

Article

Energy Community in Action—Energy Citizenship Contract as Tool for Climate Neutrality

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Abstract: Cities are responsible for 65% of energy consumption and for the 70% of CO₂ emissions. Incisive actions are fundamental to bring cities towards climate neutrality by 2050 working by and for the citizens. For this reason, the “100 climate-neutral cities Mission” anticipates the target of climate neutrality by 2030. The objective of this paper, developed within the H2020 GRETA project—GReen Energy Transition Actions (GA101022317), is to investigate energy communities and climate city contracts as key interventions to face the ambitious goal of implementing citizens-centered and climate-neutral cities. To achieve this objective, this paper is structured as follows: (1) an updated framework of European and Italian legislation concerning energy communities; (2) an overview of climate city contracts’ definition and key aspects; (3) a selection and analysis of energy communities’ case studies; (4) a description of already developed pilot climate city contracts. The results provide more advanced knowledge about EU energy communities strategies and about the possible contractual agreements that can guarantee commitment between parties and can allow the active participation of citizens in the energy system. The lessons learned contribute to the application in the GRETA Italian case study, whose first participation activities are also described in the paper.

Keywords: climate-neutral and smart city; energy community; climate city contract; energy transition process; citizen engagement; energy citizenship contract



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1. Introduction

Based on the assumption that climate change and environmental crisis represent a huge threat worldwide, the European Union has set a series of energy targets that all Member States and local authorities are required to respect: the European Green Deal defines the general objective of reducing emissions by 55% by 2030 and of achieving climate neutrality, with zero emissions of CO₂, by 2050 [1]. The EU Climate Law, that constitutes a part of the Green Deal, aims to put in act the 2050 objectives within the EU legislation [2] and the Fit for 55 package of proposals orientates the EU legislation towards the 2030 Green Houses Gasses (GHG) emissions reduction targets and the 2050 vision [3]. A further accelerated step is given by the EU mission of “100 climate-neutral cities by 2030—by and for the citizens” (abbreviated in “Cities Mission”) that is part of the Mission on Climate-Neutral and Smart Cities [4], one of the EU Mission initiatives introduced by the Horizon Europe programme. Horizon Europe will invest EUR 360 million in research and innovation actions related to the City Mission in the period 2021–2023. The 100 Climate-Neutral cities mission aims to select, support and promote 100 valid examples of the EU cities that have the ambition to become climate neutral by 2030, with the objective to make them pilot innovation hubs and references for all the cities. This ambitious goal cannot be achieved without an ecological and cultural transformation, involving all interested stakeholders from public administrations, businesses, researchers and citizens [5]. During the conference “Conversations on the New European Bauhaus” on 22 April 2021, Ursula von der Leyen stressed that the transition to a climate-neutral Europe is synonymous with

cultural transformation, since, in order to be reached, it must primarily be understood, discussed and shared with people [6].

The role of citizens within the urban energy transition has not been relevant enough during the previous decade with negative consequences on the fulfilment of the energy targets [7]. From the recent output of the assessment report developed by the Covenant of Mayors, the most-emitting building sector is the residential one, responsible for the 28.3% of the total CO₂-eq emissions [8]. This means that the energy transition process of the residential private sector, for which citizens are the main responsible, is among the most backward, as also demonstrated by the data reported in the Bologna Sustainable Energy and Climate Action Plan (SECAP) [9]. Therefore, engagement processes need to be reinforced through practice of participation and collaborative design, starting from thinking of a new role of citizens and communities as active partners. Moreover, citizens' participation needs to be made stable and formalized through defined contracts with the public administration and all the stakeholders involved in the energy transition process [10]. An opportunity to formalize this relationship is given by the institution of the innovative legal entity of Energy Community. Energy communities are identified as one of the most strategic implementation actions to reach the energy goal, included within the integrated energy plans, such as the Covenant of Major SECAPs key documents. The SECAP integrated energy plans are considered effective tools, adopted by public administrations to coordinate medium-long terms initiatives and maximize the positive consequence of shared processes [11]. The energy community definition and, consequently, its formation and implementation, are strongly linked to the normative framework at EU, national and local levels [12]. Some of the most successful experiences of energy communities have been created under public administrations' initiatives—e.g., Magliano Alpi Community in Italy (<https://cermaglianoalpi.it/>, accessed on 15 December 2021) as they can play a central role in planning and implementing energy efficiency and sustainable actions and in involving citizens as key drivers in the urban energy transition process.

The Cities Mission sees citizens as fundamental actors in their decarbonization strategies, for their concurrent and overlapping roles of political actors, users, producers, consumers and owners. In order to better frame and exploit citizens' involvement in cities energy transition projects, the mission introduced the Climate City Contract [4] that expresses the ambition and commitment of all involved parties to the mission objectives, with a particular emphasis on the participatory approaches and the multi-level governance collaborations, that are considered triggering factors for innovation and change towards climate neutrality.

The first aim of this paper is to provide a qualitative analysis of a selection of already existing energy communities, focusing on the citizens engagement processes and strategies that lead to their establishment and that contribute to the fulfilment of their scopes.

The research is framed by an ongoing project, the H2020 “GRETA—Green Energy Transition” project (<https://projectgreta.eu/>, accessed on 3 December 2021) funded under the Call: H2020-LC-SC3-2018-2019-2020 Building a Low-carbon, Climate Resilient Future: Secure, Clean and Efficient Energy, GA101022317. The general objective of GRETA project, started in May 2021 and running for 30 months, is the enhancement of the knowledge of the conditions and barriers for the emergence of forms of citizens active participation within the energy system in support to local and global decarbonization goals. GRETA investigates a set of case studies and their different energy citizenship initiatives, framed at various geographic levels and contexts, as a core methodology for understanding current energy citizenship conditions and for designing and testing methodologies for its emergence and stabilization.

The growing of communities' engagement in green energy transition matters is not easy to fulfil [13]. Citizens may not have enough knowledge of the complex energy market dynamics and are not always aware of the possible benefits they can gain in participating in actions and initiatives, as individuals or in organized groups. Technical and cultural barriers are still present and represent reasons for exclusion and inequality. Thus, innova-

tive approaches and strategies are needed to foster the clean energy transition and to be consistent with the vision of energy as a social necessity and a democratic requirement [14]. It is crucial to offer communities effective, reliable, tested instruments but also tailored and contextualized paths to establish and structure the relationship with all the stakeholders included in the transition process [15]. In the GRETA project, the dedicated instruments to explicit, formalize and regulate mutual benefits, rights and duties, are identified in agreements called Energy Citizenship Contracts (ECCs). They take inspiration from the social contracts (intended as in [16], citing Rousseau, a “form of social organization in which the role of the state is to assure and guarantee rights, liberties or freedoms, and equality”) and the newly drafted Climate City Contracts from the “100 climate-neutral cities by 2030” mission. For this reason, the second aim of this paper is reporting the investigation into the existing forms of climate/energy-related contracts that regulate and frame citizens’ engagement in collective actions. In the investigation about the legal bonds and commitments between citizens and between them and the other actors involved, energy communities are the main context of inquiry, as they represent the most evolved current organized practices of citizens engagement in the energy sector.

Finally, the paper presents the first participatory initiatives carried out in the Italian GRETA case study, located in Bologna, previously introduced in [17].

The paper is structured as follows: Section 1, “Introduction”, offers a legislative framework about energy communities and their recent Italian transposition, and an overview of the existing climate contracts; Section 2, “Materials and Methods”, outlines the research methodology applied to carry out a qualitative literature review on climate/energy/social contracts including communities’ participation, and a comparative analysis of energy community case studies focusing on their contractual forms and participative approaches. Section 3, “Results”, is divided into Section 3.1 “Contract literature analysis within selected documents”, Section 3.2 “Citizenship’s engagement analysis within the selected case studies”, Section 3.3 “Citizens’ engagement initiatives” and Section 3.4 “First implementations of the Climate City Contract. The Swedish Viable Cities programme”. In Section 4, “Discussion”, the results are related to the GRETA project objectives and its first implementation action; finally, in Section 5, “Conclusions”, some final reflections are presented.

