land

MDPI

Review

Rural Energy Communities as Pillar towards Low Carbon Future in Egypt: Beyond COP27

Ahmed Abouaiana

Department of Planning, Design and Technology of Architecture, Sapienza University of Rome, Via Flaminia 72, 00196 Rome, Italy; ahmed.abouaiana@uniroma1.it

Abstract: Egypt pays extraordinary attention to climate action, which is gaining momentum, coinciding with reaching the peak of the status quo by hosting the 2022 United Nations Climate Change Conference, Conference of Parties (COP27). Renewable energy sources are one of the principal axes of the state's plan to combat climate change and open new horizons toward decarbonization. Rural commons act as a food basket and are essential to function in urban areas and enhance ecosystem services, even though currently they are facing extraordinary environmental challenges. Therefore, this study aims to restore the function of the rural commons from consumerism to productivity as an energy basket and create a tendency and momentum toward a self-sufficiency dogma by promoting the rural energy community concept from a top-down approach in Egypt. Two steps can articulate this: First, defining the legal key concept and showing its roots in European policies to provide a direction to this research. Second, by analyzing the current Egyptian legalization, laws, efforts, and best practices, those could address, allow, and encourage the concept's core. The results proved that this is the first research to discuss the concept from the climate–energy–land use perspective, integrated with a previous bottom-up intervention. Meanwhile, it explains the current state of knowledge and a better understanding of the institutional context, showing the high level of coordination of cross sectors and proving that rural energy communities are presented in the bottom-up practices. This can support decisionmakers and paves the way for researchers, academic bodies, and energy experts to explore other insights.

Keywords: climate action; land–energy–climate nexus; multi-function land use; policy evaluation; renewable energy sources; sustainable rural development

Citation: Abouaiana, A. Rural Energy Communities as Pillar towards Low Carbon Future in Egypt: Beyond COP27. *Land* **2022**, *11*, 2237. https://doi.org/10.3390/land11122237

Academic Editors: Kleomenis Kalogeropoulos, Andreas Tsatsaris, Nikolaos Stathopoulos, Demetrios E. Tsesmelis, Nilanchal Patel and Xiao Huang

Received: 11 November 2022
Accepted: 7 December 2022
Published: 8 December 2022

1. Introduction

1.1. Research Background

Mediterranean rural and agricultural areas play a substantial role in attaining sustainable development and food security, particularly in Egypt. The nature of rural commons is characterized by productivity and self-sufficiency. They act as a food basket and are essential to the functioning of urban areas, enhancing ecosystem services and providing aesthetic value and recreational services.

Rural areas have witnessed significant transformation due to consecutive factors since the past mid-century. Producing modern built environment patterns and different anthropological activities leads to shifting them from productivity to consumerism and irreversible adverse environmental impacts, in addition to confronting exclusive environmental challenges as one of the most fragile spots due to climate change (CC) surpassing the global norms and the annual decrease of the farmlands.

The global community has intensified its efforts since the Paris Agreement in 2015 (international treaty on CC) to fulfill the commitment at the national scales to mitigating climate actions in urban and rural contexts, in which energy is a pivotal element in this equation. Among these efforts is the energy communities concept. It has been gaining

global tendency and interest, especially in Europe, since 2018 as one of the successful strategies for enhancing sustainable development goals, as emphasized in References [1,2].

European regulatory frameworks are already recognized and clearly explained to develop many energy community projects as possible in the different European countries (Section 2.2). Recently, the European Commission launched the Rural Energy Community Advisory Hub (REACH) initiative in June 2022 to set up energy communities in European rural areas, officially launching direct technical assistance in September 2022 for developing concrete energy community initiatives across the EU. In light of this, the welfare of rural communities (the heartbeat of the EU) is a priority [3].

In the same vein, two recent bottom-up studies by the author support this direction and boost energy communities and agrivoltaic key concepts in rural contexts, as has been concluded by them in two rural agricultural-based settlements in Egypt and Italy. On top of that, a recent field study concluded that low domestic electricity consumption in rural buildings in Egypt showed the potential to achieve zero energy building targets [4,5] as well as achieving positive energy ones.

Based on the integration of the introduced facts and these outcomes, this study is an attempt to provide a comprehensive foundation bringing attention to restoring the function of the rural commons from consumerism to productivity and acting as energy baskets, in addition to creating a tendency and momentum to self-sufficiently dogma by promoting the rural energy community concept in Egypt. This can be addressed by investigating the following research questions (RQ):

- RQ1: What is the current status of the concept's core in the legal framework from a top-down standpoint?
- RQ2: Is the concept implemented in Egypt, and can it be localized?

It is noteworthy that, in an African context, Ambole et al. [6] provided a similar approach, where they aimed to identify the potential of energy communities in sub-Saharan countries. However, their intervention was different from this study for two reasons. First, the majority of these countries face a lack of energy supplies and energy poverty. Second, they focused on the role of bottom-up practices; namely, they promoted a collaborative design method to deliver a platform to involve multiple stakeholders that enables citizens' incorporation during the life cycle of establishing energy communities, showing how local societies can push innovation and development in the direction of sustainable energy systems.

1.2. Study Hypothesizes

The author argues that the rural energy community and agrivoltaic concepts can enable green transition in Egypt and enhance land and food security for many reasons, summarized as follows:

- The concepts are gaining momentum, which can benefit the local community and decisionmakers alike and preserve natural resources in the light of the land–energy–climate nexus. The development scene in Egypt and climate and energy policies are also witnessing significant improvement (Sections 3.1 and 3.2) post the socio-political fluctuations in the past few years;
- The extraordinary support to regenerate rural built environments within the national presidential project Decent Life "*Haya Karima*." (Section 3.3.1);
- In the national agenda to achieve sustainable development Vision 2030, Egypt supports innovation and scientific research (Goal 4) as essential pillars of development, showing how this research can support decision-making;
- Egypt qualifies to become a regional hub for producing and exporting renewable and low-carbon energy to Europe [7], the Middle East, and North Africa [8]. For instance, the EU–Egypt partnership priorities formally endorsed on 19 June 2022, to work jointly, focusing on renewable energy (RE) and energy efficiency actions based on implementing ambitious climate policies and targets. Meanwhile, its pivotal role is in representing Africa during COP27;

- The rural energy communities concept promotes a self-sufficiency dogma that can mitigate external uncertainties that human society is being exposed to in recent times, which have reached unheard-of levels, such as the coronavirus pandemic and regional wars, which brings to mind the specter of the 1970's energy crisis. Beyond that, it is an issue of existence.

Figure 1 illustrates the rationale behind promoting the rural energy community key concept in the legal framework, from global to local perspectives, as an effective strategy toward green transition and a low-carbon future in Egypt.

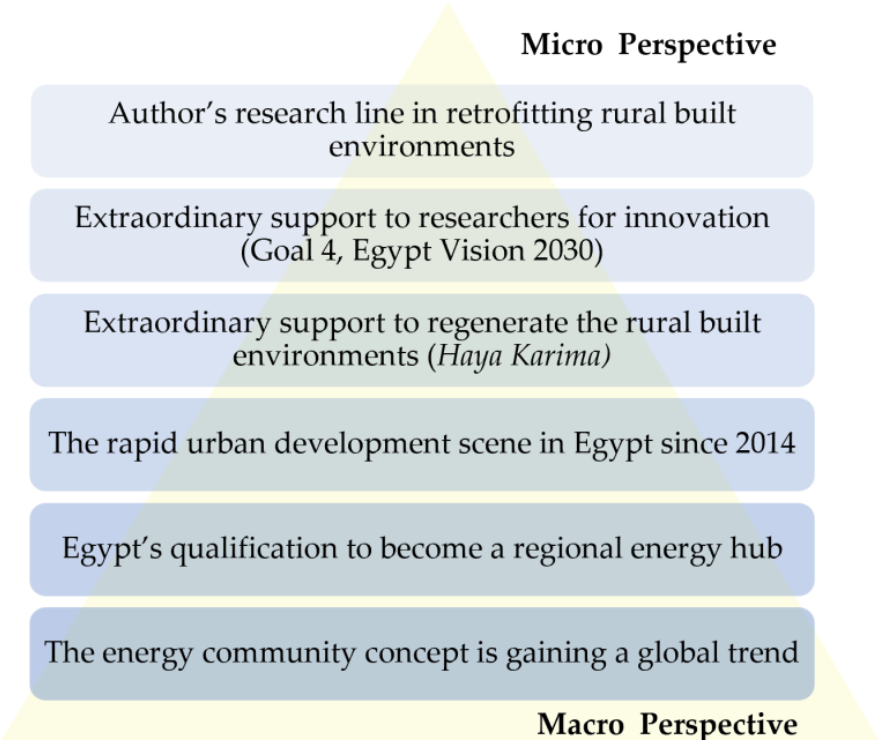


Figure 1. The argument's rational background, from a global to national scale.

2. Materials and Methods

2.1. Reserch Structure and Metodology

To articulate how the aim was accomplished and the research questions addressed, this study blends diverse methods:

2.1.1. Part 1—Theoretical Method

The aim is to provide a general direction to the Egyptian context via:

- Defining the rural energy community's key concept and highlighting the concept's roots, progress, and current legal framework in the European context (Section 2.2).

