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Toward sustainable energy switch in built environment: learning from ongoing experiences

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Abstract. The contribution addresses the topic of the ecological transition of energy production and supply systems of built environment, mean as an evolution towards sustainable forms of reorganization of human communities. To this end, focuses its attention on the most recent application experiences, to compare what has been outlined at the political and financial level, with the output generated by the concrete interventions, by the energy, environmental and social point of view. A broad and varied picture emerges, in which the actions ranges from the energy solarization of individual or complex of buildings, to the solar use of large portions of territory. The analysis and classification of each initiative it made possible to understand which are the most widespread solutions and which requires greater support to be accepted at the local community level. It also consented to understand the need to integrate each initiative within a design process oriented towards preserving the quality of urban and rural landscape. This innovative approach, based on a bottom-up operational models founded on a public-private partnerships, a multidisciplinary of actors and an active participation of citizens, constitutes the next objective assumed by research work, oriented to define an operative design based procedure, able to support public and private actors in the choices formulation.

Keywords: Energy use, Sustainable urban renovation, Renewable Energy Communities, Best practices, Project management

1. Introduction

The theme of ecological transition towards new models of low-carbon renewable energy production represents one of the objectives introduced by the European Union (EU) as early as 2019 with the approval of the Green Deal (European Green Deal (EGD) COM/2019/640), aimed at addressing the challenges posed by climate change and environmental degradation. This program is designed to build an efficient, resource-efficient, competitive economy based on achieving net-zero greenhouse gas emissions by 2050, decoupling economic growth from the consumption of natural resources (especially non-renewable ones), and ensuring inclusion of all citizens regardless of where they live. Implemented in phases, it includes a series of proposals to transform EU policies on climate, energy, transport, and taxation, with an intermediate goal of reducing net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

This objective was reaffirmed with the approval in 2021 of the Fit for 55% package of Directives (European Commission. COM/2021/550), which includes a set of actions such as:

- Promoting renewable energy sources in the overall energy mix, with the minimum target increasing from the previous 32% set by the Renewable Energy Directive II (RED II) 2018/2001 to at least 42.5% by 2030 as set by Directive 2023/2413, which sets an even stricter target of 49% for the building sector by 2030.
- Promoting energy efficiency and combating energy poverty, where Directive 2023/1791 Energy Efficiency First (EEF) sets a minimum 11.70% reduction in energy consumption by 2030 compared



to the EU 2020 reference scenario projections and requires a corresponding reduction in overall final energy consumption by public bodies of at least 1.9% per year from 2021.

- Improving the energy performance of buildings, for which the revision of Directive 2018/844 EPBD (Energy Performance Building Directive) is underway. The draft agreement signed in December 2023 proposes a 16% reduction in energy consumption for residential buildings by 2030 and a 20-22% reduction by 2035, the elimination of fossil fuel use for heating and cooling by 2040, all new residential and non-residential buildings to be zero-emission by January 2030, all new buildings to be solar-ready (with photovoltaic or solar thermal systems), and existing public and non-residential buildings to integrate solar technologies starting from 2027.

From the analysis of the programmatic framework, several points highlight the leading role entrusted to public administrations, whose buildings must undergo energy refurbishment by at least 3% annually and be transformed into zero-emission buildings or at least nearly zero-energy buildings. Additionally, active roles are assigned to Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs). For the latter, their contribution is expected to count towards achieving energy efficiency goals and combating energy poverty [1].

The introduction of RECs can be traced back to the RED II Directive, which describes them, along with Local Collective Self-Consumption groups (LCC), as a model of distributed self-production across the territory, actively involving local communities in the production, use, and exchange of energy from renewable sources (Clean energy for all Europeans package. European Union, 2019). This model is further elaborated within the Electricity Internal Market Directive (EIMD) 2019/944 package, establishing Citizens Energy Communities (CECs), and in the Clean Energy for all European Package, defining them as local communities comprising individuals and institutions residing within the territory, committed to goals such as CO₂ emissions reduction, climate neutrality, energy consumption containment, increased use of Renewable Energy Sources (RES), and waste reduction through the promotion of solutions related to both individual and collective self-consumption.

