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Scienza in azione

Exploring the integration of Renewable Energy Communities in urban planning. The case of Italy

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Abstract. Although Renewable Energy Communities (RECs) represent a valuable tool for urban planning to address the global challenge of carbon neutrality at the local level, planning is listed as an obstacle to the RECs deployment across Europe. With reference to the Italian case, the aim of this work is to investigate the current degree of inclusion and implementation of RECs in urban planning tools, in order to understand to what extent they are considered and possibly promoted in planning practice. The methodological approach followed is to start with the study of the general and sectoral urban planning tools of the municipalities in which there are RECs implemented. Subsequently, the analysis is extended to the general urban planning tools of the provincial capitals. The results obtained show that Italian urban planning is mostly obsolete with reference to the RECs issue. However, some municipalities stand out on the national scene as not silent, promoting RECs in their plans. Nevertheless, these are very recent urban planning tools, for many of which the formation process is still ongoing. Consequently, the inclusion of RECs promotion policies is mostly limited to strategic projections. In this direction, it is of interest to monitor the evolution of these plans to understand if and how the strategic forecasts enunciated will be translated into operational choices and rules, with particular attention to reward measures for the RECs promotion.

Keywords: carbon neutrality; Renewable Energy Communities; Italian planning practice; general urban plans; Sustainable Energy and Climate Action Plans

1. Introduction

Achieving carbon neutrality is a challenge to which all countries are called to respond to combat climate change taking place globally, regardless of their development level, so that it can be considered sustainable (UN 2015).

In Europe, by 2030 Member States are obliged to reduce GHG emissions by 55% compared to 1990 levels, and to achieve carbon neutrality by 2050 (EU 2021). In this scenario, urban planning becomes essential to increase sustainability and address the worsening of climate-changing emissions in urban areas (UN-Habitat 2021; 2022).

As an emerging and recommended tool to combat these global issues, Renewable Energy Communities (RECs) are coalitions of citizens, small and medium-sized enterprises and local authorities, which cooperate to produce, consume and share locally produced energy from renewable sources, according to rules established by agreement between all members, with the main aim of providing environmental, economic and social benefits to the community itself or to the areas in which it operates, rather than financial profits (EU 2018). The geographical link with the cities and territories in which they are located differentiates RECs from other configurations of collective self-consumption, such as Citizens Energy Communities (CECs),which can use both renewable and fossil fuel energy sources, therefore CECs do not require the plants to be in close spatial proximity necessarily (EU 2019). So, RECs are a relevant tool for achieving the above-mentioned urban planning objectives.

Directive EU/2001/2018 (RED II), part of the 'Clean Energy for all Europeans' regulatory package, obliges Member States to promote RECs with an adequate framework of support and incentives at all levels, from national to local (EU 2018).

In Italy, RECs were introduced by Decree-Law No. 162 of 30 December 2019, while the aforementioned Directive was transposed by Legislative Decree No. 199 of 8 November 2021. Pursuant to the latter, RECs must comply with specific spatial and technical constraints to obtain economic incentives, even if less restrictive than the previous Legislative Decree 162/2019, in order to promote their widespread dissemination. These constraints concern the connection to the same primary substation, i.e. medium-high voltage (expanded with respect to the secondary substation imposed by Legislative Decree 162/2019), for all potential members, and the use of renewable energy production plants (RES) with a power not exceeding 1 MW each (greater than the total 200 kW required by Legislative Decree 162/2019). With the recent Ministerial Decree of 7 December 2023 no. 414, issued in implementation of the decree transposing the European directive, the regulatory and incentive framework on RECs has been clarified (Figure 1). Further incentives are provided for small municipalities with less than 5000 inhabitants, more than 80% coinciding with the so-called 'Inland Areas' of Italy (Istat 2022), by the National Recovery and Resilience Plan (NRRP), which interprets RECs as a lever to combat the depopulation typical of these areas (Italian Government 2021).

At the same time, numerous Italian Regions have legislated on the subject, providing funds for RECs financing, both with specific laws and by recalling them in other laws of a more general nature, sometimes issued in advance of Legislative Decree 199/2021 (Bonifazi *et al.* 2023). Depending on the case, the financial allocation is more or less substantial (Figure 2).

Some regional laws supporting RECs make explicit reference to "Renewable and Supportive Energy Communities" (RSECs). The adjective 'supportive' indicates RECs with a strong social value, i.e. aimed at alleviating conditions of energy poverty and settlement hardship, with particular reference to public housing. This is the case of the Regional Laws of Apulia (R.L. 45/2019), Campania (R.L. 38/2020) and Emilia-Romagna Region (R.L. 5/2022).