1.1. Energy Communities: Legislative Framework Updates and the Italian Legislation Transposition

The concept of energy community was introduced by the Clean Energy for all Europeans package [18] and, in particular, was developed and defined by the Renewable Energy Directive (EU) 2018/2001 [19] and by the Common rules for the internal market for electricity—Directive (EU) 2019/944 [20]. The national and regional levels of energy community normative have been defined under the umbrella of the European Directive (EU) 2018/2001 (RED II) on the promotion of the use of energy from renewable sources. According to the RED II, the Renewable Energy Community (REC) is defined as a legal entity based on an open and voluntary participation; it is authorized to independently produce, consume and sell energy from renewable sources and has the aim of providing environmental, economic or social benefits to the community, for its stakeholders, its members or the local areas in which it operates. It can be constituted by natural persons, SMEs or local authorities, including municipalities. The Directive (EU) 2019/944 introduces the definition of the Citizen Energy Community (CEC) with the aim to “recognize certain categories of citizen energy initiatives” and “provide them with an enabling framework, fair treatment, a level playing field and a well-defined catalogue of rights and obligations” [20] p. 7. The CEC’s definition differs from the REC’s one, because the CEC’s activities concern only the electricity sectors [21]. Moreover, CECs specifically focus on the return of benefits to the community’s members, stakeholders or to the local area where the community operates and are not linked to a proximity level geographical dimension, as for the RECs [17]. CECs represent, in general, a “potentially more inclusive model than RECs, since participation is not restricted to a specific location” [21] p. 4. The concept of energy community is strongly connected to the

energy citizenship one, which aims to further explore the sociological and cultural aspects, as well as the technological aspects of shared energy [13,22].

One of the most innovative aspects of the RED II is the establishment of specific rules for energy self-consumption and for the use of renewable energy sources for electricity, heating and cooling supply. The need to use available energy sources in a more efficient and sustainable way, also considering the population's increase, finds a possible solution in the concept of energy sharing, drastically changing the approach from energy self-production and self-consumption to energy produced and consumed at community level. On the other hand, the RED II promotes energy production from renewable sources as strategic action to tackle climate change, protect the environment and reduce people's energy dependency, as well as to contribute to improving the industrial and technological sectors. The REC definition opens new possibilities and paths towards the development of smart cities and communities in view of the climate neutrality target, giving citizenship's involvement a central role.

Several EU countries went through the revision and update of existing national laws, to comply with the supranational legislation. This process proved to be a complex task due to the cross-cutting economic, social, technological and environmental involved issues [23]. In the Italian context, the first national transposition of the RED II is the "Milleproroghe" Decree n. 162/2019 [24] and its subsequent amendments [25]. The 162/2019 Decree [26] fosters the close collaboration between the public administration and the private sector, strengthening interaction with local stakeholders and citizens, to achieve the energy objectives. This Decree rules the creation of communities that exchange energy for the purpose of collective self-consumption, based on co-benefits, both economic and environmental. Anyone who consumes energy can participate in the community, regardless of whether they own a photovoltaic system, a storage system or they are a simple supporter of clean energy. The dimension of the energy community is determined by the power plant fixed at 200 kW. An important further step at Italian national level is provided by the Decree n. 199/2021 [25] which completely transposes the RED II. This Decree brings the dimension of energy community to 1 MW that represents the maximum power to have access to direct incentives. Consequently, the practical and applicative national definition is finally established. Nevertheless, in Italy energy is also regionally regulated. Therefore, before energy communities are in condition to fully operate, the adoption by all the 20 Italian Regions must be completed. At present, only few Regions have currently legislated on energy communities, with normative dated before the Decree 199/2021 [26–29], and other Regions, such as Lombardia and Emilia-Romagna, are currently working on new legislative frameworks [30,31]. This is indicative of the fact that the pathway for energy communities' institution is an on-going activity and it appears still far from concrete and functional in the urban energy transition process. Another consequence is that there is no legislative indication on how formalizing citizens' engagement actions and, as will be discussed later in this paper, there is a multiplicity of contracts that each community has applied depending on the dimension, the legal structure of the cluster, the specific objectives and the characteristics of the involved actors.

At National level, an overview of energy community's creation is provided by the Legambiente ArcGIS Map [32], where Italian energy communities are mapped for a total of twenty-six projects and divided in already constituted (three communities) and currently in project (twenty-three communities). Specifically, among constituted and in exercise energy communities Legambiente mentioned the following:

- Pinerolo (Piemonte Regione);
- Magliano Alpi (Piemonte Region);
- Napoli (Campania Region).

1.2. Definition and Key Aspects of Climate Contracts at City Level

This paragraph provides an overview of the main climate contracts adopted at city level on the basis of a review of the main EU programs and planning processes aiming

at climate targets and clean energy transition. The Climate City Contract's definition is contextualized within the already mentioned Cities Mission as "new mechanism to deliver EU support to cities in the form of more innovation, better regulation, and integrated financing" [4] p. 7. This Contract's definition comes from the need to recognize a new active role of citizens, whose actions can be supported by dedicated platforms and fundings. According to the Cities mission, the signatories are the local government represented by the city mayor, local stakeholders, national or regional authorities and the EU Commission as witness. Through the Climate City Contract, the commitment of the involved parties can be formalized empowering citizens and allowing them to find their role in the energy transition process. This concept has been further expressed within the "Info kit for Cities" [33], published in October 2021 by the European Union to guide interested cities in participating in the call for expression of interest (EOI) to be included in the Cities Mission. In November 2021, the call was launched and will be closed in January 2022.

The Climate City Contract is the central feature and focus of the mission: it is conceived as a non-binding contract, in the form of a memorandum of understanding. The term "contract" is used to underline the clear political commitment on the part of the city to its citizens as well as to the Commission and to the national and regional authorities. According to the "Info Kit for Cities", the planning for net-zero emissions by 2030 regards the following actions: building blocks; governance and stakeholder engagement; Climate Neutrality planning process; GHG emissions accounting and target setting; accounting for residual emissions; GHG emissions roadmaps. An example of cities that have already signed their commitment to climate neutrality by 2030 is represented by the 23 Swedish Cities involved within the Viable Cities strategic innovation programme (<https://en.viablecities.se/> (accessed on 14 December 2021)). Nine of these Viable Cities have already developed their Climate City Contracts 2030 (for more details, see later in this paper).

In other regulatory contexts, climate contracts have different definitions and declarations. Examples are the Local Pact for Transition [34] and the Green City Accord [35]. In the Energy Cities publication [34], Local Pact for Transition is more generally associated with the way that municipalities create their own Participatory Agreement for the Climate Transition (PACT) by translating the Paris Agreement at a city level. Their scope is to set a precise strategy to reach neutrality by 2050 considering both the municipality's competencies and the climate footprint of local activities. The Green City Accord is a European initiative with the objective of implementing sustainable actions in five areas of environmental management through the cities' commitment: air, water, nature and biodiversity, circular economy and waste, and noise. The Accord differs from the Climate City Contract since the latter is more centered on citizens and on pushing the formalization of the city and stakeholders' commitment. Moreover, for the 100 cities selected by the mission, the climate-neutrality target is anticipated by 20 years, generating relevant planning and implementing actions that need the involvement and collaboration of all the parties.

Another contract at city level is the most known and already mentioned Covenant of Mayors [36], launched in 2008 in Europe with the goal to gather local governments that voluntarily committed to achieving the EU climate and energy targets by the past 2020, 2030 and 2050. The signatories are Mayors or delegated city representatives, that declare the city strategies in the Sustainable Energy and Climate Action Plan (SECAP). A consolidated method to monitor the energy consumption of public and private fields is applied and future implementation actions for mitigation and adaptation to climate changes are foreseen. The SECAPs are developed following a specific methodology that provides principles, procedures and best practices. They are updated based on a two-years monitoring of the urban energy consumption, determined by private and public buildings, public lighting, mobility, tertiary and industrial sectors [11]. They represent a consolidated tool at the disposal of public administrations to control and manage their pathway and progress towards the climate targets.

2. Materials and Methods

The analysis of energy communities and climate contracts as multilevel co-creation processes and effective approaches to intensify the citizens' engagement within the clean energy transition of cities, has been built on the framework of the report "100 Climate-neutral Cities by 2030—by and for the Citizens" [4]. The report summarizes the objectives, approach and roadmap of the mission "100 climate neutral cities by 2030" proposed by the Mission Board for climate-neutral and smart cities to the EU Commission as part of the Horizon Europe framework programme. The continuous collaboration among stakeholders involved in the climate transition process represents one of the main principles at the base of the mission and the new role of citizens is indicated as a priority in order to reach the 2030 energy target.

Moreover, this paper capitalizes on the information collected in the "Info Kit for Cities", published as an operative tool for the mission's implementation in supporting cities for their candidacy to climate neutrality [33]. In these publications, the concept of Climate City Contract is presented as a live document, including energy goals, targets and strategies and action plans for transition, emphasizing, at the same time, the participatory approach and the multi-level governance collaboration. The two aforementioned publications [4,33] have been used to find links between the energy community dimension, in its updated legislative framework, and innovative climate contracts that involve citizens in the energy transition process.

Furthermore, in line with this scope, the adopted methodology consists of a two-pronged approach:

- a qualitative literature review on climate, social and energy contract concept, employing Scopus database (<https://www.scopus.com/>, accessed on 18 November 2021) and Google Scholar (<https://scholar.google.com/>, accessed on 20 November 2021), was run focusing on its applicability in energy transition processes at community level;
- a bottom-up analysis performed examining case studies of already constituted energy communities, benefitting from a previous publication from the GRETA project [17] that provides a more general qualitative overview of successful strategies that supported energy communities setting up and growing. The present research mainly focuses on the contracts that rule their institution and on social innovative measures and participative approaches as main driving factors.

