delays and lack of transparency at the initial stages alienated the local population.*" Initially it was expected that the local people would install solar panels on their rooftops and supplement the energy of Gorona del Viento. This was delayed due to the high economic cost of the project that absorbed all the available funds, and due to the royal Decree 900/2015 that added a tax on solar energy produced in households. With the suspension of the decree and the repayment of the bank loan to Gorona del Viento, the installation of solar panels on households and companies is the next step. The local population is also showing an increased interest in this idea – as one interview put it: "*we will all be happy if some of the income gained is used to subsidize the households with solar panels. Then we could talk about energy democracy and energy independency because it will affect us more closely*" (I9).

Initial complaints regarding the visual and aesthetic impact of the use of cement were resolved by covering the concrete massifs with stone and other materials that blend in with the surroundings. Some of the local environmental organizations requested a detailed environmental impact assessment after the presentation of the initial plant, which then led the Canary Islands Government to set 18 conditions for the project. Many people also voiced concerns that the project did not leave any money for the community and did not reduce energy bills. As one interviewee put it "*the economic impact on our pockets is the same but at least we know [that electricity] comes from a sustainable source*" (I10). In response, the local government ensured that part of the investment return (around 1 million euros annually) will be used for energy upgrade projects in old houses, as direct payments to households that face energy poverty, and to subsidize solar panels in warehouses and public buildings.

The organization and facilitation of the training by experienced non-governmental organizations, such as WWF and Red Cross, was a way to spark the interest of the local people. The training aimed to familiarize people with the energy project, and to educate them on the efficient use of energy and resources. In Tilos, WWF ensured the involvement of local people and organized public consultation as well as training on the use of smart meters.

The role of the local governments as a connector between the local community and the project was highlighted by participants in both cases. Local governments not only represented the needs of their people,

but also ensured a fair and just allocation of the benefits through the redistribution of the revenues to other socioenvironmental projects. On the other hand, private actors, it was felt, served as an impediment to participation and left little space for negotiation about the direction of the projects, especially after the design phase.

The projects enhance some of the notions of energy democracy, and, in that sense, they are interesting, but they cannot be considered as representative of a deep democracy and, by extension, of degrowth. Although the primary goal of the projects is not profit-maximization, there are no democratic mechanism in place, such as assemblies, elected citizen members on the board or the ability to directly discuss public petitions. This is because surplus revenue is still distributed as private profit to the actors. This is more evident in the case of El Hierro, where the main private company, Endesa, is also responsible for the operation of the thermal station on the island, raising questions regarding a financial interest of the consortium against generating too much renewable electricity [61]. In order to move closer to the notion of energy democracy as a degrowth principle, these projects should find ways to embed participatory approaches in decision-making, either through the creation of energy cooperatives, or through direct participation and voting. Similarly, the allocation of the benefits should be fair, transparent, and aligned with local needs.

4.2. Electricity self-sufficiency and reliability

The two islands aim to reduce their dependence on fuel imports and to become electrically self-sufficient. For this to be achieved, and insisting here on the degrowth perspective, a decrease in energy demand should be one of the main objectives, but this is not the case. On the contrary, some of the other goals surrounding the projects imply an increase in energy demand, as, for example, plans for more new tourist activities, opening of new businesses and increased in-migration. Such plans raise doubts about reaching energy independency in the long term. Both islands still rely on conventional diesel generators as backup engines, especially for days with high demand and low wind. In Tilos, the back-up diesel generator (1.45 MW) is manually operated [55].

As can be seen from Fig. 3, in El Hierro there was an increase in electricity consumption per capita until 2012, although this has stabilized since the beginning of the project, in 2012. Renewable energy still does not cover all the demand of the island (Fig. 4). El Hierro was covered for 596 consecutive hours. Between July 13 and August 7, 2019, all electricity demand from renewable sources. But it is now clear that the project has reached its full capacity, covering around 50–60% of the island's annual demand, and unlikely to reach 100% cover. The hydro-pump system has significant energy losses due to sharp fluctuations in load, the small capacity of the lower reservoir, the inappropriate location of the turbines and their small size [62]. The managers whom we

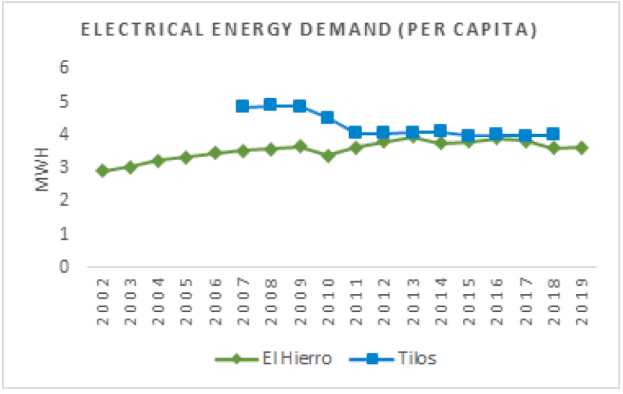

Fig. 3. Electricity consumption per capita for the years 2002–2019 (Sources: Instituto Estadistico de Canarias 2021, HEDNO 2021).

interviewed accepted technical obstacles and miscalculations, but claimed that the project is showing increased performance, claiming that "*difficulties are inevitable in innovative projects like this*" (I8). These problems are expected to be resolved with new investments that will "*reinvent the project*" (I8), including smart meters similar to those in Tilos, by reducing the demand when the turbines are no longer spinning by notifying people to reduce their consumption and turn off unnecessary devices. In this way, the island's hydro reserves will last longer. The installation of solar panels on houses and businesses will also help the island to work towards its target of 100% renewable electricity.