Figure 1. Evolution of the Italian regulatory framework on RECs.

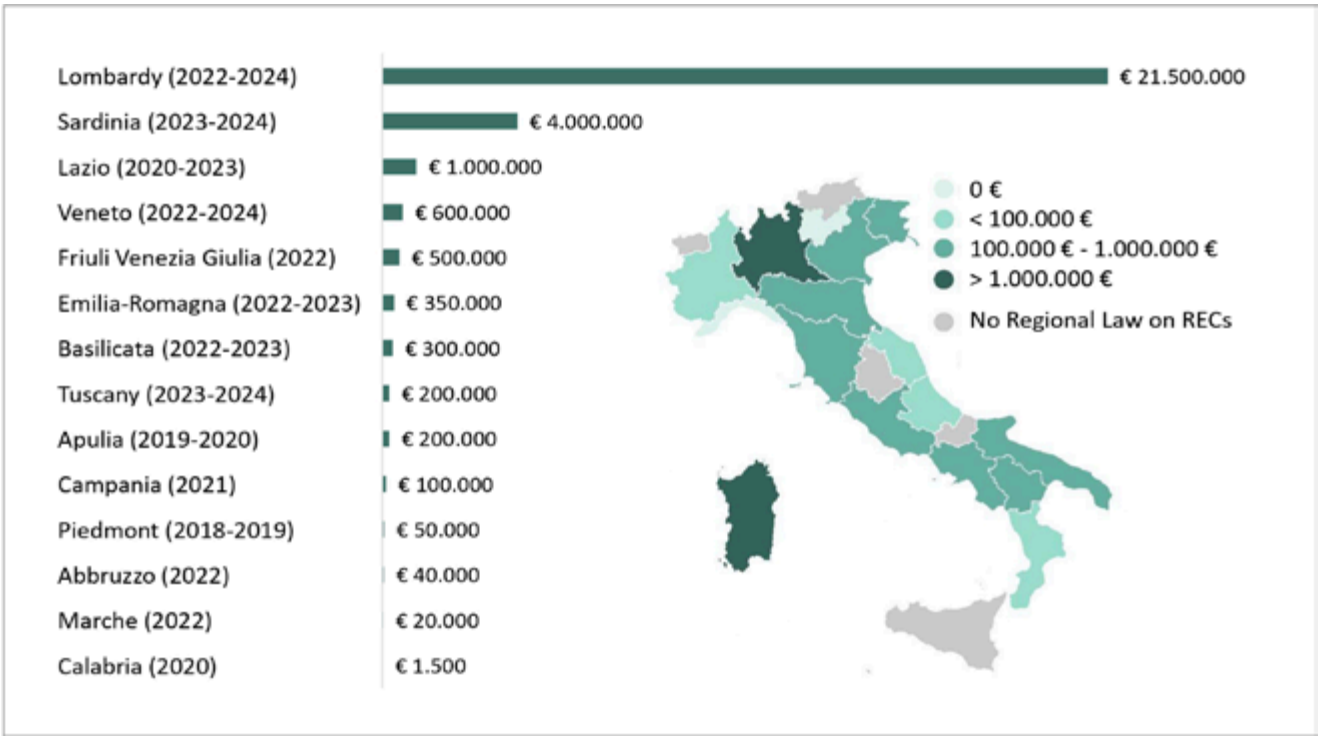

Figure 2. Financial allocation of the Regional Laws that incentivize RECs. The amount reported is to be considered total with respect to the years in which the economic contributions were granted.

2. Objectives of the work and methodological approach

Although RECs are widely favoured as part of *Green Deal* initiatives, their uptake in Member States is limited, as shown by a recent EU report on this issue. Among the main barriers identified in the report are urban planning obstacles, in terms of constraints, intended use and previous building rights, in the authorization process of projects, as well as the absence of incentives at local level (EU 2024).

This framework does not differ much from the Italian one, in which the experiences of RECs carried out are still small (Legambiente 2021), also due to a national regulatory framework defined only recently.

In the Italian context, urban planning, when not up to date with respect to the topic, is listed as a potential obstacle, as denounced in the Italian Integrated Plan for Energy and Climate (Ministero dello Sviluppo Economico *et al.* 2019) and by some scholars (De Lotto *et al.* 2022). Even in academic planning research, RECs have only recently aroused interest (Balletto *et al.* 2022). A review of the international literature has shown that in the search for optimal RECs spatial configurations, energy/technological and economic convenience aspects prevail, rather than those related to urban planning (Gerundo, Marra 2022).