2.1.2. Part 2—Analytical Method

The aim is to provide a comprehensive foundation on the topic and explain the current situation to support decision-making and pave the way for the scientific community in Egypt towards a better understanding of the concept in order to answer RQ1 via:

- Review of the current Egyptian efforts related to climate actions and renewable energy that could address the core of energy communities; namely: climate actions (Section 3.1) and energy policies (Section 3.2), in addition to highlighting the rural and agricultural policies and related national projects (Section 3.3.1).

2.1.3. Part 3—Field Method

The aim is to investigate bottom-up studies, to define whether the energy community concept (as its present European form) or its core exists or not, and to provide holistic insights showing to what extent the concept is localized on-ground (to answer RQ2), in addition to supporting the promoted top-down approach, via:

- Discuss local relevant best practices on different scales based on the previous literature (Section 3.3.2) and on-site investigations (Section 3.3.3).

Figure 2 summarizes the methodology and research structure.

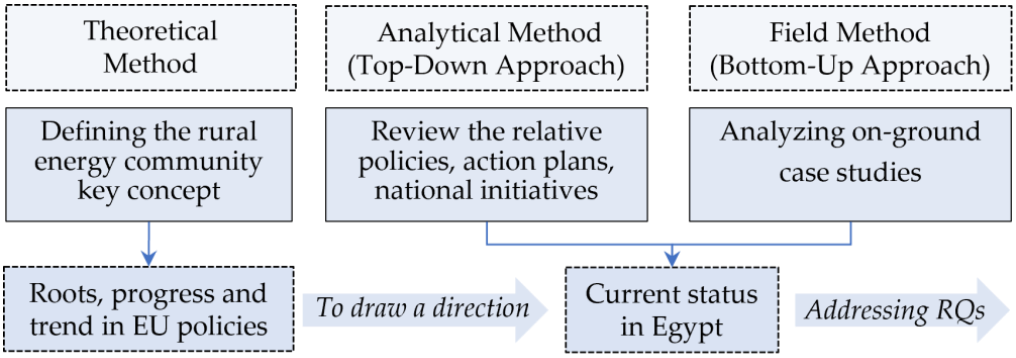


Figure 2. A visual summary of the article's methodology and design.

2.2. Rural Energy Community Key Concept

2.2.1. European Legal Framework: At Glance

Many literature reviews have discussed the concept's roots in the European regulatory framework. For example, references [9,10] have reviewed the direct and indirect regulations that addressed the energy community concept in European policies until full legal recognition. They presented how the concept rooted since the 1990s, since the first energy wave (Directive 96/92/EC), and the white paper "*Energy for the Future: Renewable Sources of Energy*" in 1997, the need for "Community Strategy" mechanisms of coordination of the broad policies engaged in promoting renewable generation process. Both can be considered the first phase of liberalization of the electricity sector.

Then, the second energy package in the 2000s [11] consisted of policies, such as Directives (2001/77/EC) and (Directive 2003/54/EC) to organize the European en-ergy sector in the RE field and to secure a competitive retail market. This was followed by the third energy package in 2009, including Directives (2009/72/EC) and (2009/73/EC) to increase the independence of national regulatory agencies and open fair retail markets. In addition, (Directive 2009/28/EC) allows the concept of local energy structures of a civic character such as energy cooperatives. Finally, the fourth (clean) energy package [12] added new electricity market rules to enable Europe to meet its climate and energy targets and attract investments (leading to energy communities).Self-consumption energy communities have two categories: the renewable energy community (REC) endeavors to expand the role of renewables (energy communities and self-consumers) in line with the revised renewable energy directive (EU) 2018/2001 [13]; and the citizen energy community (CEC), which aims to make energy communities accessible for citizens as active contributors to blend in the electricity system effectively, in line with the directive on shared rules for the internal electricity market (EU) 2019/944 [14].

2.2.2. Definition and Forms

The European Commission defined energy communities as "Citizen-driven energy actions that contribute to the clean energy transition, advancing energy efficiency within local communities." [15]. Cappellaro et al. [16] added the self-consumption of energy as an association of users through voluntary membership of a legal entity who collaborate

to produce, consume, and manage energy through one or more local energy plants for self-consumption and collaboration. Each community has particular characteristics, but they all share the same goal: to self-produce and provide affordable renewable energy to its members. A study by de Simón-Martín et al. [17] defined them as generic terms describing a set of consumers and producers that belong to the same legal entity (e.g., cooperative, consortium, and association).

The concept itself is adaptable, granting a variety of initiatives that have numerous practices and forms [18,19], such as the clean energy community [20] and local energy initiatives [21]. All aim to decentralize energy production.

In the same vein, numerous studies have discussed the implementations of the concept and its forms at the European level. Their practices have been growing gradually since the 2000s as significant actors in the energy transition by improving social acceptance and enabling citizen participation. In general, Europe demonstrates an exceptional benefit in investments of the REC [22]. Nevertheless, the concept still has vast growth potential, particularly in rural areas in northwest Europe [23].

For instance, Heaslip et al. [24] promoted sustainable energy communities, and they stated that a lot of European studies are still needed to introduce the concept in rural areas and islands. They suggested an inclusive consideration of how to transform obstacles into enabling tools to enhance the successful development of energy communities in rural areas. Chamorro et al. [25] defined the rural energy community as delivering low-cost and reliable electricity to supply households and prevalent farming and agriculture business models to fill the gap between rural and urban communities while preserving individual characteristics. Furthermore, the Future of Rural Energy in Europe initiative (FREE) was established in 2010 to promote sustainable energy use within rural communities and aid in the objective of climate neutrality by 2050 [26].

Although Frieden et al. [27] stated that although most European countries had established regulatory frameworks to implement EU legislation, implementing efficient policies to foster energy communities seems challenging [28], they do not have a unified and mature definition. They are still "highly heterogeneous" at many levels, such as business patterns, operational geographical range, members' attributes, and numbers, in addition to the adopted forms of policy and regulation [29].

Tarpani et al. [30] mentioned that European regulation is complex as it depends strictly on the countries and their management of national policies. They classified the European countries based on establishing energy community projects into "early adopters" and "laggard" countries, such as Italy (however, it has launched its national regulatory framework [16]). Whereas in a country such as Poland (the most coal-dependent economy in the EU), Jasiński et al. [31] highlighted the absence of rural energy communities, despite having existed in 2019 in a similar form: energy cooperative as a policy to enable a collaborative approach (no on-ground cooperative established yet).

Otherwise, Abouaiana and Battisti discussed the juxtaposition of the energy communities concept's core with relevant regulatory frameworks, Figure 3. Briefly, for example, the energy community concept juxtaposed with the reformed common agriculture policy (CAP) by four out of ten keys. The EU rural pact makes EU rural areas more resilient, green, connected, and robust. Some initiatives provide support and keep the rural communities' locals involved. It is noteworthy that the covenant of mayor initiative on its official website indicated that it is for cities. However, it includes the action plans for rural settlements, so it has been included. The author is implementing a similar study focusing on the Pontinia rural settlement in Italy that will support the action plan of Pontinia [32].

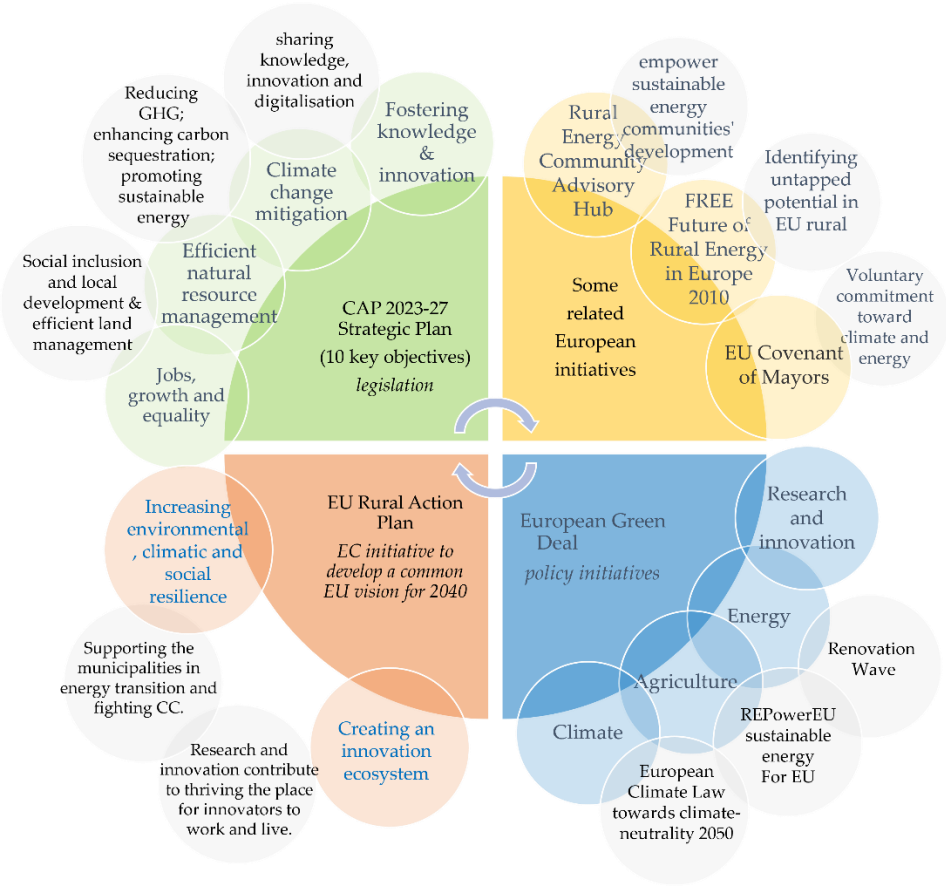


Figure 3. Mapping the core of the energy communities concept in current European policies and initiatives.