2.1. Selection of Papers about Energy/Climate/Social Contracts

In order to select relevant papers for conducting the literature review, a systematic research was performed on Scopus database (<https://www.scopus.com/>, accessed on 18 November 2021) searching in title, abstract and keywords sections the following query: "Energy" or "Climate" and "Social Contract", "Energy Contract" and "Climate Contract".

The emerged literature, consisting of both journal papers and conference proceedings, was filtered for relevance according to some subject areas considered of particular interest for the research (e.g., "Energy", "Environmental Science", "Social Sciences", etc.). Then, the research was limited to the Open Access methods of publication.

This process results in a collection of 71 peer-reviewed publications, on which authors focused their analysis and review moving towards a further screening phase that led to a selected group of publications according to the main research interests. Figure 1 shows the methodological approach adopted in the selection process of literature review.

Another research, using the same key words, was performed on Google Scholar (<https://scholar.google.com/>, accessed on 20 November 2021). The results for "Energy" or "Climate" and "Social Contract" were a total of 18 of which 6 relevant but already selected through the Scopus research. As for "Energy Contract" and "Climate Contract" key words, the results were several hundred, but most of the documents were not pertinent with the objectives of the present paper, dealing with market, financial, managerial, or technological related issues.

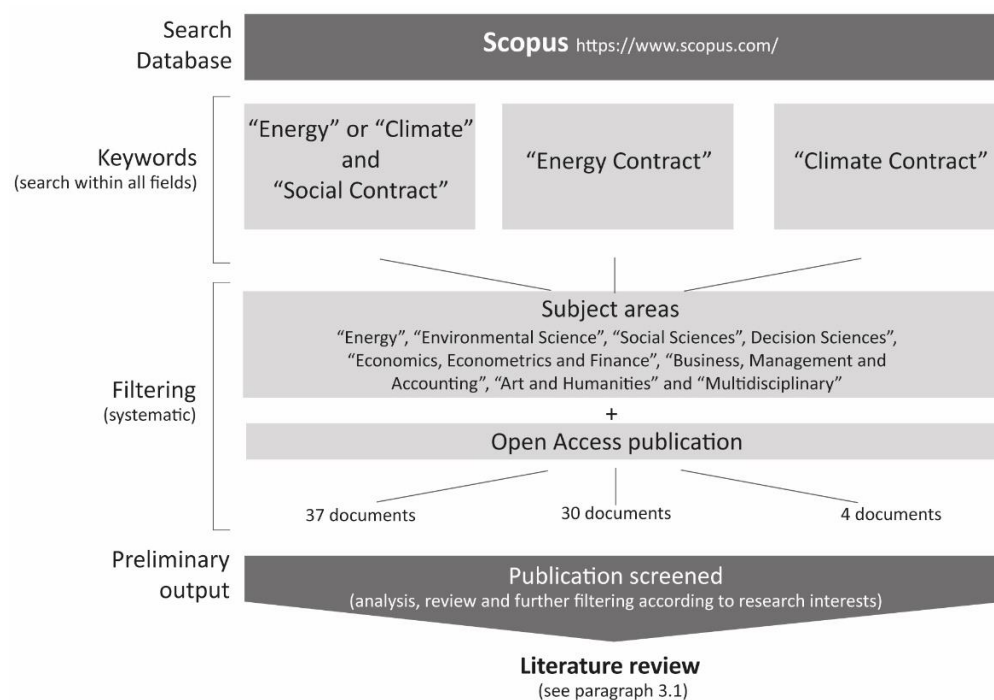


Figure 1. Literature review methodological approach.

The abovementioned research provided in general poor or not relevant results. According to "energy citizenship contract" no articles emerged neither in Scopus nor in Google Scholar. This fact highlighted that the energy contract concept at community level, linked to the formalization of citizenships' engagement, is still little explored in the existing literature, and it needs to be further investigated and discussed.

2.2. Selection of Case Studies

As already mentioned above, the literature review about the Climate City Contracts has been flanked by the analysis of case studies about already constituted energy communities or assimilable entities (hereafter, for brevity, we call all of them energy communities), focusing on the form of legal bonds or commitments that link stakeholders and various actors involved, regulate their relationships and define their rights and duties as adherents [37]. The case studies have been selected from recent publications and the most current innovative research outputs at European level and national level [38–40] specifically focusing on the already implemented energy community that extensively adopted participatory approaches.

The selection and analysis of case studies benefits also from the GRETA project' progress and, in particular, from the ongoing research within the Work Package 5 "Community Transition Pathways for decarbonization across geographical levels" (WP5) led by Bologna University. The aim of WP5 is to investigate which are the main factors influencing the emergence and growth of energy citizenship and its relations with geographical levels, and to examine under what conditions energy citizenship conducts allow to reach broader decarbonization policy goals. Within this WP, a first selection of energy communities and other similar entities has been carried out and the relevant information has been organized in a sheet to be filled-in for each case study (Presence of innovative business plan; Presence of normative framework that enables the energy community's creation; Presence of innovative technologies; Presence of innovative cooperation streams; Presence of innovative contracts; Keywords that better describe the case study; Critical elements of the community; Positive and replicable elements; Main milestones towards the creation of energy community; Other interesting elements).

For the specific purposes of this paper, a more limited set of information has been identified, collected and categorized to make the case studies comparable and to per-

form a critical analysis. The collected information, reported and organized in Table 1, is the following:

- Location (North/South Europe): the selected case studies are located in both Northern and Mediterranean parts of Europe.
- Dimension of energy community: the boundaries of the case studies are relevant for our research since they give information about the dimension of the community and, consequently, the expected quantitative impact on people.
- Typology of community's contract: the type of contract or legal agreement at the base of the energy community institution has been analyzed, focusing on similarities and differences and comparing them.
- Stakeholders: the main energy community stakeholders are identified in order to understand who the main actors and activators of the energy community strategy are.
- Level of citizens' engagement process: this is a crucial element to highlight the connection between energy community and climate city contract that can contribute to formalize and stabilize the citizens' role and their active participation in the transition process.

The list of case studies selected and analyzed by the research reported in this paper includes 14 energy communities and energy citizenship experiences as the result of the match between the case studies identified through the literature review, the European project review and the list from GRETA WP5.

Table 1. Main features of the selected case studies: location, dimension, contract typology, stakeholders, evaluation of the level of citizens' engagement.

Case Study	Dimension	Contract Typology	Stakeholders	Citizens' Engagement Level
Oborniki slaskie ¹ (Poland)	Local	Bioenergy community (on-going creation)	local authorities, citizens	aware
Tirano ² (Italy)	Regional	Energy Cooperative	local municipalities, district heating company, research centers, citizens	aware
Thessaly ³ (Greece)	Regional	Energy Community	municipalities, SMEs and local associations	aware
Basque Country & Navarra (Spain) ⁴	Regional	Energy Cooperative	local municipalities, industry, citizens	involved
Courant d'Air ⁵ (Belgium)	National	Social Enterprise Cooperative	natural or legal persons that subscribe the statute	involved
Marstal Fjernvarme ⁶ (Denmark)	Local	Social Enterprise Cooperative	district heating company, consumers in general	aware
Svalin ⁷ (Denmark)	Local	Energy Community (co-housing)	residents	involved
Enercoop ⁸ (France)	National	Social Enterprise Cooperative	consumers and producers	aware
SAS Ségala Agriculture et Energie Solaire Cooperative ⁹ (France)	Regional	Energy Cooperative	farmers	involved
Som Energia ¹⁰ (Spain)	National	Energy Cooperative	consumers and producers	involved
Solbyn Association ¹¹ (Sweden)	Local	Cooperative housing association	building company, citizens	involved
Magliano Alpi ¹² (Italy)	Local	Energy Community	national and local public authorities, local industries, research centers, citizens	involved
Melpignano ¹³ (Italy)	Local	Energy Cooperative	Local authority, industry, university; citizens	involved

Table 1. Cont.

Case Study	Dimension	Contract Typology	Stakeholders	Citizens' Engagement Level
Banister House Solar ¹⁴ (United-Kindgom)	Local	Energy Enterprise	industry, citizens	involved

¹-<https://www.becoop-project.eu/pilot-areas/poland/> (accessed on 15 December 2021); ²-<https://www.becoop-project.eu/pilot-areas/italy/> (accessed on 15 December 2021); ³-<https://www.becoop-project.eu/pilot-areas/greece/> (accessed on 15 December 2021); ⁴-<https://www.goiener.com/> (accessed on 15 December 2021); ⁵-<https://www.courantdair.be/wp/> (accessed on 15 December 2021); ⁶-<https://www.solarmarstal.dk/> (accessed on 20 December 2021); ⁷-<https://www.housingevolutions.eu/project/svalin-co-housing-p2p-energy-community/> (accessed on 15 December 2021); ⁸-<https://www.enercoop.fr/> (accessed on 20 December 2021); ⁹-<https://energie-partagee.org/projets/segala-agriculture-energie-solaire/> (accessed on 15 December 2021); ¹⁰-<https://www.somenergia.coop/> (accessed on 20 December 2021); ¹¹-<http://www.solbyn.org/> (accessed on 20 December 2021); ¹²-<https://cermaglianoalpi.it/> (accessed on 20 December 2021); ¹³-<https://www.comunirinnovabili.it/cooperativa-di-comunita-di-melpignano/> (accessed on 15 December 2021); ¹⁴-<https://www.repowering.org.uk/> (accessed on 15 December 2021).