In this scenario, the aim of the work is to integrate the state of the art, briefly outlined above, with the analysis of the current degree of RECs implementation in Italian urban planning tools, in order to understand to what extent RECs are considered and possibly promoted in planning practice. The sources of this study are part of the so-called 'grey literature' (Schöpfel 2012), considered complementary to the scientific literature and of relevance for the work purposes.

The methodological approach is to start from the study of the general and sectoral urban planning tools of the municipalities in which there are operational RECs, to ascertain whether RECs experiences are linked to local planning processes.

In the energy sector, a significant initiative is the Covenant of Mayors, which is linked to the 'Sustainable Energy Action Plans' (SEAPs), even in their most recent declination, which more clearly connotes its objectives by adding 'and the Climate' to the previous name (SECAP). Although sectoral in nature, it is an urban planning tool that pursues objectives common to the general municipal plan, such as the abatement of climate-changing emissions and the fight against energy poverty to ensure a sustainable and fair transition, providing citizens active participation in decision-making processes (Proka 2023). The integration between general planning and energy planning, historically difficult in Italy (De Pascali, Bagaini 2021; Curreli, Zoppi 2021), is increasingly advisable considering the ambitious carbon neutrality targets set by the European Union.

Therefore, the choice of urban planning tools to be analysed focuses on the general urban plans and SEAPs/SECAPs of the municipalities involved.

Considering that the Italian RECs fully realized do not constitute a numerically significant survey sample (Legambiente 2021a), the analysis is subsequently extended to the general urban planning tools of the provincial capitals, where the urban planning tools are on average less obsolete (Inu 2019), therefore a reference to RECs is considered more likely (Figure 3). Finally, the main reflections following the results obtained from the review are reported.

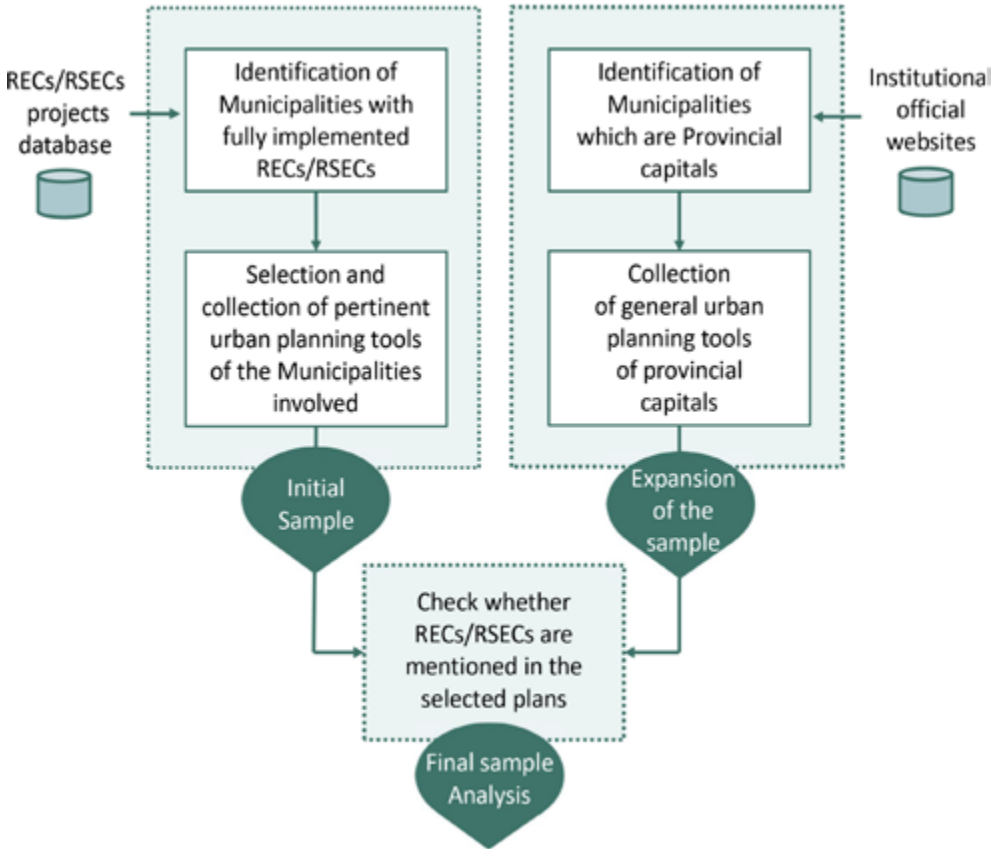

Figure 3. Schematic representation of the methodological approach underlying the study.