3. Results

3.1. Egypt's Global and Local Climate Commitment

Egypt has intensified its efforts since the Paris Agreement, represented by developing its national sustainable development agenda Egypt Vision 2030 in 2016 to fulfill its commitment, for which energy is a pivotal element in this equation. Therefore, climate and energy policies push for carbon neutrality in general, in addition to supporting citizens' quality of life, well-being, local economies, and ecosystems.

Hosting the United Nations Climate Change Conference, Conference of Parties (COP27) of November 2022 in Sharm El-Sheikh represents the status quo's peak milestone in climate action, which will undoubtedly affect Egypt's development scene towards decarbonization in the near future. Hence, climate and energy policies' objectives are backed via explicit targets, policies, restructuring laws, and the development of coordinated cross-sectoral national action plans.

Cross-Sectorial Coordination of Climate Action

In 2015, due to Prime Minster (PM) Decree 1912, Formation of the National Council on Climate Change (NCCC), supported by PM Decree 1129 to draw up the state's general policies in dealing with climate change via linking, for the first time in Egypt, policies, plans, and strategies for climate change with sustainable development at the state's sectorial levels were implemented. The ministries and concerned authorities assigned one of their relevant units to work on CC issues to provide implementation and follow-up plans to compact climate change (Article 11).

In 2016, the national agenda of sustainable development (Egypt Vision 2030) was launched, based on Egypt's commitment to providing and ensuring a good life for inhab-

itants, in line with the sustainable development goals and the Agenda of Africa 2063. It represents the governing structure for all projects and development programs that will be put into operation until 2030.

In 2018, the report "*Egypt's Voluntary National Review*" (VNR) was launched to present the country's progress toward achieving the sustainable development goals. The second VNR was established in 2021 [33]. In 2020, PM Decree 193 identified the tasks and competencies of the Ministry of Planning and Economic Development (MPED), which includes following up and assessing the state's performance to implement the sustainable development agenda.

Meanwhile, in 2021, MPED launched the "*Environmental Sustainability Standards Guide: The Strategic Framework for Green Recovery*" in association with the Ministry of Environment and all relevant governmental entities [34]. The guideline aims to raise awareness of interventions that positively impact the environment, guiding government and private sectors towards investment and showing the strategic objectives and priorities in all sectors. For example, in the energy sector, solar and wind energy production came first among the priority projects and activities in green financing.

In 2022, the NCCC requested to prepare a benchmark, the National Climate Change Strategy (NCCS) 2050, to incorporate CC components across sectors and combat its impacts [35]. In addition, reducing greenhouse gas (GHG) emissions, considering that the contribution of the energy and agriculture sectors is 75% of the total, shows the potential of the rural energy community to decrease emissions.

The benchmark consists of five pillars. Each has a set of objectives and enabling directions (tools and policies). In a nutshell: (i) achieve low-emission development (e.g., promoting micro-scale decentralizing RE systems and increasing the RE share towards energy transition); (ii) resilience to CC (e.g., conserving and increasing the agricultural land, developing infrastructure in rural communities); (iii) supporting climate action governance (e.g., aligning CC units across sectors); iv) green finance units (e.g., promoting green jobs and climate funding opportunity; (v) knowledge management (e.g., boosting the scientific research's role in CC in all fields).

3.2. Energy and Renewable Energy in Egypt

The Egyptian Electricity Holding Company manages the electricity sector on behalf of the Ministry of Electricity and Renewable Energy (Formerly named Ministry of Electricity, changed in 2014). It is regulated by the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EgyptERA), responsible for implementing policy decisions and administering licenses.

The electricity sector has significantly improved since 2014, after a few years of domestic electricity shortage. Generally, electricity production increased by 128% in the past decade. Regarding the Electricity Holding Company's annual reports, the installed capacity was 25,705 MegaWatt (MW) in 2012 and 58,818 MW in 2021. However, the associated GHG emissions require significant steps to increase the RE share to mitigate CC impacts, as emphasized in reference [36] (solar and wind represented 5% of the total in 2021).

Does Regulatory Framework Liberalize the Sector?

Egypt pays remarkable attention to achieving energy efficiency at many levels. The first attempt in 1986, Law 102, was to establish the New and Renewable Energy Development and Use Authority that followed the Ministry of Electricity. In 2012, the national energy efficiency action plan (NEEAP)'s phase one was established to improve energy efficiency (e.g., by saving public lighting, improving electrical appliances, and improving energy plants). It provided a bottom-up approach with limited applications, such as the missing energy-saving component in the agriculture and transportation sectors [37].

For these reasons, in 2016, phase two was released with a holistic approach considering the laws and numerous buildings, such as industrial and educational ones. The main aims are to be an energy efficiency (EE) hub leading the region toward low carbon dioxide

(CO_2) policies, such as enhancement of energy use efficiency into energy, environment, and economic policies to mitigate the carbon footprint [38]. In this domain, the "Integrated and Sustainable Energy Strategy for Egypt 2035" was adopted to achieve energy security and make suitable renewable energy source development conditions engaging all sectors to reach the ambitious share of RE by 42% in 2035 [39]. Figure 4 depicts the NEEAP implementation milestones, reflecting the clear intention to open a competitive energy market that may contribute to fully liberalizing the sector within the next decade and enabling the application of energy communities or more advanced innovative solutions.

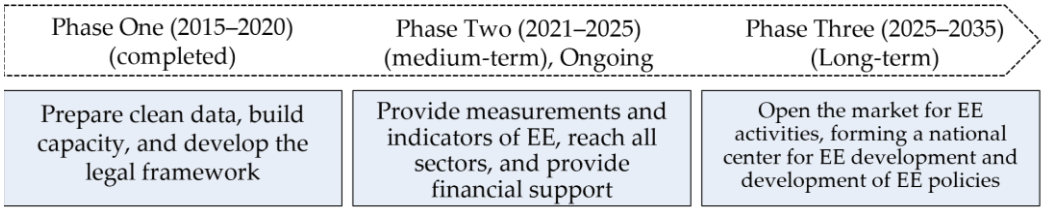


Figure 4. NEEAP's implementation and time frame.

In 2014, Law 203 determined the purchase prices of electrical energy supplied to electricity distribution companies from electricity production plants used for RE sources (sun and wind) to be contracted with the feed-in tariff (FiT) scheme. The electricity prices from solar and wind energy were determined by PM decree 1947. Additionally, Republican Decree 135 allows the RE authority to invest in RE.

In 2015, Law 87 aimed to restructure the electricity sector. It is a crucial step toward liberalizing the electricity production and distribution market. It encourages private investments in the energy sector, where the transition period is from ten years up to twelve. In 2016, the Republican Decree 116 allocated governmental lands for RE projects by the authority. In 2019 PM Decree 183 identified the electricity prices from biomass energy to diversify RE sources.

In 2017, EgyptERA issued Decree 3/2017's amendment of the regulatory rules for encouraging the exchange and use of electric energy produced from solar energy by the net metering system; the client should be the solar plant owner. This was followed by decree 3/2018: Amending Contracts Forms of Net Metering, which enabled making an energy purchasing agreement between a qualified third-party company (operating and managing the plant) and a client who benefits from the purchased energy and making a contract with the electricity distributor. Figure 5 visualizes the mechanism.

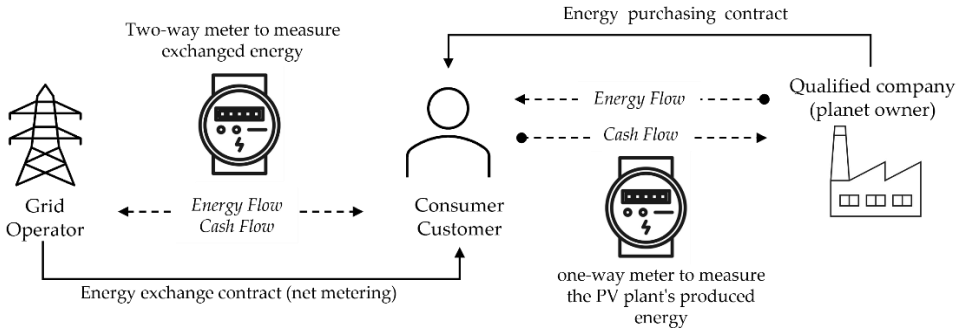


Figure 5. Contractual mechanism of energy purchasing agreement within the net metering scheme.