The transposition of the directives at the Italian level can be traced back to the approval of Legislative Decree 2021/199 and Law 2021/53 implementing the RED II Directive 2018/2001 on the promotion of energy from renewable sources, Legislative Decree 2021/210 implementing the EIMD Directive 2019/944 on rules for the internal electricity market. These are followed by Guidance Document 390/2022 on configurations for self-consumption issued by the Regulatory Authority for Energy, Networks and Environment (ARERA), Integrated Text on Distributed Self-Consumption 2022/727, issued by ARERA and updated in January 2024, Ministerial Decree 2023/414 of the Ministry of Environment and Energy Security on the determination of the incentivizing tariff for renewable energy plants integrated into RECs and configurations of remote and collective self-consumption. The latter also identifies criteria for the disbursement of non-repayable contributions introduced by the National Recovery and Resilience Plan (NRP) in favor of RECs and LCC in municipalities with up to 5.000 inhabitants.

Considering the regulatory framework just described the current literature review on the subject presents a dynamic scenario where the debate primarily revolves around the role of RECs in participatory and sustainable energy transition [2], their techno-economic feasibility, and related legal-administrative procedures [1]. Some authors focus on the role played by citizens in the establishment of RECs [3, 4], the definition of a programming and management methodology for RECs [5], relationships between RECs and urban planning [6, 7], and the development and application of digital tools to support projects, especially in urban areas [8]. Particularly noteworthy is the attention given to the need for a census and valorization of locally available resources [9, 10, 11] and the preservation of landscape and architectural aspects associated with the spread of RECs in protected territories and historical centers [12, 13, 14]. The topic of designing energy transition and self-sufficiency interventions in rural or internal areas remains relatively underexplored, despite being the subject of specific community support policies (<https://rural-energy-community-hub.ec.europa.eu>). What emerges today, prompted by multiple stakeholders, is the urgent need to establish a procedural and meta-projectual tool capable of governing and managing the diverse interests of the parties involved in the development of RECs [15].

This tool should be project-based, supporting local administrations, economic operators, and citizens in formulating a comprehensive set of requirements upon which to base intervention choices, envisioning their urban, building, and landscape implications [16, 17]. Considering these indications, it was deemed useful to examine the applied experiences reported in this contribution, focusing solely on the Italian territory, in order to assess their content and methods in relation to the thematic areas identified by the aforementioned studies and research. The analysis started with some mappings already available in the literature [18, 19, 20] and/or online, accessible on the Renewables-Networking Platform (<https://www.renewables-networking.eu>), the European Union repository (ec.europa.eu/index), and the RSE repository (<https://www.rse-web.it/wp-content/uploads/2022/02/OrangeBook-22-Le-Comunita-Energetiche-in-Italia-DEF.pdf>). Recently, GSE has monitored active configurations and published key data in the semi-annual report dated February 12, 2024, in the "Energy and Climate in Italy - first half of 2023" report, outlining an increase in collective self-consumption (AC) configurations and RECs in operation, totaling 109 configurations including 74 AC configurations and 35 RECs (https://www.gse.it/documenti_site/Documenti%20GSE/Rapporti%20delle%20attivit%C3%A0/Rapporto%20semestrale%20Energia%20e%20clima%20in%20Italia.pdf).

2. Materials and methods

The study focused on analyzing the dynamics, implications, and challenges associated with RECs, as well as examining how these integrate territorially and address the development of RECs in environmentally and landscape-compatible proposals within the involved territorial scope. The scientific operation involved collecting and cataloging extensive informational data over a period of four years, from January 2020 to January 2024. During this timeframe, four categories of sources were utilized, including existing records and databases, individual websites of initiatives, periodic reports and communications from initiatives, and indirect interviews (conferences, seminars, online webinars) with members of initiatives or experts in the field of online and/or in-person energy transition topics.

2.1 Methodological Approach

The methodology adopted is based on an inductive approach with a reasoning method grounded in the observation of specific cases and/or experiences to deduce broader conclusions, integrating both qualitative and quantitative methodologies, constituting a key element of our research. Thus, addressing an initial phase of specific exploration for individual RECs, we proceeded with the configuration of analysis sheets designed to provide a comprehensive overview of data and detailed information on specific cases. In the initial assessment, it is important to understand a classification of intervention scales and consider the administrative management system. At the municipal level, issues related to construction are addressed, including permits according to Legislative Decree 2001/380 and municipal urban planning (Master Plan; Urban Plan).