In Tilos, the total annual electricity consumption of the island decreased between 2008 and 2011, due to the economic crises and out-migration. But, in recent years, it remained stable at around 3GWh, with a peak load demand of around ~ 900 kW and an average load of 350 kW. It is difficult to draw conclusions regarding energy savings, as there is lack of available data regarding the real population on the island, as a significant number of people registered as residents live outside during the winter. The results of the trial period between 1/9/2018 and 20/1/2019 [63] indicate that the hybrid station can cover the electricity needs of the island for several days, especially during the windy month of December, when the RES achieves an average monthly penetration of about 90%, that, in some cases, allows the export the excess of energy to Kos [64]. However, there were still periods of deficit where energy had to be imported, especially during summer when there are no strong winds, and the energy demand is high. To cope with these periods of high energy demand, about 100 smart meters were installed, offering the potential to manage 15–20% of the peak load demand of the island. With these smart meters, the load demand of the island can adapt to better match the available RES production and avoid blackouts.

In both cases interviewees share the belief that increases in energy demand can be compensated for by increases in energy efficiency. For example, in Tilos, "*investments in new and more efficient devices*" (I8) and "the *purchase of upgraded and more efficient electric supplies*" (I19) is expected to reduce energy demand. Indeed, there are some efforts to push for behavioral change towards more sustainable consumption. In Tilos, education programs regarding electricity consumption, the distribution of LED lights, and the use of smart meters aim in this direction. According to one interviewee (I15): "*the use of smart meters that are already installed in various households will help regulate the energy demand and achieve 100% energy autonomy*", as they will allow people to modify their electricity consumption based on the available levels of renewable energy. This type of regulation of consumption on the demand side is important because "*people value more energy excessiveness and pay less attention to energy efficiency*" (I12).

In El Hierro there are also efforts to raise awareness regarding energy consumption, especially, as in the first phase, a misunderstanding led the local population to believe that energy produced with water and wind is free, that they could pay less than before, and, thus, that they could consume more; an indication of a rebound effect. Since 2019, Gorona del Viento implemented action to adjust demand behavior, acknowledging that energy efficiency does not only depend on how energy is generated or distributed, but also how consumers use it.

Additionally, both projects aim to invest in electric vehicles. El Hierro approved a plan to subsidize 50% of the cost for the purchase of private electric cars and motorcycles. In Tilos, the priority is a public electric bus and electric vehicles for the municipality. The use of electric cars, while reducing CO2 emissions, also increases electricity consumption and the extraction of resources. Some of the environmental organizations in El Hierro raise significant questions regarding the ambitions of the local government to simply swap the 6,000 conventional petrol and diesel cars for electric ones over the next 10 years, without promoting alternatives such as car sharing or improving public transportation. The example of Tilos, that aims to promote public transport instead of the purchase of new cars, lies closer to a degrowth spirit.

As the goal to achieve 100% electricity self-sufficiency seems unattainable under the current project design, more "high tech solutions" are

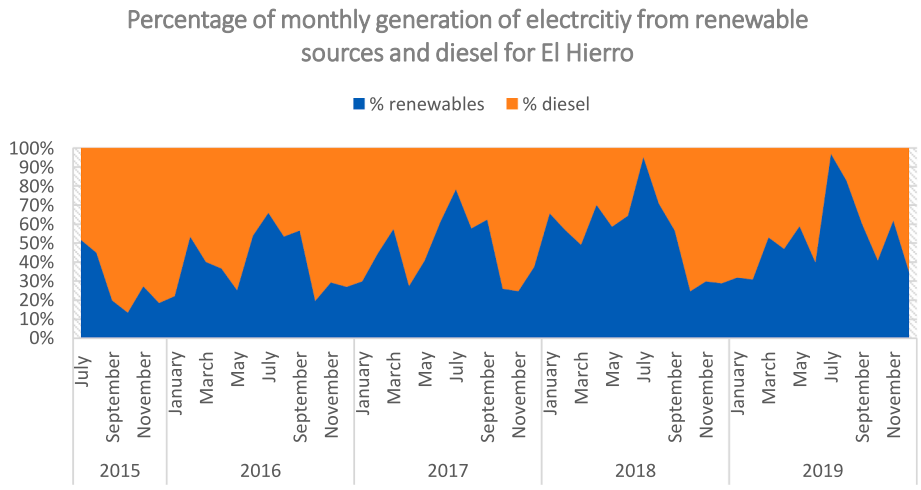

Fig. 4. Percentage (%) of monthly generation of electricity from RE and diesel for El Hierro (Jul 2015-Nov 2019).

put on the table. Instead of trying to find ways to further decrease energy consumption, the expansion of technological solutions is being considered to cover the increased demand resulting from the economic growth of the communities.

The idea fostering innovation and testing new technologies under the ecological modernization banner is supported mostly by the private sector and the research institutions who see these projects as an ideal way to test and promote new smart renewable energy solutions. This has overshadowed the idea of simpler low-tech initiatives and has given less attention to consumption. This is contrary to the spirit of degrowth, that claims that energy efficiency improvements are not enough and, thus, more radical changes in consumption patterns are required [65].

A better degrowth approach to achieve the goal of self-sufficiency would include small-scale, simpler technological solutions with a stronger focus on the demand side and changes in social norms and lifestyles. There are several alternatives that could help the islands reduce their electricity consumption and achieve their goal of 100% electricity autonomy, from biking and public transport to communal cooking and DIY projects.