This was followed by Decree 2/2020, which set regulations on governing the net metering system, and its update Decree 6/2022 [40], which increased the permissible capacity limit for the total solar energy projects to be operated on a net metering system to 1000 MW (it was 400 MW). The entire solar capacity owned by any licensed party or one of the corporate clients should not exceed a total of 35 MW (it was 25 MW) with a

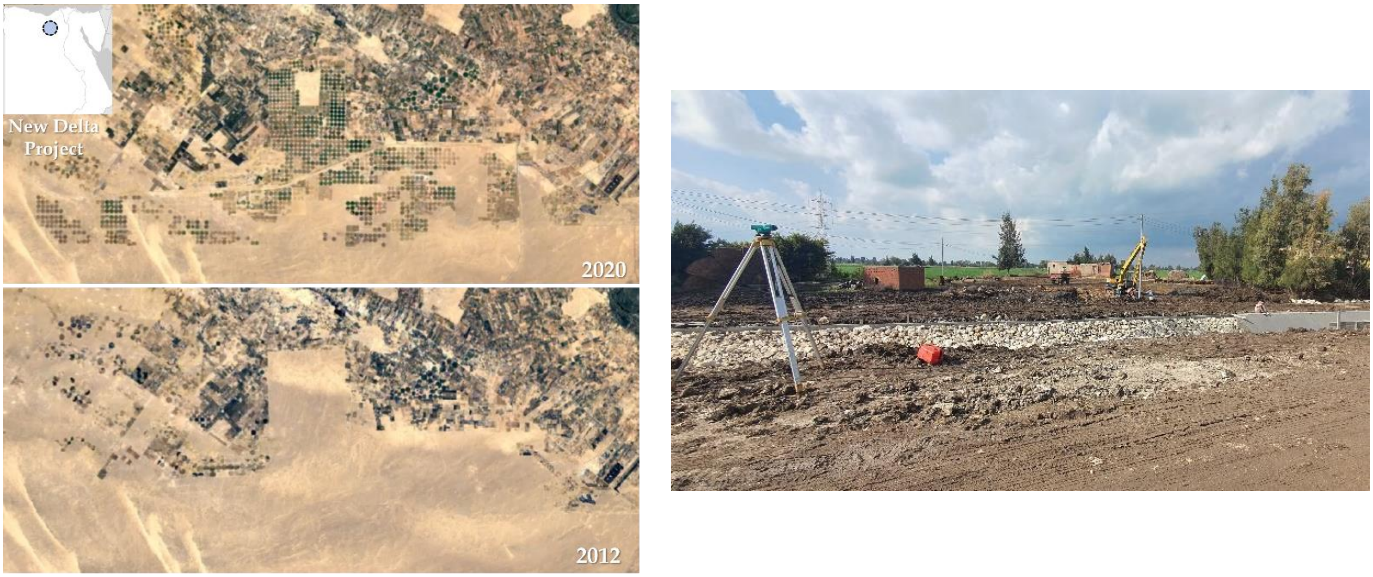
shorter limit of 30 MW (it was 20 MW) for one project [41]. The legalization was amended to contribute to the preparation for hosting COP27. This shows one of its indirect impacts on the regulatory framework and supports this study's argument. Reference [42] shows more about investment mechanisms.

3.3. Rural Development and Rural Energy Communities

3.3.1. Top-Down Implementations

The government reflects all policies, particularly energy and climate, into national urban development, chiefly in rural commons, that host 58% of the total population (104 million inhabitants in October 2022) and host the majority of building stock by 70% (11.4 million buildings) of a total 16.2 million buildings [43].

This occurs within two main prominent streams. First, to regenerate the existing rural built environments. Second, by penetrating the desert (93% of the total area) to double the inhabited areas and agricultural lands (from 7% to 14.5%), such as with the New Delta Project, Figure 6a, which aims to achieve food self-sufficiency. It is noteworthy that the state controlled the phenomena of infringement on agrarian land through intensive penalties (Law 164/2019), which peaked in the aftermath of the January Revolution of 2011.



(**a**) (**b**)

Figure 6. (**a**) An example of increasing the reclaimed land areas: New Delta national Project between 2012 and 2020 (Google Earth Engine, 2022) Available online: https://earthengine.google.com/timelapse#v=30.14018,30.36834,9.591,latLng&t=3.63&ps=100&bt=19840101&et=20201231&startDwell=0&endDwell=0 (accessed on 15 October 2022). (**b**) Progress on a project's canal lining, implemented to improve road quality and enhance water efficiency and climate adaptation (taken by Ahmed Abouaiana).

On the other side, the government aims increase the amount of reclaimed agricultural land by showing the potential of considering them as energy baskets and employing energy communities since the early planning. Table 1 summarizes the state trend in supporting agriculture and food security.

Table 1. Amount of annual infringement on agricultural land and reclaimed ones, by roughly one thousand acres—"feddan" [44].

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Agricultural land Infringements	15.6	14.8	12.9	9	8.1	8.7	4.2	2.5	2.9
Reclaimed lands	39	22.9	22.6	14.5	38.5	38.9	59.2	115.7	81

The presidential initiative Decent Life "*Haya Karima*" is the central pillar to achieving sustainable rural development in Egypt. The main objectives are to improve the quality of life and regenerate the existing built environments through intensive and instant interventions. For instance, renovating public buildings and dwellings, offering job opportunities, agriculture development, and developing infrastructure, Figure 6b. It is split into three phases, according to the poverty rate: greater than 70% (2019–2021, completed), 50–70% (from 2021 until three years after, currently running), and less than 50% (the completion date 2030) [45,46]. Reference [47] visualizes examples of these interventions.

3.3.2. Bottom-Up Practices: Literature Review

Many practices have been implemented in rural settlements in Egypt to achieve sustainability in general and meet energy demands from RE at different scales, such as mono-buildings, multi-buildings, and farms. Scholars have discussed these issues for more than three decades [48]. For instance, Ahmad [49] provided a technoeconomic assessment of rural dwellings; their life cycle costs are competitive with other conventional energy sources.

Abdelsalam et al. [50] implemented decentralized photovoltaic (PV) solar cells on the rooftops of five buildings in two villages, with a total capacity of 11 kW. Shouman [51] provided a stand-alone solar system (off-grid) for a dwelling, with a daily consumption of 4.555 kWh, in remote areas as an optimum solution for villages with no access to centralized electricity power. She stated that solar energy systems are sustainable technological solutions for rural electrification and are cost-effective compared to expensive grid extensions in remote areas.

Nemr et al. [52] have provided technoeconomic optimization for alternatives of stand-alone RE systems applied in rural areas to cover the energy load of domestic, agricultural, greenhouse system, and fish farm loads (a total of 365 kWh/day). They recommended a hybrid system according to the cost and fulfillment of the required loss of power supply probability term.

Mohamed [53] mentioned that solar energy is efficient in remote areas, and the return on investment is much better-recommended than conventional power supplies. He stressed the importance of providing economic incentives and equipment and encouraging agricultural investors to rely on solar energy solutions by providing the system's components and financial support.

Ibrahim et al. [54] recently provided technoeconomic optimization of proposed decentralizing solar energy in an industrial building, school, and farm in remote rural areas (a total of 10.8 kWh/day). They focused on developing storage systems (batteries) that significantly increased the efficiency of the PV system in all case studies and decreased the cost in both buildings by an average of 65%.

At a large scale, Heliopolis University [55] discussed the impact of their projects; beyond harvesting the RE and meeting their demands from RE, they showed how their sustainable agricultural practices, mainly using bioenergy, reduced 11,930 tCO2e of Egypt's share. In this light, they proposed developing "a national framework for emissions reduction and carbon credits from the agricultural sector." They discussed that the promising future of the "Agricultural Carbon Credit" could follow two paths: certified emission reductions via registering for the development mechanism or voluntary emission reductions. The author emphasizes the last pattern that exists in Egypt but still needs more visibility.

Fortunately, on 6 November 2022, the Egyptian Exchange established the Carbon Certificates Trading Company, in partnership with the Agricultural Bank, as the first platform to enable the carbon certificate trading mechanism [56]. It came true after a few months of discussion [57], reflecting a dramatic change at the national level.

3.3.3. Bottom-Up Practices: Field Study

Recently, the author has implemented a field trip to a nearly zero-energy private farm in Ismailia Governorate, Suez Canal Region in eastern Egypt, located at longitude 30.498597 and latitude 32.076638, with a total area of 15 feddan. The owners aimed to provide a

prototype of a self-sufficient agriculture community. The project offers typical farming activities: livestock, fisheries, and farming. Consequently, it has the necessary equipment (e.g., pumps, refrigerators, heaters, and washers) and a few buildings (accommodation, stores, industry, and a lecture hall).

Different RE sources were established to meet the annual electricity demand (100,680 kWh), namely solar energy (on-grid and off-grid), wind turbines (horizontal and vertical), and hybrid systems, Figure 7a. This system is more efficient than the mono one (supporting the results of Reference [58]). This mix produces 96,372 kWh annually, which covers 96% of the total, considering that pumps and the associated equipment consume the majority (58%), followed by ventilation (19%), other equipment (17%), and lighting (6%)—showing the importance of energy-efficient irrigation and pumps in similar realms.