3. Results

3.1. Contract Literature Analysis within the Selected Documents

The concept of social contract applied to the clean transition and the transformation to sustainability implies the need for a fundamental realignment of societies, which, in turn, requires the legitimization of their citizens. According with Messner, D. in [41] “like the low-carbon transformation, the process of industrialisation was above all an energy regime change. However, industrialisation cannot be solely reduced to a fundamental change in the energy system. Similar to the ideas, concepts and theories of the Enlightenment in advance of the industrial revolution the sustainability discourses can be interpreted as cognitive and normative innovations serving to prepare the way for economic and technological transformation processes” [41] p. 262. The author describes the emerging pillars for the social contract of sustainability, starting from an historic overview of the concept and summarizing the scientific debate on the issues of social agreements for low carbon and sustainable development.

For Ziegler, R. in [42], social contract has become mostly associated with hypothetical and philosophical reasoning about justice, tending to exclude the value and potentialities of social contracts in practice. To avoid confusing terminology, the term “social agreement” is identified as actual variant of social contract, not comprehensively but focused on a specific theme such as energy provision. Several case studies about such action-contexts social agreements are presented by the paper.

In [43] Pihl. E., et al. a horizon scan of the most important insights is carried out from advances in integrated research related to climate change over the past year (focusing on findings published in 2019–2020). The paper summarizes the inquiry about the wide interdisciplinary arena of climate research, identifying key insights and focusing on those that provide evidence of their pivotal importance for evidence-based policymaking. The findings of the research lead the authors to suggest long-term changes to governance and a social contract to address climate change, learning from the current pandemic: climate change and COVID 19 are both identified as systemic risks that cannot be unilaterally addressed by governments, local communities or companies, and “systemic risks will require innovative, adaptive, reflexive, transparent, participatory and accountable approaches to governance. Rapid, networked, transformative responses that foster greater trust and more just relationships between diverse actors will be indispensable to creating a thriving and equitable global future for all” [43] p. 9.

One of the main issues discussed by the selected papers is what type of political authority has legitimacy to promote and guide a new social contract, what roles global, regional, national or local energy governance could have in bringing about the required behavioral, economic, technological changes [44] and the role that can be played by cities [45] or by an open society of equal peers that share sustainable goods and services among participants [46].

Cassen, C., et al., in [47] link the need for a negotiation of the social contract to specific fiscal reforms and measures to secure funding for initiatives aimed at broadening

and upscaling low carbon experiments, to foster both radical changes in infrastructures and deep transformations in people behavior. They also underline the related challenges, highly dependent upon the political context in each EU country or region and on how decarbonization proceeds at the global level.

Hewitt, R.J., et al., in [48] carried out a detailed review of literature around the social dimension of renewable energy, collecting, describing and mapping initiatives from 7 EU countries and the UK. The aim is to recognize Social Innovation (SI) aspects in various typologies of citizen-driven renewable energy projects, named collectively as community energy (CE). The common trait that links the diverse projects is their emphasis on citizen participation around the common issue of energy. The SI concept is confirmed to be relevant as it is an answer to societal challenges through the reconfiguring of social practices, aimed at improving societal well-being through the engagement of civil society actors. As an innovation in energy focusing on community participation, CE is identified as a form of SI and associated with the idea of “creative reconfiguration of social relations” around energy.

The authors claim that “the strategic approaches to energy transition currently being advanced by European policy-makers remain firmly anchored to this earlier “technology focused” innovation paradigm, and do not seriously contemplate any form of genuine reconfiguration or “new social contract for energy” [48] p. 2. The same paper offers a literature review of key themes around the social dimension of CE, such as legal and organizational forms, energy type, local government projects with citizen participation.

In [49] collected in the special issue Social Innovation and the Energy Transition, Hoppe, T. and de Vries, G. agree that “social innovation may also entail to issues like introducing new energy practices (i.e., related to the likes of production, storage, distribution, and use), new behaviors and relationships for supporting and managing social groups or new solutions that contribute to low carbon energy transition and at the same time to solving social problems.” and define social innovation in the realm of energy transitions as “innovations that are social in their means and contribute to low carbon energy transition, civic empowerment and social goals pertaining to the general wellbeing of communities” [49] p. 4.

As well as social aspects associated to contracts developed within energy transition processes, the climate contract concept has also been investigated. According to Gudde, P. et al. in [50], the local area climate contract represents the base of a new proposed governance framework where it is possible to connect national government and local areas under the same Net Zero ambitions. As explained by the authors, “a Local Area Climate Contract is therefore proposed functioning within a new governance framework of mutual cooperation based on agreed Climate Freedoms” [50] p. 11. The climate freedoms are ruled by a set of pre-agreed conditions and allow removing barriers that obstacle local authorities acting to mitigate the climate emergency and provide them the flexibility to finance initiatives, manage stakeholders, deliver infrastructure, goods and services with the final aim to reduce carbon emissions. The proposed governance framework defines the relationship between central and local governments and, at the same time, includes spaces for citizens’ engagement “with the opportunity to reinvigorate the social contract between the individual and the local authority” [50] p. 11.

In [51] the climate contracts refer to relationship between the municipality and large energy enterprises for reaching sustainability transitions’ goals, on the base of the real case study of the Hyllie urban area in the city of Malmö, Sweden. The authors analyze the steps that followed the contract’s signature in order to critically investigate its direct and effective consequences on sustainability transitions. According to this research, “the greatest potential of the climate contract lies not in its direct impact on reducing energy demand and climate emissions, but in the institutional innovation that it represents” [51] p. 13, since it represents a new type of collaboration among private and public actors. Cities are proved to be able to work purposefully and in a long-term scenario towards sustainability transition if they receive explicit support also from regional and national authorities. The climate contract signed by the Malmö City is also discussed within [52] (Park, D., 2020). Deeply

analyzing the Malmö lesson learnt, the author examines the influences that the vision provided within a climate contract can have on urban changes and if the climate contract can have direct responsibility on the urban energy transition. An initial general vision of the transition path must be included in climate contracts but it can be subsequently redefined according to more detailed socio-technical configurations that can emerge over time. The author explains that “in such techno-promissory moments, the vision is no longer translated into the socio-material relations of assemblages; instead, it is the state of socio-material assemblages that become translated into new promises.” [52] p. 406.

The majority of papers focusing on energy contracts discuss and define the modalities regulating the local energy exchange between buyers and sellers or among different prosumers. In the present paper, market-oriented contracts are not considered relevant as they are not directly related to the specific object of the inquiry. We point out only the following few papers because they deal with methodological pathways leading to contracts in energy communities’ contexts. In particular in [53] Kirli, D. et al., provide a systematic model for defining smart energy contracting process focusing on “the two mainstream application areas identified for smart contract use: energy and flexibility trading and distributed control” [53] p. 1. Concentrating on consumers preferences, in [54] Chakraborty, S. et al., “present an automated peer-to-peer (P2P) negotiation strategy for settling energy contracts among prosumers in a Residential Energy Cooperative (REC) considering heterogeneous prosumer preferences” [54] p. 1 and, similarly, in [55] Wang, Y., et al., propose a P2P energy sharing mechanism for energy community model where, through the definition of an energy contract as a tool for the management of energy exchange, “participants form an alliance and can trade energy with each other to maximisation individual benefit without a central controller” [55] p. 1. Giving greater importance to prosumers role, [56] develop a decision support system for bilateral negotiations consisting of 10 different combinable strategies to be adopted throughout the negotiation process in electricity markets.

3.2. *Citizenship’s Engagement Analysis within the Selected Case Studies*

According to the most recent EU energy policy, the citizens’ engagement in energy collective actions is considered a crucial strategy and viable solution to foster the green transition process. More specifically, energy communities are committed at increasing the use of renewable energy sources through an innovative energy sharing system where citizens are the main involved actors [57]. It is important to recall that the 14 case studies are not all strictly defined as energy communities. The operational settlement of energy communities, as defined by the EU legislation, is still not possible in all the EU countries because of the lack of national or regional legislation. This research aims to cover all the geographic EU macro-areas, so the analysis of case studies was extended also to other forms of collective initiatives involving renewable energy prosumers [21].