4.3. Re-localization of production

The projects promised a re-localization of electricity production. Currently, the two cases have partially achieved this, in that a portion of the operation and maintenance has indeed been localized. The experienced staff for the construction, however, came from outside the islands. In Tilos, there is one trained person to maintain the installations, while in El Hierro the staff of Endesa operates the Llanos Blancos thermal station and are responsible for the maintenance of the renewable energy project. The control rooms with the software for demand forecasting and real time management are not located on the islands. Most interviewees claimed that this outsourcing is reasonable given that the lack of people on the islands with the relevant knowledge to work in the projects. This, together with the lack of local funds, has led the projects to depend on external funding and big private actors. Some respondents were sceptical, claiming that, although some of the processes had to be outsourced, such as the construction of solar panels and aerogenerators, the possibility remained to install control rooms on the island, and to train local people to operate the projects, thereby avoiding dependence on either Endesa, or Eunice.

Degrowth advocates for localized production, whether publicly or communally governed, minimize the distance between production and consumption and enhance community autonomy. This analysis indicates that this ideal is challenging for the periphery as far as renewable energy is concerned. Islands have been traditionally dependent to a high degree on bigger urban centers. And the technologies used, at least in the two cases studied here, depend on external support and funding that make private–public partnership necessary, although it inevitably limits local autonomy. However, even under this partnership, there could be space for more degrowth approaches focusing on supplementary low-tech initiatives, training and employing local people, relying more on inhouse expertise and circulating free knowledge through workshops that will restructure and re-localize the production. Instead of focusing on creating only green employment as a consequence of innovative technologies, degrowth advocates focus on local sustainable production and a better work-life balance.

4.4. Revitalization of the economy

By linking the energy sector to other dimensions of society, feedback loops bring side effects and indirect benefits. Investments in RE can attract more capital, and drive population growth through reduction of out-migration and increase of in-migration, because of better public infrastructure, better public services, and new job openings. They can also enhance community cohesion and boost local entrepreneurship. On both islands, the investment in the energy project was envisaged as part of broader plans to create longer-term economic benefits.

By moving in this direction, the income from selling energy will be used for other local projects that can revitalize the local economy under the supervision of the municipality. Apart from the two direct new job openings in Tilos and eight in El Hierro, employment opportunities were also created in other sectors, like or example in the local museums and visitor centers. Gorona del Viento, in partnership with Red Cross, during 2020, trained 17 people on energy saving measures, energy efficiency, electrical risk in homes, and other related skills. Eventually, these trained people will carry out inspections and audits to identify vulnerable households that suffer from energy poverty. According to one respondent from the island (I3): "*it is important that the local government decides how to re-invest part of the gains. Because of that, social goals are a priority compared to the private interest which is mostly profit-oriented.*" In El Hierro these gains will be significant, as the local government is the main stakeholder and, thus, allows for further investment in other social projects and endogenous growth of the communities. In Tilos, gains are estimated at around 5.000 euros annually, while still offering some indirect benefits to the local community with small projects such as improvements in road infrastructure, public lighting, and similar municipal initiatives.

In Tilos, the lack of employment opportunities and the difficulties related to infrastructure and education pose difficulties for young people. The project provided income diversification and an increased

standard of living. Indeed, Tilos was one of the islands that reported an increase in population over recent years; the number of permanent registered residents increased from 271 in 1991 to 823 in 2013 [66]. Although this cannot be directly associated with the energy project, the local government claims that it is a result of the broader sustainability plan of the island, the main pillar of which is the renewable energy project, which has improved living conditions overall and the opportunities that people can see for themselves on the island. Access to reliable energy with fewer blackouts is expected to favor the establishment of small-scale industries and new businesses that will stimulate income generation activities. For instance, one of the members of the local cheese cooperatives mentioned that access to secure energy allows them to increase their milk and cheese production, knowing they can keep their products in good condition until they sell them. They also claimed that, after the recognition of the island as a sustainable destination, their products have gained publicity.

In El Hierro, the Gorona de Viento and the Natural Biosphere Reserva have joined forces for the purpose of "*maintain(ing) the traditions and idiosyncrasies of the Herreño people*" with "*new development projects, which demonstrate the integration of the population in the territory, with the responsible use of its resources*." These projects put an emphasis on the promotion of local products as part of a brand entity, that will revive the island's cultural identity, and support local business and sport activities [67].

Tourism was another sector that benefited indirectly from the energy project. Secure energy supply reduced the frequent blackouts that were harming the tourist sector and the reputation of the island. Additionally, energy tourism is being promoted as a new concept. This form of tourism includes visits to energy sites, visitor centers and educational programs promoting the energy project. Both Tilos and El Hierro combined the energy projects with programs of environmental education, summer schools and conferences, in order to attract technologically-curious, environmental-friendly and 'off-the-beaten-path' tourists.

Additionally, public advertising of the islands using energy projects as a tourist marketing strategy, has led to an increase in tourist arrivals. For instance, since the beginning of the project, tourism in El Hierro has jumped from 5773 visitors at the beginning of the project in 2013 to 9028 in 2019, while Tilos has extended its tourist season by 2 months (May and September). One interviewee from Tilos (I11) mentioned that: "*we had many loyal visitors who (have) come for about 30 years. However, (we) now see more young people coming who found out about Tilos because of the renewable energy project and they want to express their support.*" Every summer, energy demand in Tilos almost triples because of tourist arrivals, however, project managers do not expect this demand to increase further as: "*Many of our tourists are camping or spend the whole day outdoors, not using air-conditioning or other electric devices*" (I11). For this reason, with the installation of private solar panels, the island expects to manage the demand from renewable sources even during most of the tourist months.