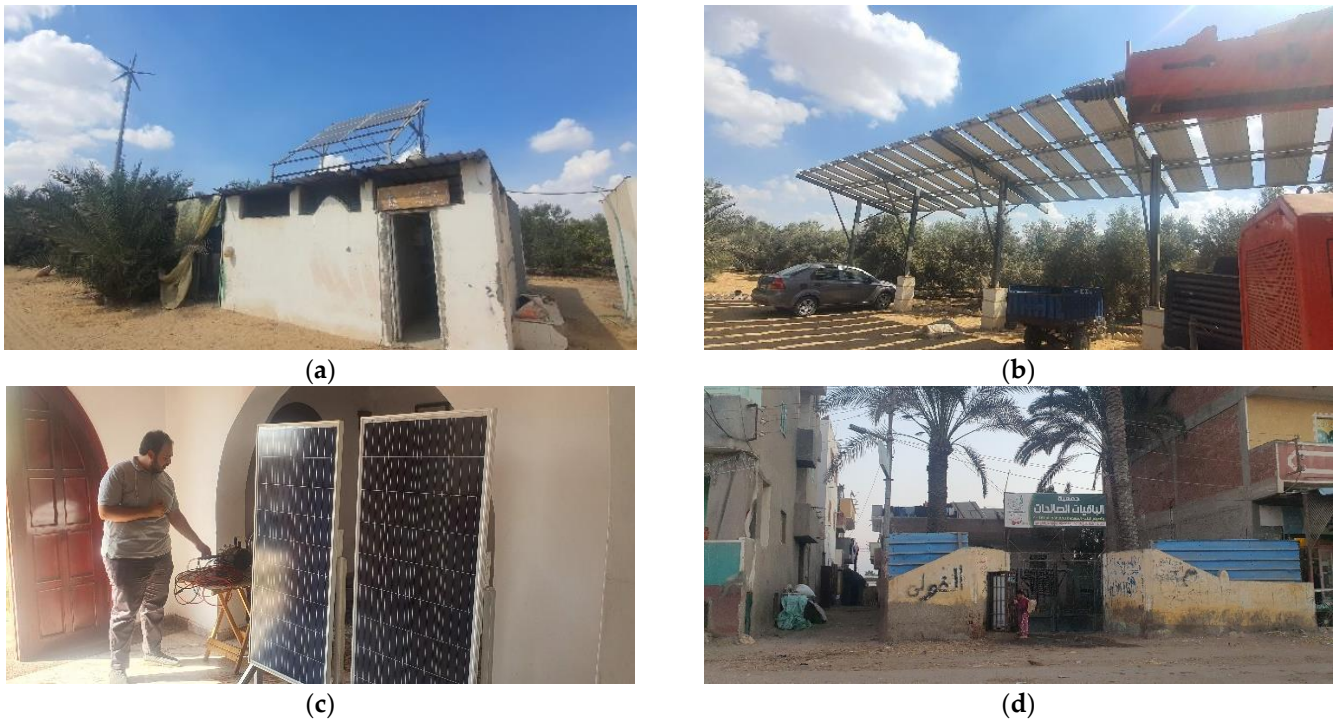


Figure 7. Different implementations promote the REC concept in rural Egypt. (**a**) A hybrid off-grid system. (**b**) Multi-function land use: parking shading and producing electricity to balance consumption in the adjacent activity (solar pump). (**c**) The manager describes a micro-scale practice to generate green hydrogen. (**d**) The first self-consumption social building in the village and surrounding ones. (Images taken by Ahmed Abouaiana.)

In contrast, biogas units were implemented to meet the annual gas demand of 14,364 m^3 (21% for kitchens and 79% for animal wards and barns) and manage waste (25.8 tons). The units produce gas with a surplus of 15% and produce 1.3 tons of compost yearly.

It is noteworthy that the author discussed multi-function land use (Figure 7b) with the manager, specifically, the agrivoltaic concept. The manager was willing to apply the idea to a small agricultural area that requires shading (it already exists and uses a conventional shading device). Moreover, the farm developed a micro-scale implementation to produce green hydrogen, and the system is under development, Figure 7c.

On a different scale, the author implemented a self-consumption building (service building) of a non-governmental organization (NGO) that consumes 100% of generated RE (3 kW plant capacity) in January 2022 [5]. The author declares the project is not feasible economically, in terms of the long payback period, because of the high cost of the batteries and annual maintenance fees. However, this project was implemented as a pilot project, with a clear intention to create momentum for the core of the renewable energy communities concept.

Considering that the author discussed (the NGO founder) a possible volunteer collaboration to develop the vast area in front of a building (Figure 7d) through temporary outdoor activities for kids with a client, the fence of the building will have lighting, which will be operated from the installed PV, to light both the building and the surrounding area, showing another prospective positive impact of this intervention. It is noteworthy that the author was invited to an interview on national TV to discuss this intervention a few days after implementing it [59], indicating the special attention of decisionmakers to scientific research and bottom-up practices as well, which also supports the argument of this manuscript.

Figure 8 shows an imaginative example of an actual case study in Lasiafr Albalad village in northern Egypt, showing prospective investment in PV cells by families within the existing legal framework. Each family within the same building internally arranges their consumption and monthly electricity prices. This ambitious proposal may succeed, especially in extended family buildings (e.g., father and sons), with the argument that they can maintain a cooperative level. The author aims to implement this rudimental idea within his research line to provide a positive social impact on his original community.

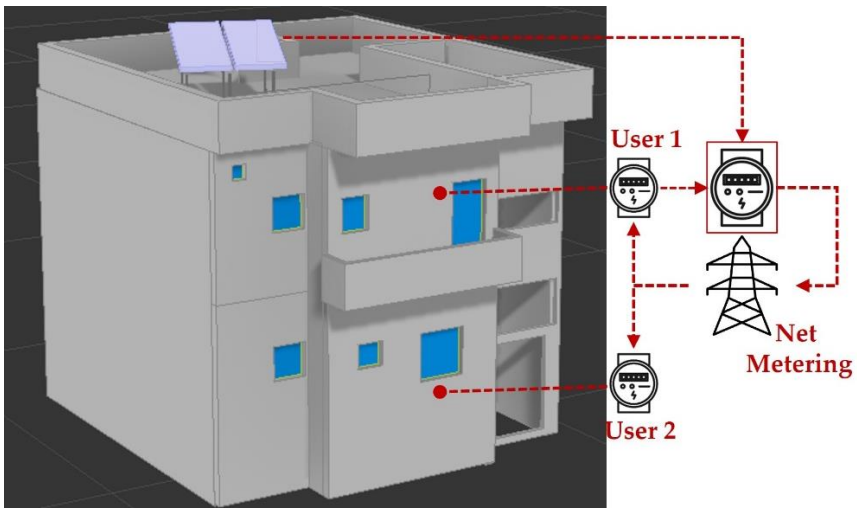


Figure 8. An imaginative vision of a collective PV production (net metering scheme). The model was generated by the author using 3ds Max.

4. Discussion

In Europe, the progress of liberalizing the electricity sector and renewable energy communities was initiated over two decades until it settled into the legal framework (Directives (EU) 2018/2001 and (EU) 2019/94). Energy Communities are the heart of innovation in the energy sector. Despite the associated vagueness at the national EU level, according to Rossetto, the concept's core covers broad domains in European policies (Figure 3). The obvious takeaway from the European experience is the focus on citizen engagement as an active contributor through the value creation of RE.

This study contributes to the local context by generating momentum to support decision-making in Egypt—which is witnessing intensive and rapid development (new projects and retrofitting the existing ones) in addition to hosting COP27, which will indeed affect the scene and increase opportunities for the paper's argument, as well as having already positively impacted RE laws (EgyptERA decree 6/2022)—via promoting the rural energy community as a pillar to support land, agriculture, and rural development and accelerating the transition towards low GHG emissions from the agriculture and energy sectors. Both represent 75–80% of the total (352 MtCO2e in 2019), which increased by 19% compared to 2009 [60]. Thus, the concept is optimal for revitalizing the productive nature of rural commons, as recommended by Abouaiana and Battisti, besides the introduced

rational argument in Figure 1. Moreover, rural commons can be a safe haven for the country under global uncertainties and their associated threats.

4.1. Key Concept Juxtaposition in Legal Framework (RQ1 Answer)

The overview of climate–energy–land policies proved that they are intermingled at a sectorial level, and that the government has started a high level of coordination in recent years among the sectors from the top of the planning pyramid, beginning by arranging institutional frameworks since launching Egypt Vision 2030, where MPED plays the pivotal role in achieving that, in addition to establishing the dedicated entity NCCC. On the other side, it proposes the inclusion of, for the first time, carbon policies with energy action plans, creating climate benchmark NCCS policies, and developing key performance indicators to measure the progress towards the sustainable development goals. Despite this, seeing the effects of these policies on the bottom levels still requires time.

Electricity policies have improved since the introduction of Law 87/2015, which, with NAEEP, aids in liberalizing the sector. However, Kamal [61] stated that the transition to a genuinely competitive market in Egypt still requires more time. Thusly, she highlighted that blockchain applications in sector management could speed up the transition, such as electric energy exchanges through smart electronic contracts to allow customers to choose between many energy suppliers who provide electricity at competitive prices.

In the same context, there is a meaningful improvement in electricity production. However, RE transition in Egypt is sluggish, being below the target of the RE share in electricity generation (20% in 2020), possibly because of the massive expansion of other conventional power plants [62]. Salah et al. [63], in their holistic investigation of RE transition in Egypt, emphasized that the current regulations slow down the development of the RE sector, such as the "non-harmonized regulations between the government sectors." Notwithstanding, the author may differ from them, as this study showed the coordination level. The author believes there is "no roadmap without a narrative" [64], and this study tries to contribute to this belief.