In this paragraph, the results of the selected case studies analysis are reported in order to highlight their main characteristics and enabling factors. The focus of the analysis is on the participatory practices that determined the development of the citizenship’s engagement processes.

The 14 case studies have been selected covering both Northern and Mediterranean parts of Europe, as shown in Figure 2.

For each selected case study, the enabling analyzed factors are reported in Table 1 and explained more in detail below in the text.

3.2.1. *Dimension of The Case Studies*

Three levels of case studies’ dimensions have been set:

- “local” that means that the energy community is developed in an urban-rural area related to a single city;
- “regional” including urban areas under more than one city’s competency;
- “national” where people can join at national level.

The dimension provides indication about the impact of the energy community in terms of citizens involved and their engagement's capacity. The local and regional energy communities are strongly linked to the local plants' installation used for the renewable energy supply of the community itself. At local level, the plants are mainly photovoltaics installed on buildings, as the cases of Svalin (Denmark), Magliano Alpi (Italy), Melpignano (Italy) and Banister House Solar (UK). The local plants that produce renewable energy can also be solar collectors, supplying collectively-owned district heating networks, as the case of Marstal Fjernvarme (Denmark), or the case of the Solbyn eco-village (Sweden) with the integration of photovoltaic and wind shares. At regional level, plans can be both big photovoltaic plants installed on roofs or in rural areas, as the case of SAS Ségala Agriculture et Energie Solaire Cooperative (France), which is a company created to install solar PV on agricultural buildings. Biomass plants, supplying district heating network in regional areas, characterize the cases of Tirano (Italy), Thessaly (Greece) and Basque Country & (Navarra Spain). At national level, any citizen can become member of the community, by means of buying renewable energy, locally produced by the community owned plants, as in the cases of Enercoop (France) and Som Energia (Spain) or, in alternative, by purchasing shares to finance renewable energy projects listed in the community's statutes, as the case of Courant d'Air (Belgium).

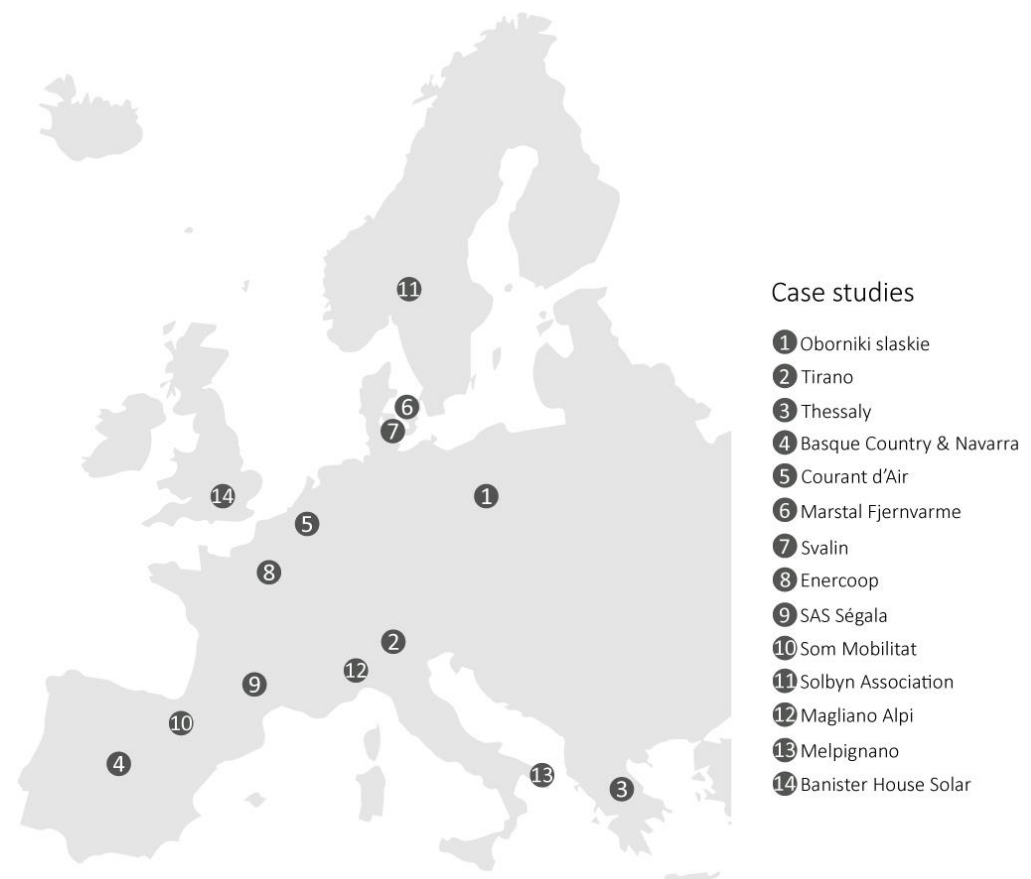


Figure 2. Distribution of the analyzed case studies. Infographic made by the authors.

3.2.2. Contracts' Typology

Energy communities are oriented towards the redistribution of the generated economic benefits among the members and not towards a commercial purpose for externals [58]. To define and fix the terms of the agreements at the basis of the partnership, several legal structures are applied to support citizens in participating to the energy system [33]. In this research, the word "contract" is used to refer to a form of agreement that states and explains a formal pact between different people or parties. It is not necessarily a binding legal document.

For an extensive review of the regulatory framework of REC, CEC and jointly-acting renewable self-consumers in 9 EU countries and regions, see Table 2 in [21] p.5.

Table 2. Focus on relevant citizens' engagement initiatives.

Case Study	Citizens' Engagement Initiatives	Links to the Initiatives
Basque Country & Navarra (Spain)	new business line for different types of consumers; map of social services	https://www.goiener.com/red-goiener/?s (accessed on 15 December 2021)
Courant d'Air (Belgium)	educational programme for citizens and schools; CoopHub platform for data managing and sharing with the cooperative	https://www.courantdair.be/wp/activites/sensibilisations-et-informations/ (accessed on 15 December 2021) https://www.coophub.eu/manuel-utilisateur/ (accessed on 15 December 2021)
Svalin (Denmark)	own energy generation; outdoor lighting system changing colors according to the CO ₂ emissions; real-time energy data measurements systems; energy community hub	https://www.housingevolutions.eu/project/svalin-co-housing-p2p-energy-community/ (accessed on 15 December 2021)
SAS Ségala Agriculture et Energie Solaire Cooperative (France)	Citizens' energy campaign; quality label and shared energy card; shared energy data; educational programme	https://energie-partagee.org/decouvrir/energie-citoyenne/label-charte-energie-partagee/ (accessed on 15 December 2021) https://energie-partagee.org/decouvrir/energie-citoyenne/chiffres-cles/ (accessed on 15 December 2021)
Som Energia (Spain)	participation tool; local groups for sharing information; shared maps of data; laboratory and educational programme in schools	https://www.somenergia.coop/ca/participa/#espai-participa (accessed on 20 December 2021) https://www.somenergia.coop/ca/participa/#grupslocals (accessed on 20 December 2021) https://www.somenergia.coop/ca/participa/escola-de-som-energia/ (accessed on 20 December 2021)
Solbyn Association (Sweden)	Eco-village; tenant-owner association; association board made of residents; community cultivation and forest garden cultivation	http://www.solbyn.org/about (accessed on 20 December 2021)
Magliano Alpi (Italy)	Energy4Com platforms; PODs maps; GOC—Community Cooperative Group	https://cermaglianoalpi.it/index.php/chi-siamo/ (accessed on 20 December 2021)
Melpignano (Italy)	members-citizens-users system; “live the water” project for decrease the use of water plastic bottles	https://www.comunirinnovabili.it/cooperativa-di-comunita-di-melpignano/ (accessed on 15 December 2021)
Banister House Solar (United-Kingdom)	community-owned solar energy project; local leadership promotion; meetings with the community; energy surveys; educational programme	https://www.repowering.org.uk/wp-content/uploads/2020/05/Banister1pgReport_2015.pdf (accessed on 15 December 2021)

The following types of adopted contracts emerge from the analysis of the selected case studies:

- Cooperatives and social enterprise cooperatives, where associated members consume and produce renewable energy for non-profit by adhering to a statute [59]. They are mostly created on the initiative of private. Example of statutes are the cases of Basque Country & Navarra in Spain and Courant d'Air in Belgium, for which it is possible to find the statutes in the related websites.
- Association, mostly on a local scale, set up by public initiative like the case of Magliano Alpi (Italy). The energy community is in fact an association between producers and consumers of energy. It is established through an expression of interest published by the Municipality and the signing of the incorporation's deed of the association.
- Energy enterprise, where members can join as consumers of energy produced from renewable sources. They are generally promoted by companies that deal with providing and installing technologies for renewable energy production to be shared. They are mostly created on the initiative of private. A case is the Banister House Solar in UK, that is a community-owned energy enterprise in Hackney.