Similarly, "sustainable tourism" was a central objective in El Hierro over the past two decades, and "*the energy project has sparked the interest of tourists, who want to visit the small island*" (I9). To protect against mass tourism, the number of visitors is regulated through limited available accommodation options that include mostly eco-friendly hotels and hostels, eco establishments, agrotourism, etc. Further, the island has strict regulations regarding hotel and taxi licenses. As with Tilos, El Hierro has no international airport or cruise port making access difficult. Sailing has recently been promoted as a low impact alternative for visiting the island. By regulating tourist activities, the project managers claim that there will be no excess energy demand from tourism in the coming years.

Tourist activities are not inherently against degrowth. Indeed, many forms of tourism can help communities achieve locally defined goals which go beyond income and economic growth. In our case studies, there was an explicit orientation towards 'slow tourism', community-owned tourism and energy tourism, with the energy projects being successfully used as promotional tools. The increase in tourism is regulated to avoid peaks in energy consumption. In this way, we can conclude that the two energy projects support a tourism economy that is not incompatible with the ideal of degrowth towards economic diversification and revival. Tourist activities on the two islands are not focused solely on an economic bottom-line, but, on the contrary, can help achieve long-term community goals that include strengthening the primary sector, cultural reclamation, and environmental protection.

5. Discussion

This study has examined in-depth two LE projects located on islands in southern Europe. The rapid growth of LE projects in Europe and the increased attention on islands as socio-technical imaginaries, make the present paper relevant to the discussion of energy politics, democracy, and societal transformation. Despite their small size and local boundaries, LE projects have the transformative power to lead the energy transition and to push for new social imaginaries [68]. Degrowth provides a promising post-capitalist imaginary, but it still lacks a concrete connection with LE initiatives in real life settings. Our research draws such parallels and while pointing out the caveats.

More concretely, on the one hand, local governments can exercise some leverage in negotiations for new pathways for local development, exploring ways to benefit the community. This aligns with expectations that local government can play an important role in local bottom-up RE initiatives [69]. On the other hand, private companies ensure that funds and knowledge are available, while using the islands as laboratories for new technologies. Our research challenges the notion that the roles and relationships between actors are scripted a priori, and points to a more experimental model that blurs the boundaries between corporate, public, and civil roles, leaving space for greater social change. In the 'hybrid' arrangements studied in the present paper, corporate interests were associated mostly with profit and promotion of renewable technologies, but they also supported social development to a degree, and engaged with the aspirations of the communities. On the other hand, there was limited interest from the local population to engage in decision-making in formal settings.

The incentives for the projects are not incompatible with degrowth objectives of clean energy, sufficiency, and localization, however, certain outcomes remain tied to an economic growth mindset. For instance, increased energy demand is met with energy efficiency measures, not sufficiency or demand-side management. The present inability of the projects to reach 100% electricity self-sufficiency will continue to be encountered as additional investments in renewable energy technology come on stream.

Despite expectations that a more inclusive, just participation can be achieved through re-municipalization and decentralization, these desires were not reflected in the two cases examined here. On the contrary, we share the skepticism among scholars [11,16,25,70] that, although local voices are encouraged, they have little actual influence in decision-making, with their role limited to consultation, implying a lack of real energy democracy and justice in these local energy projects. The role of citizens was limited; they did not hold power through direct participation, but were mostly represented through the municipalities. At the moment, the focus on clean technology investments in line with the strong presence of private actors, leaves little space for direct democracy and community empowerment, despite the efforts of local governments. Thus, we can assume that the higher level of energy democracy through deliberative democratic mechanisms, which is a prerequisite for a degrowth-oriented transition, has not yet been achieved in these projects.

Although there was an increased focus on the local character of the projects, these are still highly dependent on the mainland and global capital and knowledge flows. This dependency, although inevitable to a certain degree, is also a result of the private involvement in the projects and goes against the goal of increasing self-sufficiency. This finding

aligns with similar findings from other research, such as that of Cebotari and Benedek [71], who also reported a strong dependence of peripheral LE projects on core urban centers, where many of the companies providing capital and know-how are located. Alarcón Ferrari and Chartier [25] mention that, although the shift to renewables led to higher self-sufficiency, the community of Vaxjo is still dependent on imported fuels for transportation to access the biomass. Findings from Indonesia also indicate that energy projects did not ensure capacity-building for the communities involved [72].

Local energy projects seem to create opportunities for community activities through endogenous development, supported mainly by local governments. Considering the relationship between tourism and degrowth, the two case studies are good examples of an alternative form of slower tourism. Although the islands used the energy projects as place-branding for tourism, the local population and municipalities designed tourist plans that avoided mass tourism and attendant increased energy and resource consumption.

In the light of what has been discussed so far, one might wonder how these initiaves would look under the lense of degrowth. One would imagine local energy projects with much more direct involvement of local communities (through regular assemblies), and with democratic control of the technological system, through, say, a municipal cooperative, or some similar scheme. One would further expect a noticeable reduction in energy use as a result of the implementation of the projects, and greater appreciation among inhabitants of energy sufficiency by curbing unnecessary excess energy use. Finally, the projects would act as loci for local economies – acting both as multipliers for local activities (such as tourism or small commercial ventures), while creating employment opportunities for locals or for people wishing to move there to live. From this benchmark, it is clear that, while the two projects do not yet live up to this standard, there are many nascernt elements – from the greater degree of public participation to the revitalization of slow-pace local economic activities – that suggest that local energy projects may be a vehicle for 'slowing down' energy systems and opening up alternatives.