Consequently, localizing RE industries can inevitably reduce the high cost or lack of competencies radically, and it is the role of the state to provide sufficient enabled policies. Meanwhile, the economic incentive is insufficient, needs clear strategies, and should be more visible and competitive to the local community and individuals.

The state pays considerable attention to rural agriculture development, which is almost centralized and intensive, represented in reclaiming new lands (Table 1), and implementing new projects. For instance, the New Delta Project represents nearly 0.9% of Egypt's area (2.2 million feddan). Likewise, in regenerating existing environments, the philosophy is clear enough in defining the intensive interventions and rapid correction actions that burden the state, in light of the well-known global economic challenges, and Egypt primarily. Each may affect the optimal implementations of these trends (settled in regulations) at the micro-levels. Therefore, when developing the deteriorated contexts, the priorities would be to rapidly achieve the essential aspects of human needs, even if in a conventional way.

For instance, decent houses instead of deteriorated ones, clean water, infrastructure, enhanced internet, and public buildings to decentralize governmental services will surely enable employing RE gradually in further steps. As supported by the Food and Agriculture Organization, the gradual increase in the use of RE and considering the natural resources nexus can make agriculture and rural development more energy-smart and energy-efficient [65,66]; this is on one side. On the other, developing energy infrastructure and networks accelerate liberalizing the market, as emphasized in Reference [67].

Despite this, it cannot be dispensed that reversing adaptation and mitigation efforts [68] and renewable energy and low-emissions policies, proportionately with this rapid development's pace, is inevitable, and it should be carefully planned to be considered on the grounds of maximizing the development impacts [69]. Concomitantly, providing national sustainability guidelines for agriculture-based urban communities is absolutely

essential, as about 90% of Egypt's area is desert that can still be innovatively and sustainably developed.

Indirectly, the core of REC is included in the policies, like in the European case (Figure 3). In contrast, the core of CEC and effective citizen engagement in development, in general, are absent in the scene. For example, *Haya Karima* follows a participatory approach among the stakeholders: institutional entities, civil society, and the private sector are contributors to the implementation and monitoring of their activities. At the same time, the local communities and citizens participate in determining the requirement. However, it could be a user-centered development [70]. The author believes it is essential but is limited. In the meantime, it seems that it is too early to target the citizen until the model gets settled into regulatory framework.

The author would say that citizens should be more engaged as active contributors, which is one of the vital difference points with the EU policies [71]. Because they can provide collaborative and innovative solutions, both are inevitable in sustainable rural agricultural development in Egypt [72], especially in energy issues, as promoted in Ibrahim et al.'s study and as emphasized in Ambole et al.'s experiment.

The agricultural cooperatives should be enabled to invest in RE with clear support from the government. They can contribute as a first step toward rural energy communities, such as in France [73], Germany [74], Portugal [75], and Spain [76], or in less developed European countries such as Poland's case. Logistic and economic support from the state in rural energy transition is essential in developed countries such as the United Kingdom [77], a fortiori in Egypt.

4.2. Concept Localization On-Ground (RQ2 Answer)

From a bottom-up perspective, the REC's core exists on-ground, represented by micro-scale projects. The vast decentralized interventions are mainly for rural, remote areas and agricultural supplies, mostly off-grid solutions [78]. This remains an efficient solution despite the high cost of batteries and storage systems. The author implemented a zero-energy building in a village in Egypt (Figure 7d), utilizing a transdisciplinary participatory approach [79]; the locals determined the target building, supported establishing the project, and appreciated it. Notwithstanding, a similar process was implemented in rural Italy [80]. Both reflect that the local community can contribute if they have the chance. Accordingly, combining top-down with bottom-up approaches is inescapable.

On the other side, the role of the private sector and PV suppliers is to pay more attention to these business opportunities, as well as to carbon certificates that are circulating these days. Meanwhile, negotiations with them (from the researchers or the local authorities) shall support these projects (at an individual scale). In other words, prospecting for private sector entities with a corporate social responsibility policy would provide financial and technical support. Vice versa, this can provide them with benefits, such as job opportunities, revenue, and a good reputation in the local market. Interested stakeholders in energy, climate, and sustainable rural and agriculture development domains should seize the anticipated advantage post-COP27 to support decision-making and enhance our built environment.

5. Conclusions and Implications

In a nutshell, the rural energy community is a new actor that can decarbonize the entire energy sector [81], accelerate reaching Vision 2030 goals, support quality of life, and mitigate poverty in Egypt, as found by Belaïd [82]. This is the first study discussing the concept of rural energy communities in Egypt in their legal EU form. It presented a macro-level discussion of this new actor by providing insights to explain the current state of knowledge and a better understanding of the institutional context. In addition, it highlighted the potential of developing the concept, which is a fact in Egypt, as proven by the presented micro-scale practices, such as the self-sufficient community (Ismailia farm) (Section 3.3.3). Furthermore, multi-functional land use can support this and maximize the

government's ongoing targets to double the inhabited areas and expand agricultural land, which has already started in recent years.

Eventually, this study—distinctly—confirms it is not an attempt at Europeanization of the local context, but it attempts to highlight the cutting-edge, transferring technologies from developed countries [83] and maximizing the researchers' role as knowledge brokers and acting as mediators between the local society and authorities, which can support the decision-making and raising of locals' awareness, which is crucial to preparing for social acceptance of energy transition [84,85], especially in agricultural and rural communities [86,87].

The knowledge highlighted in this study can be a good foundation point for future work. Although the discussion of the top-down approach and limited case studies may not generalize the results on a wide scale in this initial study, they were comprehensive in nature. The results may also provide a direction in which to generalize the approach to urban contexts. Until the energy sector reaches complete liberalization, this study recommends that other investigations be conducted in the aftermath of COP27 to assess its influences and provide additional insights that can support the agricultural security and energy transition leading to a low-carbon future in Egypt.

Funding: This research received no external funding.

Informed Consent Statement: Informed consent was obtained by the author from all subjects involved in the study.

Data Availability Statement: Not applicable.

Acknowledgments: The author acknowledges the support from Engineer Waseem El Hefnawy, Triple M Farm ("REEF") https://www.facebook.com/REEFFarm (accessed on 10 November 2022), in providing technical support related to consumption and RE production patterns in the farm data presented.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Candelise, C.; Ruggieri, G. Status and evolution of the community energy sector in Italy. *Energies* **2020**, *13*, 1888. [CrossRef]
2. Ceglia, F.; Marrasso, E.; Pallotta, G.; Roselli, C.; Sasso, M. The State of the Art of Smart Energy Communities: A Systematic Review of Strengths and Limits. *Energies* **2022**, *15*, 3462. [CrossRef]
3. European Commission. A Long-Term Vision for the EU's Rural Areas Building the Future of Rural Areas Together. Available online: https://ec.europa.eu/info/strategy/priorities-2019-2024/new-push-european-democracy/long-term-vision-rural-areas_en (accessed on 10 November 2022).
4. Abouaiana, A.; Battisti, A. Multifunction Land Use to Promote Energy Communities in Mediterranean Region: Cases of Egypt and Italy. *Land* **2022**, *11*, 673. [CrossRef]
5. Abouaiana, A. Agile Methodology as a Transdisciplinary Retrofitting Approach for Built Environment in Traditional Settlements in Mediterranean Region. Ph.D. Thesis, Sapienza University of Rome, Rome, Italy, 2022.
6. Ambole, A.; Koranteng, K.; Njoroge, P.; Luhangala, D.L. A review of energy communities in sub-saharan Africa as a transition pathway to energy democracy. *Sustainability* **2021**, *13*, 2128. [CrossRef]
7. European Commission. EU-Egypt Joint Statement on Climate, Energy and Green Transition—STATEMENT/22/3703. 2022. Available online: https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_3703 (accessed on 10 November 2022).
8. Esily, R.R.; Chi, Y.; Ibrahiem, D.M.; Amer, M.A. The potential role of Egypt as a natural gas supplier: A review. *Energy Rep.* **2022**, *8*, 6826–6836. [CrossRef]
9. Sokolowski, M.M. European Law on the Energy Communities: A Long Way to a Direct Legal Framework. *Eur. Energy Environ. Law Rev.* **2018**, *27*, 60–70. [CrossRef]
10. Biresselioglu, M.E.; Limoncuoglu, S.A.; Demir, M.H.; Reichl, J.; Burgstaller, K.; Sciullo, A.; Ferrero, E. Legal provisions and market conditions for energy communities in Austria, Germany, Greece, Italy, Spain, and Turkey: A comparative assessment. *Sustainability* **2021**, *13*, 11212. [CrossRef]
11. Ciucci, M. *Fact Sheets on the European Union—INTERNAL ENERGY MARKET*; European Parliament: Strasbourg, France, 2021.
12. European Commission. Clean Energy for All Europeans Package. Available online: https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en (accessed on 10 November 2022).
13. European Commission. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Text with EEA relevance). *Off. J. Eur. Union* **2018**, *61*, 82–209.