3.2.3. Involved Stakeholders

The stakeholders involved are different depending on the objectives of the community and the adopted business plan. In the selected case studies, the citizens component is always present and is usually associated with industrial partners and public administrations. The public-private partnership is usually necessary to combine the needs and create the best strategies to implement renewable energy production projects, involving industries, for

plants' installation, and other investors. Public administrations can have the double role of leader of the community creation, as in the case of Magliano Alpi and Melpignano (Italy), and of providers of the areas where energy is produced, i.e., building roofs or public spaces, where installing photovoltaic systems for plant's installation. The initial investment for the renewable energy technologies provision and installation is usually covered by public incentives and/or it is the results of public-private partnership based on tailored business models. For example, in the cases of Oborniki slaskie (Poland), Tirano (Italy), Thessaly (Greece) and Basque Country & Navarra (Spain), funded by the Horizon 2020 BEcoop project (<https://www.becoop-project.eu/>, accessed on 18 November 2021) with the aim to implement a bioenergy community, the involved stakeholders have an important industrial component for biomass plants' strengthening and clean energy production. However, the citizens' involvement assumes a significant role by customizing the new business lines to the specific customers' needs.

3.2.4. Citizens' Engagement Level

Regarding the citizens' engagement level, the analysis performed on the selected case studies is inspired by the research conducted within GRETA project (WP1_ Framework to understand and predict energy citizenship emergence), which considers that citizens can transit among the following engagement's steps.

1. From unaware to aware energy citizens: They know about energy issues;
2. From aware to involved energy citizens: They start acting within the energy system by adopting energy saving measures;
3. From involved to active energy citizens: They decide to join an energy community;
4. From active to advocate energy citizens: They promote other citizens to join the community.

The case studies analyzed within this paper were purposely selected with a citizens' engagement from the aware to the involved level, and from the involved to the active level, in order to be able to analyze the related engagement initiatives (described within the following paragraph). In Table 1, the criteria that have been used for the citizens' engagement level definition are reported with the related explanations:

- From aware to involved ("aware" in Table 1): citizens are members because they consume renewable energy from the community but do not have relevant interaction with the community mainly participated in by industrial partners and public authorities;
- From involved to active ("involved" in Table 1): citizens are consumers and producers and are involved in information and educational programmes and activities organized by the community.

3.3. Citizens' Engagement Initiatives

In Table 2 below, a further selection of the analyzed case studies is reported, focusing on the most relevant citizens' engagement initiatives, for which the related links are indicated.

From the analysis of the engagements' initiatives performed and the involved stakeholders, the creation and managing of an energy community is strictly linked to the role of the citizens that live in the community. From an economic point of view, their role influences the adopted business model, as for example in the case of Basque Country & Navarra (Spain), where the business lines are customized to the customers' needs. From a technical point of view, the citizens' role influences the energy sharing and monitoring system. From the performed analysis, different innovative technological systems of data managing and sharing are identified, such as: the Coophub platform of Courant d'Air (Belgium), the quality label and shared energy card of SAS Ségala Agriculture et Energie Solaire Cooperative (France), the shared maps of data of Som Energia (Spain) and the Energy4Com platforms of Magliano Alpi (Italy).

The Svalin energy community case study (Denmark) is a significant example of how citizens awareness in the energy production-consumption process is fostered through

tools and technological systems for energy data monitoring and managing. They allow residents to understand when the best time range is to consume energy in relation to CO₂ emissions. In particular, an innovative and user-friendly outdoor lighting system is installed, that easily makes residents understand, through different colors, when is the best time to consume electricity, i.e., times when the CO₂ emissions are low.

Strong educational and information programmes are also presented in the analyzed case studies, highlighting how meetings and social events are important for the citizens' participation. Some examples of social initiatives are: educational programme for citizens and schools of Courant d'Air (Belgium), community and forest garden cultivation of the Solbyn eco-village (Sweden), "live the water" project for decrease the use of water plastic battles of Melpignano (Italy), the meetings and surveys with the community of Banister House Solar (UK).

Another relevant aspect is the formalization of citizens/residents' involvement through an elected board that have the role of administrating and managing the community, as the case of Solbyn Association (Sweden). This self-management system is mostly feasible in case of small local community, consolidated over the years, but the initiative to have a direct representative of citizens in the community, also in form of associations, can be an incentive for communities of bigger dimensions. For example, in the case of Som Energia (Spain), that has a national dimension, people can participate and join to local groups for sharing information.

3.4. First Implementations of the Climate City Contract. The Swedish Viable Cities Programme

European cities already have access to a variety of programmes and initiatives at regional, national, and international level to reach climate neutrality. Many of them have already started to activate the policies and the concept of doing so by 2050 is catching on, as testified by the new commitments taken by the signatories of the Covenant of Mayors just in April of the current 2021 year [36]. Nevertheless, only a very small number of cities have declared the willingness to reach the target of climate neutrality by 2030 so far. The Cities Mission answers the need to capitalize and exploit the already existing initiatives adopting a cross-sectoral and demand-led approach and creating synergies to accelerate the transition process [60]. The call for expression of interest will be closed in January 2022 and the selected cities will be released in March 2022. Thus, the co-creation process of Climate City Contracts has not officially started.

A relevant initiative to anticipate the experimentation of the Climate City Contract is developing in Sweden within the Viable Cities strategic innovation programme. The aim of this programme is to speed up the climate change adaptation in cities within the framework of the 2030 Agenda, and at the same time contributing to the recovery of the Swedish economy from the damages caused by the corona pandemic. The main enablers of the process are digitalisation and citizen engagement. The 2030 Climate Contract is the fundamental tool to express the intention of the parties to raise ambition in sustainable urban development and climate change adaptation through mutual and long-term commitments. The 2030 Climate Contracts have also the objective to put Sweden and Swedish cities in a leading position in the EU cities' climate transformation [61].

In line with the Cities Mission, 23 Swedish cities, that include the 40% of Sweden's population, expressed the ambition to become climate neutral by 2030 and nine of them have already developed their own 2030 Climate Contract. The main partners involved within this programme, are the Municipality, The Swedish Energy Agency (Energimyndigheten), the Swedish Agency for Innovation Systems (Vinnova), the Swedish Research Council for Sustainable Development (Formas), the Swedish Agency for Economic and Regional Growth (Tillväxtverket), and the KTH Royal Institute of Technology in Stockholm as host organization. The 2030 Climate Contract represents the cooperation tool between cities and the state level and has to be updated every year according to the obtained progresses. The nine cities that have already published the contract in its first version are: Enköping, Järfälla, Gothenburg, Lund, Malmö, Stockholm, Uppsala, Växjö and Umeå. The Umea contract is available online in English

(at <https://static1.squarespace.com/static/5dd54ca29c9179411df12b85/t/5fd369cad16683056e51ab28/1607690700282/1134044+Umea%CC%8A+kommun+engelska+T.pdf>, accessed on 15 December 2021), and it represents an example of application of the common scheme shared by all the cities. The structure of the contract is articulated in the sections summarized in the table below (Table 3).

Table 3. Sweden Climate City Contract structure.

Sweden 2030 Climate Contract Structure
1. Purpose of the Climate City Contract 2030
2. Involved Parties
3. Municipality's Commitments (Municipality's climate goals and targets; Strategy; Governance; Interaction and cooperative efforts with the business community, academia and the citizens/civil society; Climate change investment plan/climate city deficit/financing; Digital support for implementation; Regional innovation hub for climate-neutral municipalities; Reporting and follow-up reviews)
4. The Viable Cities programme commitments
5. Commitments by the governmental authorities
6. Strategic development projects in 2021
7. Joint work on follow-up reviews, evaluation, updating
8. The Contract signed by all the involved parties

Below, the content of the Umea Climate Contract, limited to the relevant information about the sections that are shown in brief in the table above.

Section 1: The purpose of the Climate City Contract 2030.

The aim of this Climate Contract is to accelerate the pace of climate change adaptation in cities within the framework of the 2030 Agenda, while contributing to the recovery of the Swedish economy in the wake of the corona pandemic.

Section 2: Parties.

Municipality; Swedish Governmental Authorities (the Swedish Energy Agency, the Swedish Agency for Innovation Systems, the Swedish Research Council for Sustainable Development, the Swedish Agency for Economic and Regional Growth).

Section 3: Municipality's Commitments.

- The Municipality's climate goals and targets: the common Viable cities goal is to be climate neutral by 2030. The city of Umea has also the goal to reach neutrality for the municipality as a whole by 2040. It also has the goal of reducing consumption-based greenhouse gas emissions to 2 tonnes of CO₂ equivalent per person per year by 2040 and 1 tonne of CO₂ equivalent per person per year by 2050. The Municipality and municipal-ly-owned companies have the goal of being climate neutral by 2025.
- Strategy: Municipalities have existing plans and programmes and they are developing a policy and action one in order to coordinate and link them to climate goals and targets. Umea has a Strategic Plan 2016–2028 and a master plan with associated specialisations and strategies (Strategy for Business Development, Energy Policy, Travel Policy, traffic management programmes, and others); they will converge in the Umeå Municipal Group's policy and action programme that will constitute the roadmap to reach the Climate Neutral Umeå 2030.
- Governance: governance models are built around cooperation and co-creation by the parties and the citizens. To facilitate the process, Umeå Municipality is developing several innovation platforms that will increase adaptability and innovative capacity and will explore original solutions.
- Interaction and cooperative efforts with the business community, academia and the citizens/civil society.
- Climate change investment plan/climate city deficit/financing.