This focuses on types of interventions, energy efficiency, use of sustainable materials, quality of living spaces, and structural safety. At the provincial and/or metropolitan level, an integrated approach to city planning and management is promoted, fostering social cohesion, cultural diversity, and citizen participation. This includes the design of public spaces, sustainable transportation, and urban regeneration, with attention to the socioeconomic impacts of urban policies. At the regional level, Regional Bodies and the Ministry of Culture (MiC) are involved in territorial and landscape planning, considering aspects such as terrain morphology, availability of natural resources, agricultural vocation, environmental protection, and prevention of natural risks.

2.2 Materials

Once this initial cataloguing process was completed, the systematic observation of the set of literature references allowed for the possibility of an exemplification in the elaboration of a dynamic graphic content, representing an effective tool for the analysis and communication of RECs data on the entire territory under analysis, providing a clear and detailed overview that supports informed decisions and sustainable development strategies. The aim is to highlight the evaluation capable of establishing the peculiarities relevant to the research and the points of convergence among the REC cases. Initially, the Italian context was explored in depth, and scientifically based criteria were identified for a comparative evaluation of RECs. Five criteria were derived and interpreted through indicators, divided into subcategories in line with scientifically based methodological criteria and references to research lines [21, 24]. A descriptive analytical framework was applied to classify the development model based on their progressive approach to REC. Through clustering and modeling of the reviewed community practices, three specific models were identified: Public Lead, Pluralist, and Community Energy Builder [21]. Characterized using different Renewable Energy Sources (RES), evaluating RECs is essential as it forms the foundation of a sustainable approach. This entails considering the availability and accessibility of renewable resources in the territory, such as solar radiation, wind, water resources, biomass, and other renewable sources, in accordance with the Regional Energy-Environmental Plans (REP). The analysis allows for comparing the dissemination and implementation of each energy source within different communities, enabling the identification of which sources are more prevalent and in which contexts. The RECs were analyzed based on the scale factor of the intervention, in relation to the territory itself, evaluating architectural and landscape integration within the territorial context [21].

Three levels of intervention were considered:

- Territorial scale: through interventions covering large geographical areas, often inter-municipal;
- Urban scale: through interventions focused on urban areas, including cities and suburbs;
- Building scale: through interventions specifically targeting individual buildings or building complexes.

Within its scope of intervention, the connotative criterion comes into play in relation to the evaluation of landscape and architectural integration, examining how they fit into the existing landscape, minimizing visual and environmental impact. This involves assessing the alignment of energy structures with the local architectural fabric and maintaining constructive aesthetic harmony. Finally, each municipality was categorized based on the state of REC implementation in a comparative view, distinguishing between "planned" energy realities that are not operational and "implemented" ones that are fully operational, contributing to the community's energy needs.

3. Results

The analysis of RECs in Italy has been deepened through the creation of dynamic graphitization content, an advanced data representation method. This technique allows the examination of RECs according to various parameters previously described (section 2.2) and illustrated in Figure 1. Such visualization enables the comparison of values across different categories and essential information, aiming to identify trends, differences, and relationships among the analyzed categories. This approach facilitates the understanding of the analysis results, providing a visual representation of the data that enhances the interpretation and communication of the obtained information.

In the RECs examined, they emerge and are identified as energy-consuming entities characterized by intrinsic diversity; they vary in size, scope, and objectives. Some communities focus on meeting the energy needs of single buildings or neighborhoods in metropolitan cities, while others aim to provide electricity and heat to entire market areas (identified by Tema Driving Energy - Tema Spa and approved by the Energy Services Manager (GSE - *Gestore dei Servizi Energetici* in Italy) within the context of the Integrated Text on Diffuse Self-consumption, operational areas characterized by a multi-regional

territorial division (Testo Integrato Autoconsumo Diffuso (TIAD) 727/2022/R/eel as supplemented and amended to Resolution 15/2024/R/eel; <https://www.arera.it/atti-e-provvedimenti/dettaglio/24/15-24>). The initiatives undertaken by these communities primarily include the installation of renewable energy infrastructure, energy efficiency measures, the use of smart grid technologies, and smart mobility solutions, such as electric vehicles (EVs) charging and sharing.