We agree here with Kunze and Becker [16] that local projects may have the potential to embrace some degrowth ideas, but for this to happen, communities must explicitly embrace such potential. A Degrowth-compatible model would focus on engaging more actively with the local community to redifine their role as energy citizens [36,73]. Efforts for democratizing energy systems can use informal arenas to involve the local population. [74]. Further, the fetihization of modern technology and the belief that simply more technology can solve the socio-economic problems that these islands face, can paradoxically lead to undemocratic processes and higher dependence on profit organizations and experts, thereby actually reducing the autonomy of the local population. Now that implemeted technologies are nearing matureity, the focus of the projects should shift to reorganizing social practices and fostering new values. The local government and the private companies involved can shepherd this new direction by re-investing profits in low-tech initiatves, free workshops, communal kitchens, and similar initiatives. As a matter of fact, there are exampes of for-profit organizations that have undertaken similar actions, blurring the distinction between for-profit and not-for-profit orientations [75]. Thus, the islands should take advantage of these multi-sector coalitions to grasp the mutual benefits that will improve local energy system [76], and redirect local economies away from growth determinism.

6. Conclusion

Despite similarities in their respective goals and management models, the two case studies cannot be reduced to a single dynamic. In fact, in each case, we find ideas and approaches that align with degrowth, such as the push for public transport and bikes in Tilos, or the training of young people in energy savings measures in El Hierro. However, the similarities beween the two cases indicate a trend in the organization and function of local energy projects, at least in island settings [77]. The degrowth momevent should critically engage with these new arrangements, point out structural problems, and tranfer good practices from one case to another via networking. It is important that these partnerships work to avoid creating mistrust that would, in turn, hinder future efforts, as observed in other cases [42].

Of course, beyond degrowth, one should not overlook or underestimate the achievements of Tilos and Gorona del Viento. Their initiatives embrace innovative technologies and new forms of ownership in novel settings. The energy projects give insular areas a way out of the socio-economic crisis they have faced in the past years and suggest a greater potential for a quick recovery in a post-Covid era. They open up both a path of modernization, and commodification, with a conventional opportunity for the islands to 'catch-up' with urban centers. But they also open up a degrowth path based on sufficiency, democracy, and collectivity. The story told in this paper can is an important step for local communities to follow a degrowth lead and head societal transitions.

A final reflection from our work, is that future studies are needed to explore the potential of varied organizational models of energy for degrowth, the challenges they face, their transformative potential in the era of green growth and mega-projects, and the role of the different and varied actors involved.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to thank Brayton Noll, Chris Vrettos and the three anonymous reviewers for their feedback.

Appendix A

Interviewee	Case	Affiliation
I1	El Hierro	Gorona del Viento
I1	El Hierro	Gorona del Viento
I2	El Hierro	Gorona del Viento
I3	El Hierro	University
I4	El Hierro	University
I5	El Hierro	Endesa
I6	El Hierro	Cabildo de el Hierro
I7	El Hierro	Cabildo de el Hierro
I8	El Hierro	Environmental organization
I9	El Hierro	Business owner

(*continued on next page*)

(*continued*)

Interviewee	Case	Affiliation
I10	El Hierro	Business owner
I11	Tilos	Municipality
I12	Tilos	Municipality
I13	Tilos	University
I14	Tilos	University
I15	Tilos	University
I16	Tilos	University
I17	Tilos	Eunice
I18	Tilos	Eunice
I19	Tilos	WWF
I20	Tilos	HEDNO
I21	Tilos	Public worker
I22	Tilos	Cooperative
I23	Tilos	Business owner
I24	Tilos	Business owner
I25	Tilos	Business owner

Appendix B

Open ended questions sample for the interviews

- Describe the project
- What are the main short-term and long-term goals?
- Have they changed during the implementation? If yes, why?
- What is the role of the local community?
- How did the local community participate in the design and implementation?
- Did any of the outcomes change after consulting with the local community?
- How did you ensure that the project is inclusive?
- What are the benefits for the local community?
- Are there any other environmental initiatives on the island? If so, which ones?
- Since the beginning of the project did you see any changes in the behavior of the people or way of thinking towards sustainability?
- Which were the main obstacles during the implementation of the Project?
- How are you dealing with these obstacles?
- Many of the goals you mentioned imply an increase in energy demand. How will you cope with this?
- Among the main goals is the revitalization of the community. Explain
- What was the role of the local government in the design and implementation of the project
- What are the next steps for the projects

References

[1] T.M. Skjølsvold, M. Ryghaug, W. Throndsen, European island imaginaries: Examining the actors, innovations, and renewable energy transitions of 8 islands, Energy Res. Soc. Sci. 65 (2020) 101491, https://doi.org/10.1016/j.erss.2020.101491.

[2] H. Doukas, A. Papadopoulou, N. Savvakis, T. Tsoutsos, J. Psarras, Assessing energy sustainability of rural communities using Principal Component Analysis, Renew. Sustain. Energy Rev. 16 (4) (2012) 1949–1957, https://doi.org/10.1016/j.rser.2012.01.018.

[3] S. D'Alessandro, T. Luzzati, M. Morroni, Energy transition towards economic and environmental sustainability: feasible paths and policy implications, J. Clean. Prod. 18 (4) (2010) 291–298, https://doi.org/10.1016/j.jclepro.2009.10.015.

[4] F. Avelino, J.M. Wittmayer, Shifting power relations in sustainability transitions: A multi-actor perspective, J. Environ. Policy Plan. 18 (5) (2016) 628–649, https://doi.org/10.1080/1523908X.2015.1112259.

[5] E. Mocca, The local dimension in the degrowth literature. A critical discussion, J. Polit. Ideol. 25 (1) (2020) 78–93, https://doi.org/10.1080/13569317.2019.1696926.