- Digital support for implementation: the development of digital tools is the key enabler to foster dialogue, the stakeholders and residents' engagement and the co-creation of the 2030 Climate Contract. Open data, Internet of Things, Augmented Reality and other technologies will establish the precondition for envisaging the future and monitoring progress. A Digital Impact North collaboration forum is in progress, focusing on circular business models.
- Regional innovation hub for climate-neutral municipalities.
- Reporting and follow-up reviews.

Section 4: The Viable Cities programme commitments.

The Viable Cities innovation programme implementation is based on broad collaboration, as part of the Swedish commitment to meet the goals of the 2030 Agenda for Sustainable Development and the Paris Agreement, being the international pioneer in the cities transition. Viable Cities involves a wide range of parties across scientific disciplines, industries, small companies and civil society organizations.

Section 5: Commitments by the governmental authorities.

The governmental authorities support the municipalities in their mission-driven work and provide a framework for collaboration via the Viable Cities programme sharing lessons learned, legislation and regulations, research and innovation, invitations for applications for funding. The governmental authorities are also working to support participation in the EU programme Horizon Europe.

Section 6: Strategic development projects in 2021.

Strategic development projects have been conducted in collaboration with other municipalities within the Viable Cities Transition Lab (<https://en.viablecities.se/viable-cities-transition-lab>, accessed on 18 December 2021), a central venture by Viable Cities that aims to co-create a common ability to meet climate transition and to boost citizens potential thanks to digitization and automation. The following strategic development projects have been carried out: Interaction and cooperative efforts with the business community, academia, civil society and citizens, Long-term investment plan relating to climate change and socio-economic impacts, Digital support for climate change and energy transition.

Section 7: Joint work on follow-up reviews, evaluation, updating.

Municipality's results within the framework of Climate City Contract 2030 are checked annually through a follow-up review.

Section 8: The Contract.

It is the final page of the document and contains the signatures of all the parties.

Some contracts include an annex with more detailed information on the municipality's plans for climate change adaptation and the municipality's commitments for implementation.

The integration among the multi-level authorities at local, regional and national levels and among all the main stakeholders involved is predominant in all the Climate City Contracts 2030.

The Climate City Contract of the City of Malmö incorporates the experiences, the programme and the already achieved results that comes from a dedicated climate contract for the district of Hyllie that has been developing since 2013. The Hyllie Climate Contract is based on a public-private partnership for implementing smart city's solutions, with 2020 energy target (https://www.youtube.com/watch?v=zIPNQhvd_Ms, accessed on 22 December 2021). Since 2020, the district is 100% renewable energy provided, locally producing renewable energy and integrating innovative solutions (e.g., energy storage systems, smart buildings, integrated smart grid, biogas tank stations and electric vehicle charging, energy balance systems). This climate contract at district level, where public and private actors collaborate and coordinate actions, provides vantages to residents, visitors and employers of the area and it can be adapted and extended to other neighborhoods. As the Hyllie Climate Contract roadmap demonstrates, these initiatives at district level can be particularly significant as pilots that can represent replicable models for the development of policy and actions in the whole city and can also inspire the collaborative transition path shared among partner cities.

In the next section, an Italian case study of possible transition pathway toward climate contracts to be developed at district level is described.

4. Discussion

Within this paper, the energy community represents the context where developing climate city contracts, that have the aim to regulate the citizenship's engagement and make citizens effective partners of the community for the climate transition process. The paper has given an overview of the already existing typologies of energy community's contracts, of the expected Climate City Contract to be developed in the framework of the EU Mission 100 Climate-neutral Cities by 2030—by and for the Citizens, and the forms of engagement commitment envisaged in the energy community and similar entities context. Climate City Contracts are introduced as urban level mechanisms to provide EU support to cities through regulations, financing and innovation. They will be signed by the city Mayor, as representative of the local stakeholders, by the EU commission and by national and regional authorities.

The still persistent uncertainty of the legal framework for energy communities at national level in most of the EU countries, is a significant obstacle for their development and implementation, even if the European Commission provided the general strategy [1,3,4]. The top-down process of adopting EU regulations at regional and local level can be accelerated by a bottom-up movement where territorial policy is participatory, lead and co-designed with stakeholders and citizens.

In the GRETA project, energy is considered a social need, a socially-based practice and a citizenship field for active participation. The concept of energy citizenship is related to democratic participation and engagement in the sustainable energy transition [62] that can manifest in different ways and different levels, from individual choices affecting limited household contexts to participation in energy communities, advocating for climate change. Thus, the project investigates and tests the potential transitions between engagement levels and develops roadmaps and paths for change, that citizens and/or communities can adopt, called Community Transition Pathways (CTPs).

Energy Citizenship Contracts (ECCs) are proposed as pacts containing the conditions through which citizens participate and act in the related socio-energy community/context. Starting from the meaning of Climate City Contract and the analysis of the engagement experiences and contract typologies associated to energy communities, ECCs are conceived as packaged policy instruments, embedding local goals and targets, as well as broader strategies and programmes. The ECC aim is to support communities in harnessing energy citizenship and achieving fair agreements with the other actors involved in the energy system and with the governance levels. The expected result is a pragmatic tool, implementable and replicable in other regulatory contexts and decision-making processes within urban resilience planning, to prospectively foster active management of urban and human ecosystems through collective actions. The definition of possible ECCs is the main outcome of the CTPs, that support communities in transitioning through different levels of citizenship engagement (Figure 3) and lead to energy policy recommendations to encourage the application of ECCs in different contexts.

First Engagement Implementation Actions in the Italian GRETA Case Study

The GRETA core methodology consists in the investigation of case studies, involving different geographic contexts, extension and types of energy citizenship, for understanding the systemic and emerging conditions of the phenomenon, in order to design and test paths for improving and encouraging awareness, participation and engagement. These case studies represent pilot innovation living hubs where experimenting bottom-up initiatives, co-created with citizens, as preparatory actions that can bring to the definition of Energy Citizenship Contracts, in collaboration with the local authorities and stakeholders. Infact, before and aside the formalization of climate contracts within traditional decision-making processes and mechanisms, an important phase of experimentation is to be included: in

search of new strategies to achieve the pressing global and local goals of resilience and sustainability, under the current conditions of uncertainty and rapid change, cities and urban institutions are opening up to experiments, often emerging outside the formal contexts of decision-making, driven by actors other than city government, and generally characterized by local and global goals, multi-level polycentric governance, and collaborative design approaches.

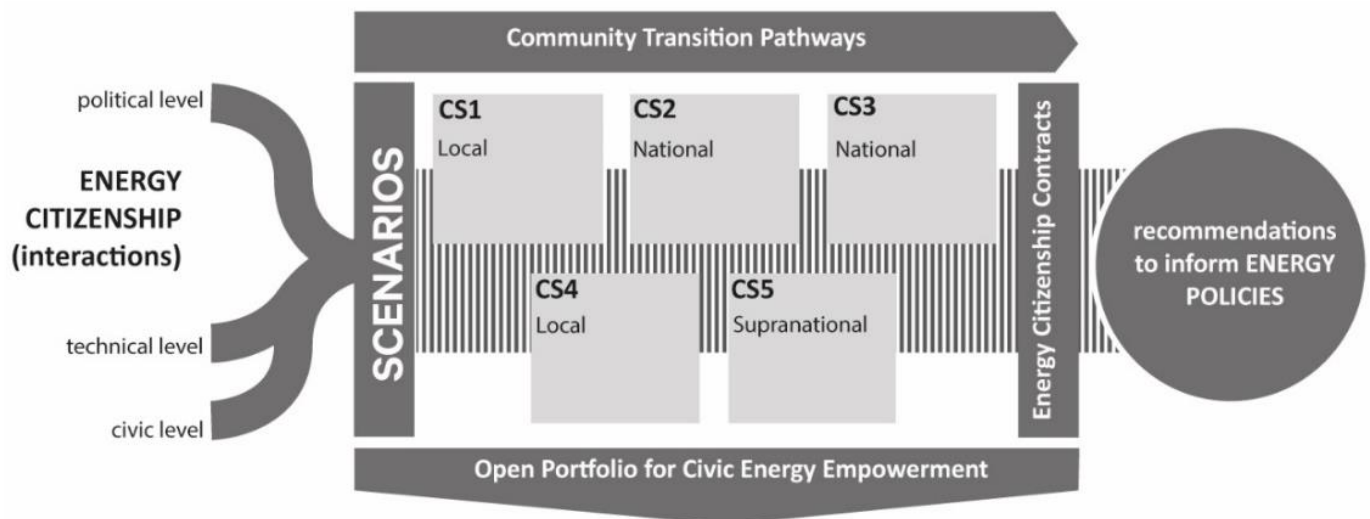


Figure 3. GRETA Project. Community Transition Pathways (CTPs) towards Energy Citizenship Contracts. Infographic made for GRETA proposal, originally made by Martina Massari, and re-elaborated for the publication by the authors.