This research explores the impact analysis of anthropogenic activities on the natural environment and the identification of strategies to promote territorial sustainability, highlighting different intervention scenarios. A synergistic interaction approach between historical centers and nearby agricultural areas assumes a strategically significant role within the examined cases. The integration of these networks with retrofitting actions on building structures demonstrates a commitment to architectural integration, which not only enhances the urban and rural fabric but can also contribute significantly to a more sustainable urban development model. The introduction of the concept of "large areas" at the provincial and/or metropolitan context level represents an innovative strategy for energy resource management. This approach involves landscape integration on a large scale, also considering multiregional dynamics. It is crucial to address infrastructural complexities and associative dynamics to develop effective solutions for constructing a requirements framework related to these issues, to promote integrated and effective solutions for territorial sustainability.

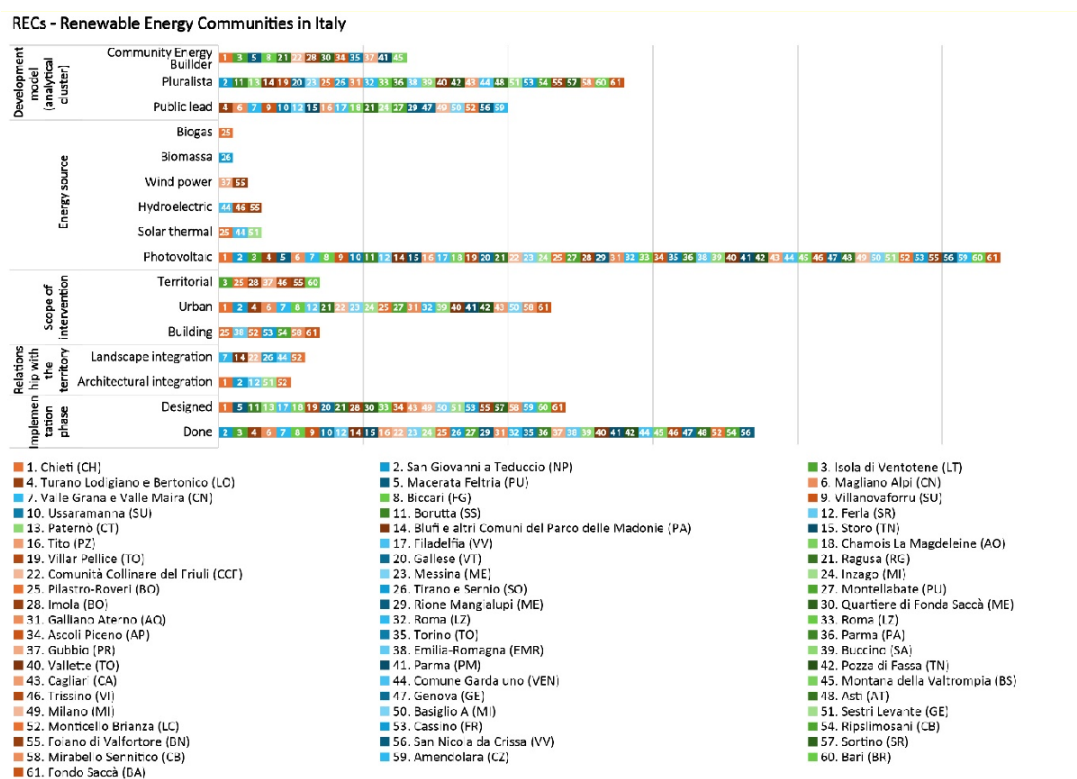


Figure 1. Comparative chart of RECs in Italy, analyzed and categorized according to specific criteria: a) Development model (Public lead; Pluralistic; Community Energy Builder); b) Types of renewable energy sources used (Biogas, Biomass, Wind energy, Hydroelectric, Solar thermal, Photovoltaic); c) Specific scale of intervention (territorial, urban, building); d) Assessment in relation to territorial implications (landscape integration, architectural integration); e) Implementation status (Planned and/or Realized).