3. Results and discussion

3.1 REC projects and urban plans

As of July 2023, Italy had a total of 57 self-consumption configurations, including completed and operational experiences, projects in progress and those still in the design phase (Legambiente 2021a).

In addition to the 17 cases of Collective Self-Consumption, there were 40 Renewable Energy Communities, consisting of 34 RECs and 6 RSECs.[1] Out of these 40 energy communities, only 13 have been fully implemented.

These operational RECs are indicated in this study with a progressive number, shown in ascending order based on the number of adhering members. The work also summarizes the general information about these RECs, in terms of name, Municipality of establishment, territorial context (Inland Areas class), characteristics of the installed plants, subjects involved and financing sources (Table 1).

All the Energy Communities examined are based on the use of photovoltaic solar panels, installed on the roofs of mostly public buildings. The power of the photovoltaic systems is between 9.75 and 71 kW, achieved by the REC of Ussaramanna, which has the largest number of members. The summary also highlighted the high flexibility in terms of subjects involved and the distribution of the financial resources necessary for the RECs implementation. The geographical contexts to which they belong are varied, with a prevalence of belt municipalities, adjacent to urban poles, and intermediate municipalities between belt areas and more inland areas.

Table 1. General characteristics of the Renewable Energy Communities fully implemented in Italy.

N°	Name	Municipality of establishment	Inland Areas Class [1]	Roof location	Power [kW]	N. Members	Recipients	Promoters	Funding Sources
1	REC "Nuove Energie Alpine"	Busca (CN)	Intermediate	Municipal bowling alley	20	3	Sports hall, Bowl club, Civic Theatre	Association "Energy Community Maira and Grana Valleys"	Public and private funds
		Villar San Costanzo (CN)	Intermediate	City hall	20	2	Public lighting line, 1 municipal user, 1 small business commercial		
2	REC "AMARES"	Ripalimosani (CB)	Belt	Amaranto Group Parking	37,145	3	Information not accessible (N.A)	Amaranto Group, Limited liability cooperative company A.RE.S.	N.A.
3	REC "Via dei Partigiani"	Marsciano (PG)	Intermediate	Private home	9,75	4	1 family, 3 businesses	Private Entity	Private funds of the promoter
4	REC "Energy City Hall"	Magliano Alpi (CN)	Belt	City hall	20	7	3 municipal users, 3 families, 1 small company	Municipality of Magliano Alpi, Energy Center of the Polytechnic University of Turin	Municipal funds
5	REC "Hills Community of Friuli – San Daniele 1"	San Daniele del Friuli (UD)	Intermediate	"Dante Alighieri" Primary School	54,4	9	N.A.	Hills Community of Friuli, Municipality of San Daniele del Friuli	Regional funds
6	REC "Rossini"	Montelabbate (PU)	Belt	Middle School "G. Rossini"	15	10	1 municipal user, 6 families, 3 commercial activities	Municipality of Montelabbate	Public funds

[1] The first RSEC built in Italy is that of East Naples, which in December 2021 founded the RSEC Network, together with the Legambiente association, in order to reduce inequalities in energy transition processes.

7	REC "Monticello Green Hill"	Monticello Brianza (LC)	Belt	Three private homes	10	12	12 families	Energy Saving Management Consultant S.p.A.	Private funds under the ESCo (Energy Service Company) regime
8	REC "Marconi"	Savigliano (CN)	Pole	Gym	19,2	14	11 families, 3 businesses	Private Entity	Private funds of the promoter
9	REC "Solisca"	Turano Lodigiano (LO)	Belt	Gym and sports center	34 + 13	33	9 municipal users, 23 families, 1 parish	Municipalities of Turano Lodigiano and Bertonico, Sorgenia S.p.A.	Private funds
10	REC "Biddanoa E' Forru"	Villanova-forru (SU)	Peripheral	Middle School Gym	44,3	34	Citizens and Small and Medium-sized Enterprises	Municipality of Villanovaforru, Energy Cooperative "ènostra"	Municipal funds
11	RSEC "Critaro"	San Nicola da Crissa (VV)	Interm.	School Citadel "Domenico Carnovale"	66,8	34	4 municipal users, 30 families	3E Environment Energy Economy S.r.l., Legambiente	Private funds with a 50% tax deduction of the "Building renovation bonus" and a fifteen-year fixed-rate bank loan
12	RSEC of East Naples	Naples (NA)	Pole	Mary's Family Foundation	53	41	40 families, 1 foundation	Legambiente Campania, Fondazione Famiglia di Maria, Fondazione con il Sud	Funds from the non-profit entity "Foundation with the South"
13	REC of Ussaramanna	Ussaramanna (SU)	Periph.	Town Hall and Social Gathering Center	11 + 60	61	Citizens and Small and Medium-sized Enterprises	Municipality of Ussaramanna, Energy Cooperative "ènostra"	Municipal funds