14. European Commission. DIRECTIVE (EU) 2019/944 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast) (Text with EEA relevance). *Off. J. Eur. Union* **2019**, *62*, 125–199.
15. European Commission. European Commission—Energy—Topics—Markets and consumers—Energy communitie. Available online: https://energy.ec.europa.eu/topics/markets-and-consumers/energy-communities_en (accessed on 23 February 2022).
16. Cappellaro, F.; Palumbo, C.; Trincheri, S. *La Comunità Energetica—Vademecum 2021 [The Energy Community-Vademecum 2021]*; ENEA: Roma, Italy, 2021.
17. de Simón-Martín, M.; Bracco, S.; Piazza, G.; Pagnini, L.C.; González-Martínez, A.; Delfino, F. The Role of Energy Communities in the Energy Framework. In *Levelized Cost of Energy in Sustainable Energy Communities*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 7–29. ISBN 978-3-030-95932-6.
18. van Bommel, N.; Höffken, J.I. Energy justice within, between and beyond European community energy initiatives: A review. *Energy Res. Soc. Sci.* **2021**, *79*, 102157. [CrossRef]
19. European Commission. Organisational Form and Legal Structure. Available online: https://rural-energy-community-hub.ec.europa.eu/energy-communities/organisational-form-and-legal-structure_en (accessed on 10 November 2022).
20. Gui, E.M.; MacGill, I. Typology of future clean energy communities: An exploratory structure, opportunities, and challenges. *Energy Res. Soc. Sci.* **2018**, *35*, 94–107. [CrossRef]
21. Ghorbani, A.; Nascimento, L.; Filatova, T. Growing community energy initiatives from the bottom up: Simulating the role of behavioural attitudes and leadership in the Netherlands. *Energy Res. Soc. Sci.* **2020**, *70*, 101782. [CrossRef]
22. Echave, C.; Ceh, D.; Boulanger, A.; Shaw-Taberlet, J. An ecosystemic approach for energy transition in the mediterranean region. In Proceedings of the 2019 1st International Conference on Energy Transition in the Mediterranean Area (SyNERGY MED), IEEE, Cagliari, Italy, 28–30 May 2019; pp. 1–5.
23. ENRD. *Smart Villages and Renewable Energy Communities*; The European Network for Rural Development: Bruxelles, Belgium, 2020.
24. Heaslip, E.; Costello, G.J.; Lohan, J. Assessing good-practice frameworks for the development of sustainable energy communities in Europe: Lessons from Denmark and Ireland. *J. Sustain. Dev. Energy Water Environ. Syst.* **2016**, *4*, 307–319. [CrossRef]
25. Chamorro, H.R.; Yanine, F.F.; Peric, V.; Diaz-Casas, M.; Bressan, M.; Guerrero, J.M.; Sood, V.K.; Gonzalez-Longatt, F. Smart Renewable Energy Communities-Existing and Future Prospects. In Proceedings of the 2021 IEEE 22nd Workshop on Control and Modelling of Power Electronics (COMPEL), IEEE, Cartagena, Colombia, 2–5 November 2021; pp. 1–6.
26. Rural-Energy About FREE. Available online: https://www.rural-energy.eu/about-free/ (accessed on 9 October 2022).
27. Frieden, D.; Tuerk, A.; Roberts, J.; D'Herbemont, S.; Gubina, A.F.; Komel, B. Overview of emerging regulatory frameworks on collective self-consumption and energy communities in Europe. In Proceedings of the 2019 16th International Conference on the European Energy Market (EEM), IEEE, Ljubljana, Slovenia, 18–20 September 2019; pp. 1–6.
28. Martens, K. Investigating subnational success conditions to foster renewable energy community co-operatives. *Energy Policy* **2022**, *162*, 112796. [CrossRef]
29. Rossetto, N.; Verde, S.F.; Bauwens, T. A taxonomy of energy communities in liberalized energy systems. In *Energy Communities Customer-Centered, Market Driven, Welfare-Enhancing?* Löbbe, S., Sioshansi, F., Robinson, D., Eds.; Elsevier: Cham, Switzerland, 2022; pp. 3–23. ISBN 978-0-323-91135-1.
30. Tarpani, E.; Piselli, C.; Fabiani, C.; Pigliautile, I.; Kingma, E.J.; Pioppi, B.; Pisello, A.L. Energy Communities Implementation in the European Union: Case Studies from Pioneer and Laggard Countries. *Sustainability* **2022**, *14*, 12528. [CrossRef]
31. Jasiński, J.; Kozakiewicz, M.; Sołtysik, M. Determinants of Energy Cooperatives' Development in Rural Areas—Evidence from Poland. *Energies* **2021**, *14*, 319. [CrossRef]
32. Associazione, G.A.P.; Brighenti, J.; Cerroni, A.; Corradini, F.; Della Rocca, M.; De Prosperis, F.; Di Girolamo, M.; Di Pastena, S.; Franco, A.; Libralato, G.; et al. *PONTINIA2020 Il Piano d'Azione per l'Energia Sostenibile [PONTINIA 2020 The Sustainable Energy Action Plan]*; Patto dei Sindaci: Pontinia, Italy, 2015.
33. MPED. *Egypt's 2021 Voluntary National Review*; The Ministry of Planning and Economic Development, Egypt: Cairo, Egypt, 2021.
34. MPED. *Environemntal Sustainability Standards Guide: "The Strategic Framework for Green Recovery"*, 1st ed.; Ministry of Planning and Economic Development, Egypt: Cairo, Egypt, 2021. (In Arabic)
35. EEAA. *Egypt National Climate Change Strategy (NCCS) 2050*; Ministry of Environment, Egypt: Cairo, Egypt, 2022.
36. Mondal, M.A.H.; Ringler, C.; Al-Riffai, P.; Eldidi, H.; Breisinger, C.; Wiebelt, M. Long-term optimization of Egypt's power sector: Policy implications. *Energy* **2019**, *166*, 1063–1073. [CrossRef]
37. Elrefaei, H.; Khalifa, M.A. A Critical Review on the National Energy Efficiency Action Plan of Egypt. *JNRD-J. Nat. Resour. Dev.* **2014**, *4*, 18–24.
38. MOEE. National Plan to Improve Electricity Energy Efficiency (2018–2020). 2018. Available online: http://www.moee.gov.eg/test_new/DOC/p.pdf (accessed on 10 November 2022). (In Arabic)
39. IRENA. *Renewable Energy Outlook: Egypt*; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2018; ISBN 978-92-9260-069-3.
40. EgyptERA. Regarding the Amendments to Net Metering Controls as an Incentive to Support and Encourage Solar Energy Projects in a Way that Contributes to the Preparation for Hosting the Conference of Parties (COP27) in Sharm El-Sheikh. 2022. Available online: http://egyptera.org/ar/download/journal/2022/6_2022.pdf (accessed on 10 November 2022). (In Arabic)