Scientific research has focused on specific cases of architectural and landscape integration, revealing an intention and attempt at a balanced approach that considers aesthetic, functional, and sustainable aspects. Noteworthy examples include:

- The REC of Magliano Alpi: situated in a predominantly agricultural context, it is characterised by its approach to retrofitting public and agricultural buildings. Thanks to the ERIGRID Project, carried out in collaboration with the Joint Research Centre (JRC) of the European Commission, the Municipality of Magliano Alpi (CN), the Energy Center of Polytechnic of Torino and Fabbrica Digitale with the aim is to develop an open-source tool for the simulation of RECs intended for local authorities. This tool allows for independent feasibility analyses and business plans, facilitating the evaluation, planning and implementation of such projects. To date, the REC of Magliano Alpi has signed collaboration agreements with neighboring municipalities forming an "Energy City Hall" with the same methodological approach tailored to territorial specificities.
- The REC ComOn Light in Ferla: also known as "Multiply city" due to its participation in the European project MULTIPLY, demonstrates a capacity for integrated planning through significant energy retrofitting interventions on municipal buildings in the historic center. This positions Ferla (SR) at the forefront of the transition towards a cleaner and more sustainable energy economy.
- The REC in Monticello Brianza (LC): the focuses on landscape preservation and environmental sustainability by installing three PV systems on the roofs of private residences, minimizing visual impact and reducing the need for additional space. In addition to practicing self-consumption and energy sharing, the benefits generated are equitably distributed among renewable energy producers based on shared quantities, with the other portion financing local welfare programs. This underscores a community-oriented approach to the initiative.
- The REC of Roseto Valfortore (FG): distinguished in the European project "Rural Energy Community Hub" for its approach to maintaining production levels close to consumption levels. The goal is to generate value through energy retrofitting interventions aimed at improving energy efficiency and promoting the use of RES in both public and private sectors.
- The REC of Valle Grana and Valle Maira: the first REC to introduce the concept of a large area in the Alpine region, involving the 22 municipalities of the Unions Montane Valli Maira and Grana (CN) in relation to the Regional Energy-Environmental Plan (PER) of the Piedmont region. There are currently two configurations of shared energy within the "CER Nuove Energie Alpine".
- The REC of Blufi: the pioneering nucleus of a Distributed Energy Community within the Madonie Park. Powered by the same primary transformation substation of Blufi (PA), it includes six other municipalities, covering only 15% of the energy demand despite scenarios projecting development with neighboring municipalities.
- The ICER of Garda Uno: the service company Garda Uno has developed the largest "large area" energy community model in Italy, aggregating 43 municipalities. The project involves nearly all municipalities in the Brescia area of Lake Garda, some in the Lower Brescia area, the municipality of Provaglio d'Iseo, and several municipalities in the Mantuan area.
- The RECOCER Project: the Collinare Community of Friuli (CCF) consisting of 18 municipalities in Pordenone (FVG), developing innovative business models based on RECs as catalysts for change and public-private collaboration. It evaluates management business models based on synergies between building energy renovation actions, aggregation of local supply chains, and centralized procurement.
- The GECO Project (Green Energy Community): the synergistic reality of the Roveri-Pilastro district in the metropolitan city of Bologna (BO), a key player in the GRETA project "Pilastro-Roveri district," addressing current energy challenges through integrated technical solutions and social innovation processes. In this context, PV systems from the Centro Agroalimentare di Bologna-CAAB have been implemented over an area of 200,000 square meters managed by the Fondazione

FICO. Some communities, like this one, consider the use of hydrogen as an alternative fuel, although plans for implementation have not yet been enacted.