[1]The classification refers to the mapping carried out in support of the National Strategy for Inland Areas in its first programming cycle (2014-2020). Depending on the distance (t) from the municipalities providing essential services, identified as 'Urban Poles', the Italian Municipalities falling into the category of 'Inland Areas' are classified into: Intermediate (20'< t >40'), Peripheral (40'< t >75') and Ultra-Peripheral (t >75') Areas. The remaining municipalities, closest to the Urban Poles (t < 20'), are defined as 'Belt Areas'. The map is made available in interactive mode by the Italian Institute of Statistics (ISTAT, 2016).

As regards the analysis of urban planning tools of the 13 municipalities in which there is an active REC, the respective general plans does not highlight any reference to RECs or RSECs. This result must be read in the light of the age of the tools examined, drawn up in a period of time prior to the European Directive "RED II". Six of these municipalities are equipped with SEAPs, while there are no SECAPs. The SEAP of the Municipalities of Villar San Costanzo and Montelabbate was drawn up jointly with the neighboring Municipalities (Table 2).

From these SEAPs recognition, it emerged that only the one in Naples makes an explicit reference to RECs/RSECs. More precisely, it is present in the technical report "Methodology for assessing risks and vulnerabilities, expected impacts and climate change scenarios for the Municipality of Naples", edited by the University of Naples Federico II, as part of a scientific support activity for the plan drafting.

N°	Municipality of establishment	Date of adherence to the Covenant of Mayors	Sectoral urban planning instrument (SEAP/SECAP)	Approval of the urban plan
1	Busca (CN)	2015	SEAP	(a)
	Villar San Costanzo (CN)	2014	SEAP of the "Aggregation DRO-ROC-VIL"	(a)
2	Ripalimosani (CB)	2010	SEAP	2013
6	Montelabbate (PU)	2015	SEAP of the "Unione Bassa Val Foglia"	(b)
8	Savigliano (CN)	2013	SEAP	2014
12	Naples (NA)	2009	SEAP	2012

(a) It was not possible to find this information in the available documentation.
(b) Under evaluation for 2017, as shown by the DUP 2018-20 of the Province of Pesaro and Urbino.

Table 2. Urban planning tools of the Municipalities in which there are RECs/RSECs fully implemented.

RECs are mentioned with reference to the energy supply of buildings, both individual and grouped, in compliance with Legislative Decree 162/2019. For individual buildings, it is envisaged that "public buildings can produce surplus energy to be put into the grid at the service of domestic users, with particular reference to public housing". For groups of buildings, the design of a renewable energy supply system "capable of covering part or all the needs (...) can represent an opportunity for the development of Energy Communities (...) with a more effective approach to climate mitigation (...) rather than by individual buildings", also to combat the phenomenon of energy poverty, particularly in public housing. Therefore, in the Naples SEAP it is evident the attention to public housing with reference to the recipients of the surplus energy produced under the REC, a topic underlying the most recent RSEC concept, particularly the active RSEC of East Naples.

Finally, a relationship between urban planning and RECs/RSECs carried out is not recognizable, except in one case (Figure 4).

3.2 RECs in the general urban plans of the provincial capitals

Regardless of the specific nomenclature, which differs according to the Regional Urban Planning Law of reference (RUL), the general urban plans of the Italian Municipalities that are provincial capitals have been examined. Of the 109 tools consulted, an explicit reference to Renewable Energy Communities is present in only 7 cases, located in Central-Northern Italy: Monza, in the Lombardy Region; Bologna, Modena and Reggio Emilia, in the Emilia-Romagna Region; Florence, Livorno and Prato, in the Tuscany Region (Table 3).

The Monza Plan provides for bonus measures that incentivize RECs within the Implementation Rules of the Plan Document, rules that govern the expansion areas (named 'transformation areas'), identified by the Plan Document itself and to be enforced through implementation plans, in compliance with RUL 12/2005.