[6] T. van der Schoor, B. Scholtens, Power to the people: Local community initiatives and the transition to sustainable energy, Renew. Sustain. Energy Rev. 43 (2015) 666–675, https://doi.org/10.1016/j.rser.2014.10.089.

[7] G. Kallis, Radical dematerialization and degrowth, Philos. Trans. R. Soc. A Math Phys. Eng. Sci. 375 (2017) 20160383, https://doi.org/10.1098/rsta.2016.0383.

[8] J. Connell, Islands: balancing development and sustainability? Environ. Conserv. 45 (2) (2018) 111–124, https://doi.org/10.1017/S0376892918000036.

[9] M. Westrom, Winds of change: Legitimacy, withdrawal, and interdependency from a decentralized wind-to-hydrogen regime in Orkney, Scotland, Energy Res. Soc. Sci. 60 (2020) 101332, https://doi.org/10.1016/j.erss.2019.101332.

[10] Local Energy Scotland, Local energy - a modern approach to sourcing and generating renewable energy, (2021). https://www.localenergy.scot/what-is-local-energy (accessed May 4, 2020).

[11] P. Devine-Wright, Community versus local energy in a context of climate emergency, Nat. Energy. 4 (11) (2019) 894–896.

[12] A.A. Eras-Almeida, M.A. Egido-Aguilera, Hybrid renewable mini-grids on non-interconnected small islands: Review of case studies, Renew. Sustain. Energy Rev. 116 (2019) 109417, https://doi.org/10.1016/j.rser.2019.109417.

[13] R. Hanna, Community renewables innovation lab: energy transition platform policy briefing, Clim. Gr. (2017), https://doi.org/10.25561/55465.

[14] M. Tsagkari, Local energy projects on islands: Assessing the creation and upscaling of social niches, Sustainability 12 (2020) 10431, https://doi.org/10.3390/su122410431.

[15] G. Seyfang, S. Hielscher, T. Hargreaves, M. Martiskainen, A. Smith, A grassroots sustainable energy niche? Reflections on community energy in the UK, Environ. Innov. Soc. Transitions. 13 (2014) 21–44, https://doi.org/10.1016/j.eist.2014.04.004.

[16] C. Kunze, Sören Becker, Collective ownership in renewable energy and opportunities for sustainable degrowth, Sustain. Sci. 10 (3) (2015) 425–437, https://doi.org/10.1007/s11625-015-0301-0.

[17] G. Taylor Aiken, L. Middlemiss, S. Sallu, R. Hauxwell-Baldwin, Researching climate change and community in neoliberal contexts: an emerging critical approach, Wiley Interdiscip. Rev. Clim. Chang. 8 (4) (2017), https://doi.org/10.1002/wcc.463.

[18] H. March, The Smart City and other ICT-led techno-imaginaries: Any room for dialogue with Degrowth? J. Clean. Prod. 197 (2018) 1694–1703, https://doi.org/10.1016/j.jclepro.2016.09.154.

[19] T. Parrique, The Political Economy of Degrowth, Polit. Econ. Degrowth. Université, 2019.

[20] J. Hickel, G. Kallis, Is green growth possible? New Polit. Econ. 25 (4) (2020) 469–486, https://doi.org/10.1080/13563467.2019.1598964.

[21] L.T. Keyßer, M. Lenzen, 1.5 °C degrowth scenarios suggest the need for new mitigation pathways, Nat. Commun. 12 (2021) 2676, https://doi.org/10.1038/s41467-021-22884-9.

[22] G. Kallis, Limits, ecomodernism and degrowth, Polit. Geogr. 87 (2021) 102367, https://doi.org/10.1016/j.polgeo.2021.102367.

[23] J. Lockyer, Community, commons, and degrowth at Dancing Rabbit Ecovillage, J. Polit. Ecol. 24 (2017) 519, https://doi.org/10.2458/v24i1.20890.

[24] C. Cattaneo, M. Gavaldà, The experience of rurban squats in Collserola, Barcelona: what kind of degrowth? J. Clean. Prod. 18 (6) (2010) 581–589, https://doi.org/10.1016/j.jclepro.2010.01.010.

[25] C. Alarcón Ferrari, C. Chartier, Degrowth, energy democracy, technology and social-ecological relations: Discussing a localised energy system in Vaxjö, Sweden, J. Clean. Prod. 197 (2018) 1754–1765, https://doi.org/10.1016/j.jclepro.2017.05.100.

[26] J. Rommel, J. Radtke, G. von Jorck, F. Mey, Ö. Yildiz, Community renewable energy at a crossroads: A think piece on degrowth, technology, and the democratization of the German energy system, J. Clean. Prod. 197 (2018) 1746–1753, https://doi.org/10.1016/J.JCLEPRO.2016.11.114.

[27] C. Kerschner, M.-H. Ehlers, A framework of attitudes towards technology in theory and practice, Ecol. Econ. 126 (2016) 139–151, https://doi.org/10.1016/j.ecolecon.2016.02.010.

[28] P. Brockway Energy efficiency and economy-wide rebound effects: A review of the evidence and its implications Renew. Sust. Energ. Rev. 141 2021 http://mendeley.csuc.cat/fitxers/40c1dc458194535295a03ea76de94b5e (accessed July 1, 2021).

[29] V. Moreau, P. Dos Reis, F. Vuille, Enough metals? Resource constraints to supply a fully renewable energy system, Resources. 8 (2019) 29, https://doi.org/10.3390/resources8010029.