- The CERTo: an initiative by the City of Torino (TO) aimed at implementing an energy self-management system and recognized as a national "best practice" during COP 28. This approach involves creating several RECs connected to primary substations and managed through feedback from companies with 125 businesses responding to surveys, 201 operational sites involved in the project, including 85 in Turin and 116 in the metropolitan area, demonstrating broad engagement. It adopts an open-source digital platform based on IoT-AI (Internet of Things -Artificial Intelligence) for integrated data management, optimizing energy distribution, maximizing energy efficiency, reducing operational costs, with low management costs and high profitability.
- The C.E.R.Chiamo Energia: a project exploring the role of Lombard GALs (Local Action Groups) such as Terre del Po, Oltrepò Pavese, and Risorsa Lomellina as aggregating entities involved in an energy regeneration synergy project involving 110 municipalities and 238,000 inhabitants in Lombardy. The GALs' challenge opens up scenarios for rural areas, aiming to radically transform energy management approaches on a northern market area scale, positioning them as a pioneer in cultural, social, and economic projects at national and European levels, orienting strategies towards the first REC applications as opportunities for development and innovation.

These energy realities require a synergistic and integrated approach to design and planning, considering both macro areas within the regional context and micro areas focusing on details and individual territorial units within those contexts. Macro areas can encompass a variety of geographic and urban contexts, such as inland and vegetational areas, historical centers, metropolitan cities and suburbs, agricultural areas, industrial zones, port areas, and hinterlands. In these macro areas, energy projects are underway that need to be evaluated and integrated into a broader framework of territorial planning. Simultaneously, micro areas necessitate detailed and specific analysis, focusing on the needs and characteristics of individual units and communities within those contexts. This approach allows for the identification and consolidation of scenarios that define RECs, encompassing both technical and socio-economic and environmental aspects, to ensure an effective and sustainable transition towards a greener and more resilient energy system.

4. Discussion

The reflections in literature and the results from case studies demonstrate how local communities, whether rural, urban, or peri-urban, adapt to address the energy transition. These adaptations influence and transform the landscape, making it complex and multidimensional, integrating natural, cultural, and aesthetic aspects. Several projects highlight a collaborative approach in local contexts, with high cooperation among local authorities and project partners. For example, the REC of Magliano Alpi (CN) has developed open-source tools through the ERIGRID project to facilitate the analysis and implementation of RECs. Innovative projects like CERTo in Piemonte Region, leveraging IoT and AI, optimize data management, enhance energy efficiency, promote self-consumption, and facilitate participation in multi-regional energy markets, thereby increasing resilience and energy independence. Community participation and adoption are influenced by cultural, regulatory, and financial factors [21]. In RECs such as Foiano di Valfortore (BN), Sestri Levante (GE), and Garda Uno (VEN), the variability and diversification of renewable energy resources improve energy supply stability but require significant initial investments. The GECO Project, integrating advanced technologies like experimental hydrogen use as an alternative fuel, demonstrates the potential of technology to support sustainability. An emerging aspect is the attention to the visual and environmental impact of RECs, seen in industrial contexts like the Rovieri-Pilstro district, where existing surfaces are utilized to minimize land use. The scalability of interventions by RECs is crucial and requires planning involving an increasing number of municipalities and the development of replicable models on a large scale. This approach demands a robust methodology,

exemplified by cases such as the municipality of Blufi (PA) and the REC Garda Uno in the province of Brescia. Monticello Brianza stands out for its focus on landscape integration, minimizing the visual impact of photovoltaic installations on private house roofs. The Lombardia Region, through the CER.Chiamo Energia Community and GALs, is committed to energy regeneration of internal areas, transforming them into energy-efficient realities. Architectural integration has been successfully tackled in the historic center of Ferla (SR) through building retrofitting of public structures with energy efficiency practices. Similarly, the REC of Roseto Valfortore (FG) underscores the role of rural areas and small communities in using design criteria that limit renewable infrastructure to community needs, thereby avoiding excess installations (Basti, A., Misceo, M., & Di Giuseppe, E. (2023). *Comunità energetiche e qualità architettonica dei piccoli centri storici*. *TECHNE - Giornale di tecnologia per l'architettura e l'ambiente*, (26), 151-162. <https://doi.org/10.36253/techne-14476>).