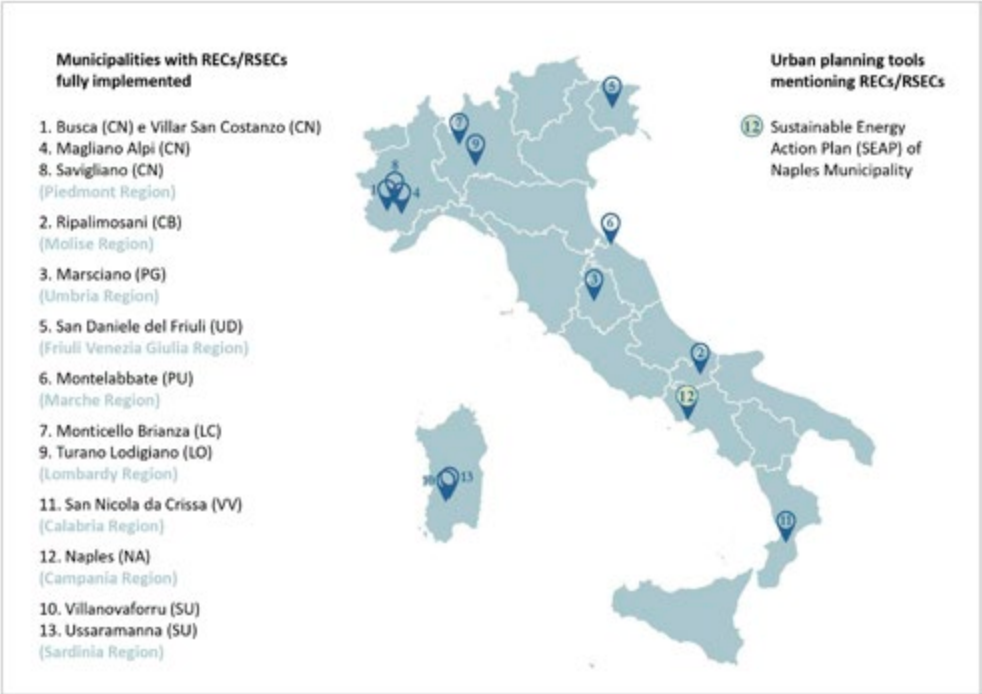

Figure 4. Map of the operational RECs/RSECs, related Municipality of establishment and urban planning tools where they are mentioned.

In transformation areas, the possible reduction of up to 15% of the need for services equipment in the case of local energy communities' establishment is envisaged, together with compliance with at least two other conditions for mitigation and adaptation to climate change (e.g. increase in permeable surfaces, green roofs and walls, collection systems for the reuse of rainwater).

According to the aforementioned RUL, the Plan Document is valid for five years, while the Plan of Rules, which regulates the entire municipal territory excluded from the areas of transformation, has no terms of validity. However, no other document of the Monza plan refers to RECs.

The Emilia-Romagna Region, with Resolution 2135/2019, approved an act of technical coordination for the Municipalities, with reference to the "Strategy for urban and ecological-environmental quality" of the general urban planning instrument, the General Urban Plan (GUP), as provided for by RUL 24/2017. Although the regional document does not contain an explicit reference to RECs, the latter finds space in the strategy of the same name in the Modena Plan and in the Reggio-Emilia Plan, both very recent.

The Strategy of the Modena GUP[2] supports the promotion of Energy Communities within the strategic line "1 - Modena green, healthy and antifragile city", with reference to action "1.c.1 - Reduce the impacts that come from agriculture and promote integrated RES production". As part of this action, which applies only to the rural municipal area, the GUP supports the deployment of agrisolar parks for the production of renewable energy and innovative energy management models, also through the RECs promotion.

The Strategy of the Reggio Emilia GUP mentions RECs in two documents: the Disciplinary Guidelines and the Urban Strategy. Regarding strategic production hubs, the Disciplinary Guidelines state that "*the agreed interventions and operational agreements will have to structure redevelopment actions through urban unification and restructuring, favoring the spread of energy communities*".

[2] The plan was elaborated with the scientific support of several Italian Universities: Bologna, Parma, Modena and Reggio Emilia, as well as Milan Polytechnic. However, it was not possible to identify the specific contribution given to the plan document where reference to RECs appears.

Urban Strategy identifies RECs as a response to the climate neutrality challenge ('Challenge 1'). In addition, in the production areas, it requires installing a share of photovoltaics increased by 20% compared to the minimum imposed by the Emilia-Romagna Region. With this manoeuvre, the Plan intends to encourage the redevelopment of the building stock to reduce energy needs as well.

The GUP of Bologna city favours the spread of energy production plants from renewable sources by creating local distribution networks ('Action 1.4b'), recalling the importance of RECs promotion, already established in the same city SECAP.