In order to help urban institutions to better coordinate, integrate and consolidate local bottom-up and third-parties contributions towards the achievement of global goals, tools such as collaborative platforms, climate assemblies, etc. have been designed, as shown in the analysis of the most relevant and innovative energy communities case studies. The GRETA ECCs concept and formation is framed in this experimental approach and ecological transition co-design path.

The Italian case study of GRETA project is the mixed-used district of Roveri-Pilastro, an area of around 400 ha, located in the north-east part of Bologna. The district was built from the '60s as a response to the growing need of social housing, for locating immigrants and is composed by two neighbourhoods: Pilastro, that is mostly residential, and Roveri, characterized by the presence of industries. This district benefits from the presence in the area of the CAAB-FICO industrial partner, which has the EU largest PV plant installed on industrial roofs (Figure 4).

In this context, the GECCO project, funded by the European Institute of Innovation & Technology (GECCO—Green Energy Community, EIT Climate KIC TC_2.2.15_190736_P125-1; <https://www.geccocommunity.it/>, accessed on 20 December 2021) is working to create the first energy community of the city, in line with the implementation action reported within the Bologna SECAP. GECCO is promoted by AESS, the National Agency for New Technologies, the Energy and Sustainable Economic Development (ENEA) and the University of Bologna (UNIBO), with the collaboration of CAAB/FICO and the Pilastro-District Nord Est development agency. For a more detailed description of the GECCO project objectives and actions, in particular those related to GRETA, see the paper [17] (pp. 14–15). The shared purpose of the two projects, GRETA and GECCO, is to foster and study the process of formation of the local energy community.

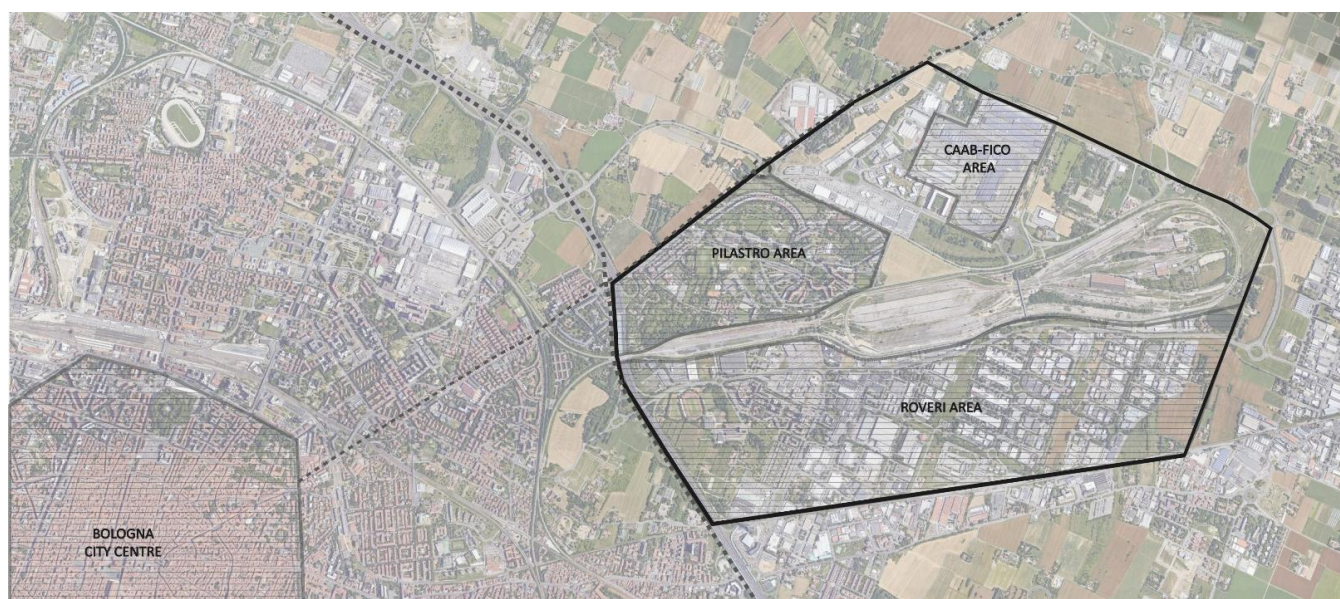


Figure 4. Roveri-Pilastro district aerial view. Infographic made by the authors.

GRETA and GECO, are collaborating in the organization of participatory events, involving the citizens of the Roveri-Pilastro district with the aim to inform, engage and start the co-design process of the Community Transition Pathway. Some of the first activities already implemented to facilitate the citizens' engagement are:

- Urban trekking initiatives, which consist on eco-conscious walks guiding citizens through the urban area and showing them the built environment from a different point of view, focusing on some relevant aspects (e.g., air and noise pollution, energy behaviours, energy sharing). The first trekking initiative in Pilastro-Roveri district was organized on the 19th of June 2021 and it was followed by two other events organised in July and September.
- Interviews to citizens to investigate what a citizenship community is for them, if they feel part of a community and how they can act to contribute to the energy transition process. Various interviews to residents of Pilastro were performed and are in elaboration.
- Educational and information events, as the Energy Days of the 10th and 11th of December 2021. During the Energy Days the following questions were answered by participants and were objectives of reflection:
- "What can help citizens move from traditional electricity consumption to a renewable energy community?"
- "How to involve the citizens of the neighborhood to monitor the electricity consumption in their homes?"
- "What additional services could the energy community offer?"

The framework that emerges after these first initiatives is fragmented and shows a non-homogeneous starting point of awareness of climate related issues and differentiated information, participation and engagement levels. Various commitment degrees concerning energy and sustainability have been detected, from almost unaware to already conscious of possible intervention actions for contributing to the area transition process. The local communities of the two areas of the district have different characterizations: mainly residents in the Pilastro area and workers in the Roveri area, and the organized events highlighted the need for more specific tailored approaches.

These participatory initiatives implemented for the GRETA Italian case study are first experimentations to start outlining the co-designed paths for change and contribute to collect an organic and shared vision that will be included within the future steps of the

project. The experimental bottom-up approach is used to support the multi-level authorities in the traditional decision-making process. On the other hand, the participatory approach can help citizens to understand both the climate and energy factors and the decision-making complexity, and to create the condition for an environment of trust and cooperation.

5. Conclusions

This paper aims at jointly investigating energy communities and climate/energy/social contracts as key factors to achieve the goal of implementing citizens-centered and climate-neutral cities. It also refers to the research progress of the ongoing H2020 GRETA project, focusing on the energy community's engagement processes and analyzing the existing examples of contracts as models for the development of the ECCs. In GRETA, ECCs represent the key instruments to link citizens participation, local and international policy makers commitment, transition targets and strategies, with a regulatory framework aimed not only at sustaining energy communities but also at enhancing their social value.

Despite the difficulties in the transposition of EU legislation in Member States' national laws and the lack of evaluation of the effectiveness in promoting and fostering the energy transition, a significant number of citizens across Europe is coalescing and developing new modes of collaboration, governance, contracts, business models and innovative financial mechanisms to enable the production, self-consumption and sharing of renewable energy. The innovation potential of energy communities needs to be boosted by a regulatory structure and a legal framework able to ensure support, guarantee commitment, equality and justice with the final aim of allowing citizens to operate in the energy market and contribute to the green transition.

As stated by Campos et al. in [21] p. 9, "given the costs, as well as organizational and knowledge needs required for groups of citizens to set up a local project, it is important to prevent the exclusion of more vulnerable communities and lower income families. Citizen Energy Communities (CEC) may involve a wide range of citizens in the energy transition that are not able to participate in place-based communities. Yet, legal frameworks seem to ignore this type of collective".

For this reason, the GRETA project has the objective to clarify the role of energy justice in the different levels of energy citizenship and to study methodologies to empower citizens to combat exclusion through the leveraging of agreed paths, the ECCs, between communities, policy makers, city actors and other key stakeholders of the energy system.

Since the GRETA project is in its first year of implementation, further research outputs and activities are expected, and an increased number of EU case studies will be analyzed. Furthermore, referring to GRETA project's outcomes, this paper presents a first set of participatory events carried out in the Italian pilot case study. During the course of the project, other actions and practical initiatives of citizens' engagement process in Bologna will be added and their results assessed, analyzed and described in future publications.

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