Understanding the most common practices, such as conflicts related to land use with top-down approaches and actions belonging to the past, is proving increasingly ineffective in the context of modern urban transformations. In response to these shortcomings, the bottom-up approach of RECs provides an innovative response with more suitable and sustainable solutions. However, despite its innovativeness, there are still challenges related to the poor management of effective planning, particularly in the implementation of renewable energy sources in rural areas and small hillside communities affected by such actions. In this emerging perspective of RECs, a crucial and foundational element lacking is the involvement of a "conceptual vision" supported by multidisciplinary expertise from professionals such as architects, landscape architects, urban planners, and especially rigorous land management [22].

This approach aims to deliver high-quality projects that reflect the unique functions and characteristics of the locality. It would optimize financial resources invested, ensuring that interventions are not only energy-efficient but also well-integrated into the environmental context and culturally respectful of the territory, addressing multiple needs effectively. Each phase of the development process of a REC is interconnected and fundamental to its overall success. It begins with a phase focused on meticulous planning to define objectives, resources, and strategies, followed by detailed programming aided by a schedule. Next comes precise design, effective implementation to execute planned and designed activities, and ongoing management. These are essential elements contributing to achieving REC project goals, aiming for environmental (Italian Legislative Decree 2006/No. 152) and landscape (Italian Legislative Decree 2004/No. 42) compatibility.

Integral to the research is the intent to characterize these territorial interventions through expert and well-coordinated land management, achievable only through accurate planning governance supported by a multidisciplinary vision integrating technical, economic, and environmental expertise for high-quality design. Therefore, it is crucial to proactively address the complexity of infrastructural performance and associated associative dynamics related to technological design, emphasizing the importance of architectural and technological choices within complex projects and their integration with morphological aspects.

Although research highlights early-stage approaches, these choices influence not only immediate outcomes but also secondary and induced effects, necessitating thorough evaluations during decision-making, policy, and strategic project phases. These evaluations are essential for fully understanding the landscape impact, involving the assessment of various factors such as the nature and distribution of installations, integration with the surrounding environment, and the input from local communities. Therefore, it is necessary to define specific project criteria for different territorial entities, aimed at territorial transformation interventions that are suitable for the context of action, and that require expert and coordinated management through a dedicated governance approach.

Conclusion

Basing on an initial reflection on the results, although not exhaustive as the census is still ongoing, a lack of homogeneity emerges with respect to the declination of the sustainability objectives, initially identified as the focus of the research.

There is a clear awareness of the need to provide a switch with respect to the energy sources used, mainly renewable, which often takes the form of the use of active solar technologies, mainly photovoltaic and in some cases solar thermal or biomass. However, the consideration of aspects related to:

- the contextualization of energy production plants in the territory and its mitigation from an environmental and landscape point of view (environmental sustainability),
- the valorization of locally available renewable sources on the basis of correct energy planning (economic sustainability),
- the creation of new local entrepreneurship based on the sustainable management of resources and related energy infrastructures, oriented to achieving the objectives of self-sufficiency and zero energy poverty (social sustainability), emerges sporadically.

Aspects that require an expansion of the current governance model of transformative processes, mainly centered on the leadership of single municipalities, usually supported by individual entrepreneurial realities carrying of technological know-how, and focused on building or urban scale. Conversely, the approach that the research intends to analyze in the near future is precisely the expansion of the subjects involved, institutional and otherwise, and the shifting to a greater attention to the knowledge and planning of territory and its energetical, environmental and employment potentiality. The tool identified to manage this process is to preliminarily identify the specific framework of local needs and resources, on the basis of which activate a DESIGN DRIVEN interventions planning process. A process in which the ability to prefigure the project implications is intended as a support for the shared formulation of decisions, in close collaboration between local bodies, universities, operators economic, enterprises and citizens associations, according to the bottom-up model already identified and described in the previous paragraph. A further aspect worthy of interest is the evolution from RECs, intended individually, towards Energy Community Districts (ECDs), realities capable of integrating the energy needs and potential of residential and productive sectors present in a given territory, according to a network organization based on the valorisation of information technologies and Artificial Intelligence, to achieve the Sustainable Development Goals (<https://www.un.org/sustainabledevelopment/>).

Author Contributions: Conceptualization, AB and EDG; methodology, AB and EDG.; formal analysis, EDG; investigation EDG; writing-original draft preparation, AB and EDG; visualization EDG; supervision AB. All authors have read and agreed to the published version of the manuscript.

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