In the Tuscan case, the RECs issue is addressed in Structural Plans, drawn up pursuant to RUL 65/2014, i.e. aimed at defining strategic-structural choices, providing guidelines for transformations, without operationally deciding where and when to act on the territory or conferring building potential on the soils. However, it is significant that these choices are valid indefinitely, revealing the intention to promote RECs in the long term.

The Florence Structural Plan proposes to work actively at the climate level by promoting, among other things, the installation of solar panels and photovoltaic systems to increase the use of renewable energy and the RECs establishment by all means.

The Municipality of Livorno, with the new general variant to the Structural Plan, proposes the "*energy community project*", according to which *"those who install solar panels on the roof producing a quantity of energy greater than their needs will be able to establish an energy community with those who are connected to the same substation, receiving a state economic contribution*". Therefore, it is an explicit reference to the state legislation on RECs, but specifying the type of RES plants allowed.

In the Report of the participatory process accompanying the formation of the Prato Structural Plan, the REC importance for the territory emerges, as a tool for "*a better qualification and management of the system on the energy front*". In addition, the topic is taken up in the Appendix of the General Report, concerning a study conducted by the University of Rome "Sapienza", as a support activity for the drafting of the plan. The work concerns the improvement effects of technological and environmental redevelopment strategies of the industrial building heritage of an urban area south of the city historic center. Among the strategic actions based on carbon neutrality is the activation of a widespread energy community, served by renewable energy production plants from solar sources, to be installed with shading canopies on parking lots and in public spaces, also providing charging stations for vehicles. Although limited to a specific urban area with a predominantly industrial character, the Prato plan goes into much greater detail than the Livorno and Florence plans, which are rather generic in terms of RECs.

Table 3. General urban planning tools of the provincial capitals in which there is a reference to RECs.

Provincial capital	General urban planning tool	Adoption	Entry into force (*)	Latest variant	Document with reference to RECs
Lombardy Region (RUL 12/2005)					
Monza	Government Plan of the Territory (GPT)	09/03/2007	19/12/2007	02/02/2022	Implementation Rules of the Plan Document
Emilia-Romagna Region (RUL 24/2017)					

Bologna	General Urban Plan (GUP)	07/12/2020	29/09/2021	-	Discipline of the Plan
Modena		22/12/2022	02/08/2023	-	Strategy for Urban and Environmental Ecological Quality - The Green and Blue Infrastructure
Reggio Emilia		08/05/2023	21/06/2023	-	Strategy for Urban and Environmental Ecological Quality - Discipline - Disciplinary Addresses
					Strategy for Urban and Environmental Ecological Quality - Vision - Urban Strategy
Tuscany Region (RUL 65/2014)					
Florence	Structural Plan (SP)	13/03/2023	-	-	Urban planning report
Livorno		26/07/2018	2019	13/07/2023 (**)	General report
Prato		27/07/2023	15/11/2024	-	General report Report on the participatory process "Prato Imagines - Part 3"

(*) Following publication in the Official Bulletin of the Region.
(**) Adoption of the General Variant to the SP.

The possible reason why only in 7 provincial capitals the general urban plans mention RECs/RSECs is to be traced back to the regional context to which they belong, in terms of the reference regulatory framework and existing cooperation networks between different institutional actors in the RECs field.

In fact, Lombardy emerges as the first region in terms of resources volume allocated as an incentive for RECs development, a circumstance symptomatic of a certain political attention to the issue (Figure 2).

Furthermore, in some of the emerged cases, the plan formation was accompanied by the specialized support of universities/research institutions, which may be related to a greater innovation degree of the urban planning tool contents with respect to this issue, as also seen for the SEAP of Naples, discussed in the previous paragraph.

It is interesting to note that, among these 7 cases, only in Bologna a REC under implementation is present, and only in this case the municipality is directly involved (Figure 5). In fact, in the case of Prato, no REC being implemented, but the Collective Self-Consumption "NzeB: Nearly Zero Energy Building Social Housing".

Framed in the "Climate-KIC" program of the European Institute of Innovation and Technology (EIT), the RSEC in Bologna is well documented, both in the sources examined here (Table 4) and in the scientific literature, also considering the involvement of the University of Bologna and of the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA).

In particular, the link with the GUP and with the SECAP of Bologna is mentioned in the study by Boulanger *et al.* (2021).

Figure 5. Map of the provincial capitals whose urban plans recall the concept of REC or RSEC, with the location of RECs/RSECs under implementation.