[30] J. Millward-Hopkins, J.K. Steinberger, N.D. Rao, Y. Oswald, Providing decent living with minimum energy: A global scenario, Glob. Environ. Chang. 65 (2020) 102168, https://doi.org/10.1016/j.gloenvcha.2020.102168.

[31] V. Asara, E. Profumi, G. Kallis, Degrowth, democracy and autonomy, Environ. Values. 22 (2) (2013) 217–239, https://doi.org/10.3197/096327113X13581561725239.

[32] C. Cattaneo, G. D'Alisa, G. Kallis, C. Zografos, Degrowth futures and democracy, Futures. 44 (6) (2012) 515–523, https://doi.org/10.1016/j.futures.2012.03.012.

[33] B. Muraca, Towards a fair degrowth-society: Justice and the right to a 'good life' beyond growth, Futures. 44 (6) (2012) 535–545, https://doi.org/10.1016/j.futures.2012.03.014.

[34] S.R. Arnstein, Ladder of citizen participation, J. Am. Inst. Plann. 35 (1969) 216–224.

[35] F. Demaria, F. Schneider, F. Sekulova, J. Martinez-Alier, What is Degrowth? From an activist slogan to a social movement, Environ. Values. 22 (2) (2013) 191–215, https://doi.org/10.3197/096327113X13581561725194.

[36] M.J. Burke, J.C. Stephens, Political power and renewable energy futures: A critical review, Energy Res. Soc. Sci. 35 (2018) 78–93, https://doi.org/10.1016/j.erss.2017.10.018.

[37] G. Pahl, Power from the People: How To Organize, Chelsea Green Publishing, VT, USA, Finance and Launch Local Energy Projects, 2012.

[38] D. Süsser, A. Kannen, 'Renewables? Yes, please!': perceptions and assessment of community transition induced by renewable-energy projects in North Frisia, Sustain. Sci. 12 (4) (2017) 563–578, https://doi.org/10.1007/s11625-017-0433-5.

[39] M. Shuman, Going local: Creating self-reliant communities in a global age, Routledge, New York, (2013). https://doi.org/10.4324/9780203824856.

[40] V. Kostakis, K. Latoufis, M. Liarokapis, M. Bauwens, The convergence of digital commons with local manufacturing from a degrowth perspective: Two illustrative cases, J. Clean. Prod. 197 (2018) 1684–1693, https://doi.org/10.1016/j.jclepro.2016.09.077.

[41] R. Bogadóttir, Blue Growth and its discontents in the Faroe Islands: an island perspective on Blue (De)Growth, sustainability, and environmental justice, Sustain. Sci. 15 (1) (2020) 103–115, https://doi.org/10.1007/s11625-019-00763-z.

[42] M. Proestou, Understanding societies beyond economics: Wind energy development on the Greek island of Amorgos in times of neoliberalism, Lebenswissenschaftlichen Fakultät der Humboldt-Universität zu Berlin, 2015.

[43] R. Alcock, The new rural reconstruction movement: A Chinese degrowth style movement? Ecol. Econ. 161 (2019) 261–269, https://doi.org/10.1016/j.ecolecon.2019.03.024.

[44] K.M. Eisenhardt, M.E. Graebner, Theory building from cases: opportunities and challenges, Acad. Manag. J. 50 (2007) 25–32.

[45] B.K. Sovacool, J. Axsen, S. Sorrell, Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design, Energy Res. Soc. Sci. 45 (2018) 12–42, https://doi.org/10.1016/j.erss.2018.07.007.

[46] R.K. Yin, Case study research : design and methods, Sage Publications, Los Angeles, Calif, Third Edit, 2003.

[47] B.K. Sovacool, What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda, Energy Res. Soc. Sci. 1 (2014) 1–29, https://doi.org/10.1016/j.erss.2014.02.003.

[48] M. Tsagkari J. Roca Jusmet Renewable Energy Projects on Isolated Islands in Europe: A Policy Review Int. J. Energy Econ. Policy. 10 2020 21 30 https://doi.org/10.32479/ijeep.9683.

[49] R. Bernard H., Research Methods in Anthropology - Qualitative and Quantitative Approaches 5th ed., 2011 Rowman Altamira.

[50] S. Stemler An overview of content analysis Pract. Assessment, Res. Eval. 7 2000 https://doi.org/https://doi.org/10.7275/z6fm-2e34.

[51] E. Blair, A reflexive exploration of two qualitative data coding techniques, J. Methods Meas. Soc. Sci. 6 (2015) 14, https://doi.org/10.2458/v6i1.18772.

[52] G. Iglesias, R. Carballo, Wave resource in El Hierro—an island towards energy self-sufficiency, Renew. Energy. 36 (2) (2011) 689–698, https://doi.org/10.1016/j.renene.2010.08.021.

[53] G. Frydrychowicz-Jastrzębska, El Hierro renewable energy hybrid system: A tough compromise, Energies 11 (2018) 2812, https://doi.org/10.3390/en11102812.

[54] F.J. Garcia Latorre, J.J. Quintana, I. de la Nuez, Technical and economic evaluation of the integration of a wind-hydro system in El Hierro island, Renew. Energy. 134 (2019) 186–193, https://doi.org/10.1016/j.renene.2018.11.047.

[55] G. Notton, M.-L. Nivet, D. Zafirakis, F. Motte, C. Voyant, A. Fouilloy, Tilos, the first autonomous renewable green island in Mediterranean: A Horizon 2020 project, in: 2017 15th Int. Conf. Electr. Mach. Drives Power Syst., IEEE, 2017: pp. 102–105. https://doi.org/10.1109/ELMA.2017.7955410.