41. EgyptERA. Periodical Books of Net Metering System. Available online: http://egyptera.org/ar/RegulatedRules.aspx# (accessed on 10 November 2022). (In Arabic)
42. NREA. *New and Renewable Energy Authority Annual Report 2021*; New and Renewable Energy Authority, Ministry of Eletricity and Renewable Energy: Cairo, Egypt, 2021. (In Arabic)
43. CAPMAS. *Egypt Population, Housing, and Establishments Census 2017*; Central Agency for Public Mobilization and Statistics: Cairo, Egypt, 2017. (In Arabic)
44. CAPMAS. *Annual Bulletin of Lands Reclamation 2019/2020*; Central Agency for Public Mobilization and Statistics: Cairo, Egypt, 2020. (In Arabic)
45. UN. Decent Life (Hayah Karima: Sustainable Rural Communities (Government) #SDGAction43597. Available online: https://sdgs.un.org/partnerships/decent-life-hayah-karima-sustainable-rural-communities (accessed on 10 November 2022).
46. Haya Karima Haya Karima. Available online: https://www.hayakarima.com/index_en.html (accessed on 10 November 2022).
47. DMC. The Documentary Film "A decent Life ... for All Egyptians" ... The Journey of the Largest National Project in the Governorates of Egypt. 2021. Available online: https://www.youtube.com/watch?v=E5GQW8ivGS8 (accessed on 10 November 2022). (In Arabic)
48. Arafa, S. Renewable energy solutions for development of rural villages and desert communities. In Proceedings of the 2011 International Conference on Clean Electrical Power (ICCEP), IEEE, Ischia, Italy, 14–16 June 2011; pp. 451–454.
49. Ahmad, G.E. Photovoltaic-powered rural zone family house in Egypt. *Renew. Energy* **2002**, *26*, 379–390. [CrossRef]
50. Abdelsalam, T.I.; Darwish, Z.; Hatem, T.M. Solar Energy for Rural Egypt. In Proceedings of the International Congress on Energy Efficiency and Energy Related Materials (ENEFM2013) Proceedings, Antalya, Turkey, 9–12 October 2013; Oral, A.Y., Bahsi, Z.B., Oze, M., Eds.; Springer: Cham, Switzerland, 2014; pp. 363–370, ISBN 978-3-319-05521-3.
51. Shouman, E.R. International and national renewable energy for electricity with optimal cost effective for electricity in Egypt. *Renew. Sustain. Energy Rev.* **2017**, *77*, 916–923. [CrossRef]
52. El-Nemr, M.K.; Elgebaly, A.; Ghazala, A.I. Optimal Sizing of Standalone PV-Wind Hybrid Energy System in Rural Area North Egypt. *J. Eng. Res.* **2021**, *5*, 46–56. [CrossRef]
53. Mohamed, E.M.S. Cost-benefit analysis and environmental impact of the use of solar energy in the Egyptian agricultural sector (A case study of the Al-Maghra Oasis in Matrouh Governorate, within the framework of the One and a Half Million Feddan Project). *Sci. J. Bus. Environ. Stud.* **2022**, *13*, 89–128. (In Arabic) [CrossRef]
54. Ibrahim, K.H.; Hassan, A.Y.; AbdElrazek, A.S.; Saleh, S.M. Economic analysis of stand-alone PV-battery system based on new power assessment configuration in Siwa Oasis–Egypt. *Alex. Eng. J.* **2023**, *62*, 181–191. [CrossRef]
55. Heliopolis University Concept Note: Creating Agricultural Carbon Credits for a Sustainable Future in Egypt. 2022. Available online: https://www.sekem.com/wp-content/uploads/2022/05/Concept-Note-Agriculture-for-Climate-Agricultural-Carbon-Credits.pdf (accessed on 20 October 2022).
56. Egypt Today Staff. Egypt to Establish Carbon Certificates Trading Company. Available online: https://www.egypttoday.com/Article/3/120419/Egypt-to-establish-Carbon-Certificates-Trading-Company (accessed on 10 November 2022).
57. CNN Egypt Is Studying the Establishment of a Platform for Trading Carbon Bonds and Experts Explain the Reasons. Available online: https://arabic.cnn.com/business/article/2022/02/09/egypt-platform-carbon (accessed on 18 October 2022). (In Arabic)
58. Akrami, M.; Gilbert, S.J.; Dibaj, M.; Javadi, A.A.; Farmani, R.; Salah, A.H.; Fath, H.E.S.; Negm, A. Decarbonisation Using Hybrid Energy Solution: Case Study of Zagazig, Egypt. *Energies* **2020**, *13*, 4680. [CrossRef]
59. Egyptian Channel One. The First Service Building Fully Powered by Clean Energy Inside the Village of Kafr El-Sheikh. Arch.Ahmed Abouaiana Reveals the Details. Available online: https://www.youtube.com/watch?v=CmfAKqkLVfE (accessed on 28 June 2022). (In Arabic)
60. ClimateWatch Egypt. Available online: https://www.climatewatchdata.org/countries/EGY?end_year=2019&start_year=1990#ghg-emissions (accessed on 20 October 2022).
61. Kamal, N. The most important messages of the International Conference of the National Planning Institute "Energy and Sustainable Development" Cairo 21–22 November 2020. *Egypt. J. Dev. Plan.* **2020**, *28*, 149–154. (In Arabic) [CrossRef]
62. Shaaban, M.; Scheffran, J.; Elsobki, M.S.; Azadi, H. A Comprehensive Evaluation of Electricity Planning Models in Egypt: Optimization versus Agent-Based Approaches. *Sustainability* **2022**, *14*, 1563. [CrossRef]
63. Salah, S.I.; Eltaweel, M.; Abeykoon, C. Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. *Clean. Eng. Technol.* **2022**, *8*, 100497. [CrossRef]
64. Escribano, G. Toward a Mediterranean energy community: No roadmap without a narrative. In *Regulation and Investments in Energy Markets*; Elsevier: Amsterdam, The Netherlands, 2016; pp. 117–130.
65. FAO. *Energy, Agriculture and Climate Change towards Energy-Smart Agriculture, Ref: I6382En/1/11.16*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2016.
66. Cheo, A.E.; Adelhardt, N.; Krieger, T.; Berneiser, J.; Sanchez Santillano, F.A.; Bingwa, B.; Suleiman, N.; Thiele, P.; Royes, A.; Gudopp, D. Agrivoltaics across the water-energy-food-nexus in Africa: Opportunities and challenges for rural communities in Mali. (20 April 2022). Discussion Paper Series, Wilfried Guth Endowed Chair of Constitutional Political Economy and Competition Policy, University of Freiburg, No. 2022-03 2022. Available online: https://ssrn.com/abstract=4088544 (accessed on 20 October 2022).

67. Andoura, S.; Hancher, L.; Van der Woude, M. *Towards a European Energy Community: A Policy Proposal*; Notre Europe, Jacques Delors Institute: Paris, France, 2010.
68. Kassem, H.S.; Bello, A.R.S.; Alotaibi, B.M.; Aldosri, F.O.; Straquadine, G.S. Climate change adaptation in the delta Nile Region of Egypt: Implications for agricultural extension. *Sustainability* **2019**, *11*, 685. [CrossRef]
69. McGookin, C.; Mac Uidhir, T.; Gallachóir, B.Ó.; Byrne, E. Doing things differently: Bridging community concerns and energy system modelling with a transdisciplinary approach in rural Ireland. *Energy Res. Soc. Sci.* **2022**, *89*, 102658. [CrossRef]
70. Braiki, H.; Hassenforder, E.; Lestrelin, G.; Morardet, S.; Faysse, N.; Younsi, S.; Ferrand, N.; Léauthaud, C.; Aissa, N.B.; Mouelhi, S. Large-scale participation in policy design: Citizen proposals for rural development in Tunisia. *EURO J. Decis. Process.* **2022**, *10*, 100020. [CrossRef]
71. REScoop. *A Supportive EU Legal Framework for Energy Communities in Energy Efficiency*; REScoop.eu: Brussels, Belgium, 2021.
72. Al-Makhzangy, A.S.M. Al-Ibtikar ka Aliyah Litahkik Altanmia Almostadama fi Misr [Innovation as a Mechanismto to Achieve Sustainable Development in Egypt]. *Arab J. Adm.* **2022**, *42*, 359–378. [CrossRef]
73. SAS. Ségala Agriculture Énergie Solaire [Ségala Agriculture Solar Energy]. Available online: https://energie-partagee.org/projets/segala-agriculture-energie-solaire/ (accessed on 5 January 2022).
74. European Union. Jühnde Bio-Energy Village in Germany. Available online: https://www.eesc.europa.eu/en/news-media/presentations/juhnde-bio-energy-village-germany (accessed on 20 October 2022).
75. Coopernico. We Own Our Energy. Available online: https://www.coopernico.org/ (accessed on 5 January 2022).
76. IRENA Coalition for Action. *Community Energy Toolkit: Best Practices for Broadening the Ownership of Renewables*; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2021; ISBN 978-92-9260-366-3.
77. Clausen, L.T.; Rudolph, D. Sustainable rural development and rural energy communities in a post-Brexit UK: Paralysis or broader visions in uncertain times? In *Rural Governance in the UK*; Routledge: London, UK, 2022; pp. 140–161. ISBN 1003200206.
78. IRENA. *Future of Solar Photovoltaic: Deployment, Investment, Technology, Grid Integration and Socio-Economic Aspects (A Global Energy Transformation: Paper)*; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2019; ISBN 978-92-9260-156-0.
79. Abouaiana, A. A Transdisciplinary Framework for Developing Energy Efficiency in Rural Communities- at Lasaifar Al-balad. Available online: https://www.facebook.com/ahmad.abdulmalek/posts/pfbid02QpMBGzv4J6JRb9uh9PUKBk9AqRKqNwkXeuRRqn8e6KnodbYXv8j2GgN6XtzpeVkhl (accessed on 20 October 2022). (In Arabic).
80. Comune di Pontinia. Available online: https://www.facebook.com/permalink.php?story_fbid=143295724790254&id=109416818178145 (accessed on 11 March 2022).
81. Golla, A.; Röhrig, N.; Staudt, P.; Weinhardt, C. Evaluating the impact of regulation on the path of electrification in Citizen Energy Communities with prosumer investment. *Appl. Energy* **2022**, *319*, 119241. [CrossRef]
82. Belaïd, F. Mapping and understanding the drivers of fuel poverty in emerging economies: The case of Egypt and Jordan. *Energy Policy* **2022**, *162*, 112775. [CrossRef]
83. Hongyun, H.; Radwan, A. Economic and social structure and electricity consumption in Egypt. *Energy* **2021**, *231*, 120962. [CrossRef]
84. Duarte, R.; García-Riazuelo, Á.; Sáez, L.A.; Sarasa, C. Analysing citizens' perceptions of renewable energies in rural areas: A case study on wind farms in Spain. *Energy Rep.* **2022**, *8*, 12822–12831. [CrossRef]
85. OECD. Managing environmental and energy transitions in rural areas. In *Managing Environmental and Energy Transitions for Regions and Cities*; OECD Publishing: Paris, France, 2022; pp. 95–121. ISBN 9789264182660.
86. Pascaris, A.S.; Schelly, C.; Burnham, L.; Pearce, J.M. Integrating solar energy with agriculture: Industry perspectives on the market, community, and socio-political dimensions of agrivoltaics. *Energy Res. Soc. Sci.* **2021**, *75*, 102023. [CrossRef]
87. Pascaris, A.S.; Schelly, C.; Rouleau, M.; Pearce, J.M. Do agrivoltaics improve public support for solar? A survey on perceptions, preferences, and priorities. *Green Technol. Resil. Sustain.* **2022**, *2*, 1–17. [CrossRef]