Other partners in the project are the Agency for Energy and Sustainable Development (AESS), which has the Emilia-Romagna Region among its founding members, as well as the Modena Municipality, included in the 7 cases identified.

This single case highlights a current gap between urban planning forecasts and their concrete experiences of application. Since these are projections referring to newly designed urban planning tools or recent plans variants, overall relating to the three-year period 2021-2023, this aspect suggests that monitoring is necessary in the future.

Table 4. General characteristics of the RSEC "Green Energy Community (GECO)" established in Bologna provincial capital.

Inland Areas Class	Plants typology and location	Power	N. Members	Recipients	Promoters	Funding Sources
Pole	Photovoltaic solar plants on: parking shelter of the agroindustrial center "CAAB/FICO"; in the "Roveri" industrial area; various social housing buildings managed by the Regional Housing Agency (ACER); commercial and crafts centre "Pilastro"; roofs of the Fashion Research Institute, ZR Experience and other neighboring companies	14 MW	15	Citizens and Small and Medium-sized Enterprises	AESS, ENEA, University of Bologna, Local Development Agency "Pilastro Distretto Nord Est", center "CAAB/FICO", centre "Pilastro", ACER, neighboring companies (Fashion Research Italy, Bastelli, Nute, ZR Experience), Emilia-Romagna Region, Bologna Municipality	EIT, AESS, ENEA, University of Bologna
	Biogas plant for the disposal of organic waste	20 kWe and 30 kWt				

4. Concluding remarks and planning perspectives

The work presented here summarizes a review of Italian urban planning, carried out with the aim of investigating the current degree of inclusion and promotion of RECs at the local level. Specifically, the sample of selected plans contains: the general urban plans and SEAPs/SECAPs of the municipalities in which fully operational RECs are located, for a total of 13 general urban planning instruments and 6 SEAPs/SECAPs; 109 general urban plans of the provincial capitals.

The review conducted highlights how Italian urban planning is mostly obsolete with reference to the RECs issue, with the risk that the same planning could hinder its rapid diffusion, increasingly fostered in government policies, both at European and national level, to face the global challenge of carbon neutrality. Therefore, many efforts are still needed for an effective integration of policies for RECs promotion at the local level into the urban planning tools. In fact, the examination of the selected plans sample reveals how the few RECs experiences fully implemented in Italy are disconnected from the urban planning processes of the municipalities involved, with the sole exception of the East Naples RSEC, consistent with the SEAP objectives of Naples Municipality.

On the contrary, in the study of the general urban planning tools of the provincial capitals seven municipalities, equal to 6,42% of the total, stand out on the national scene as not silent, looking at RECs in their plans (Monza, Reggio-Emilia, Modena, Bologna, Livorno, Prato and Florence).

Nevertheless, these are very recent urban planning tools, for many of which the formation process is still ongoing. Consequently, the inclusion of RECs promotion policies is limited to strategic guidelines, often too generic. In this context, the Monza plan emerges, in which regulatory requirements have been defined, also aimed at implementing reward mechanisms. Furthermore, the municipality of Bologna is not only distinguished by its attention to the topic in its municipal urban planning tools, but also for its direct involvement in a real REC experience, although it is still in the implementation phase.

Despite the few cases identified, it is likely that they could trigger a virtuous chain effect, so that other Italian municipalities will also promote RECs in future updates of their urban planning tools.

In this direction, it is certainly of interest to monitor the evolution of the plans recalled here, to understand if and how the strategic projections set out will be translated into operational choices and regulations, with particular attention to reward measures.

The definition of incentive mechanisms in the regulatory devices of urban plans is a way in which municipalities can meet the EU obligation to provide incentives to RECs at the local level, as the lack of local support is listed among the main barriers to the RECs spread across Europe (EU, 2024).

Such an approach represents a promising opportunity for local authorities, which take on a leading role both as institutional leaders in the REC promotion process both as an active part, as potential members of communities. This takes on further relevance in inland areas, where responding to carbon neutrality challenge is notoriously more difficult, due to the scarcity of human and economic resources, but the NRRP opens new opportunities for redemption.

However, regardless of geographical contexts, these incentive mechanisms must be based on sustainable development, so that their repercussions go in the expected direction of the necessary and urgent transition to carbon neutrality.

It is relevant the need to preserve the most vulnerable resources, starting with the soil, but also the historic-architectural resources, particularly rich in Italy, especially in historic centres (Balletto *et al.* 2023), as well as landscape and natural resources.

Otherwise, the risk is to undermine the fundamental nature of emission reduction actions, ending up accentuating the negative effects of climate change, rather than mitigating them.

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