[56] RAE, National Report 2018. Regulation and performance of the electricity market and the natural gas market in Greece, in 2017. Athens, 2018. http://www.rae.gr/site/file/system/docs/ActionReports/national_2018.

[57] J.-L. Duchaud, G. Notton, A. Fouilloy, C. Voyant, Wind, solar and battery micro-grid optimal sizing in Tilos Island, Energy Procedia. 159 (2019) 22–27, https://doi.org/10.1016/j.egypro.2018.12.012.

[58] Hellenic Republic, Official Government Gazzete of the Hellenic Repubic, 2020. https://www.deddie.gr/media/7077/υπεν-δαπεεκ-74976-2999-φεκ-3154-β-31-7-2020.pdf. (accessed February 18, 2021).

[59] D. Boulogiorgou, P. Ktenidis, TILOS local scale Technology Innovation enabling low carbon energy transition, Renew. Energy. 146 (2020) 397–403, https://doi.org/10.1016/j.renene.2019.06.130.

[60] A. Roth, V. Gerbaud, M. Boix, L. Montastruc, Holistic framework for land settlement development project sustainability assessment: Comparison of El Hierro Island hydro wind project and Sivens dam project, Comput. Chem. Eng. 100 (2017) 153–176, https://doi.org/10.1016/j.compchemeng.2017.02.002.

[61] H. Flocard, Can el Hierro be 100% electric-renewable?, (2016). https://inis.iaea.org/search/search.aspx?orig_q=RN:47061165 (accessed February 18, 2021).

[62] F. Briongos, C.A. Platero, J.A. Sánchez-Fernández, C. Nicolet, Evaluation of the Operating efficiency of a hybrid wind-hydro powerplant, Sustainability 12 (2020) 668, https://doi.org/10.3390/su12020668.

[63] J.K. Kaldellis, D. Zafirakis, Prospects and challenges for clean energy in European Islands. The TILOS paradigm, Renew. Energy. 145 (2020) 2489–2502, https://doi.org/10.1016/j.renene.2019.08.014.

[64] D. Zafirakis, Early Operation Evidence and Lessons Learnt from the first-ever-battery-based hybrid power station in Greece on the island of Tilos, in: 4th Int. Hybrid Power Syst. Work., Crete, 2019. https://hybridpowersystems.org/crete2019/wp-content/uploads/sites/13/2020/03/2A_4_HYB19_073_presentation_Zafirakis_Dimitris.pdf. (accessed February 18, 2021).

[65] P. Wächter, Components of the energy system for a degrowth transformation, in: 4th Int. Degrowth Conf., Leipzig, 2014. https://www.degrowth.info/en/catalogue-entry/components-of-the-energy-system-for-a-degrowth-transformation/. (accessed February 18, 2021).

[66] I. Spilanis, T. Kizos, Atlas of the Islands, University of the Aegean, Mytilin, i, 2015.

[67] Gorona del Viento, Gorona del Viento y Reserva de la Biosfera conjugan sus programas de acción, (2020). http://www.goronadelviento.es/gorona-del-viento-y-reserva-de-la-biosfera-conjugan-sus-programas-de-accion/. (accessed February 22, 2021).

[68] M. Hasanov, C. Zuidema, The transformative power of self-organization: Towards a conceptual framework for understanding local energy initiatives in The Netherlands, Energy Res. Soc. Sci. 37 (2018) 85–93, https://doi.org/10.1016/j.erss.2017.09.038.

[69] F. Mey, M. Diesendorf, I. MacGill, Can local government play a greater role for community renewable energy? A case study from Australia, Energy Res. Soc. Sci. 21 (2016) 33–43, https://doi.org/10.1016/j.erss.2016.06.019.

[70] L. Tricarico, Is community earning enough? Reflections on engagement processes and drivers in two Italian energy communities, Energy Res. Soc. Sci. 72 (2021) 101899, https://doi.org/10.1016/j.erss.2020.101899.

[71] S. Cebotari, J. Benedek, Renewable Energy Project as a Source of Innovation in Rural Communities: Lessons from the Periphery, Sustainability. 9 (2017) 509, https://doi.org/10.3390/su9040509.

[72] H.S. Fathoni, A.B. Setyowati, J. Prest, Is community renewable energy always just? Examining energy injustices and inequalities in rural Indonesia, Energy Res. Soc. Sci. 71 (2021) 101825, https://doi.org/10.1016/j.erss.2020.101825.

[73] K. Szulecki, I. Overland, Energy democracy as a process, an outcome and a goal: A conceptual review, Energy Res. Soc. Sci. 69 (2020) 101768, https://doi.org/10.1016/j.erss.2020.101768.

[74] A. Smith, M. Fressoli, D. Abrol, E. Arond, A. Ely, Grassroots Innovation Movements, Routledge (2016), https://doi.org/10.4324/9781315697888.

[75] R. Raven, F. Kern, B. Verhees, A. Smith, Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases, Environ. Innov. Soc. Transitions. 18 (2016) 164–180, https://doi.org/10.1016/j.eist.2015.02.002.

[76] B. Batidzirai, P.A. Trotter, A. Brophy, S. Stritzke, A. Moyo, P. Twesigye, A. Puranasamriddhi, A. Madhlopa, Towards people-private-public partnerships: An integrated community engagement model for capturing energy access needs, Energy Res. Soc. Sci. 74 (2021) 101975, https://doi.org/10.1016/j.erss.2021.101975.

[77] E. Heaslip, F. Fahy, Developing transdisciplinary approaches to community energy transitions: An island case study, Energy Res. Soc. Sci. 45 (2018) 153–163, https://doi.org/10.1016/j.erss.2018.07.013.