



Università degli Studi della Basilicata

Dottorato di Ricerca in
“Ingegneria per l’innovazione e lo sviluppo sostenibile”

“Green transition and voluntary planning: an integrated approach for a
climate-responsive territorial governance”

Settore Scientifico-
Disciplinare “ICAR/20”

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Foreword

Large European cities, over the years have been the driving force for the development of tools and policies for reducing CO₂ emissions and the promotion of climate adaptation and mitigation actions. Leading cities that are paving the way for this "green revolution" and that represent the best examples of integration of climate and energy policies into urban planning in Europe can be identified among some of the major cities of Northern Europe, such as Malmö, Stockholm, Antwerp, Amsterdam or Rotterdam. [1–4].

Additionally, the EU urban agenda specialized the climate and energy transition policies on the target of medium and large cities, which are considered as a major leverage to achieve climate targets. The main focus of this research is to identify the role and the contribution that smaller cities (i.e. with less than 5,000 inhabitants) can provide to the EU climate and energy commitments. The research hypothesis is that the current approach defines an imbalance between large cities and metropolitan areas, ignoring the larger part of the EU territory characterised by small and fragmented settlements. In this scenario, tools and monitoring campaign still not refer to clearly identify the relevant contribution coming from small municipalities, characterized by weaknesses in terms of technical capacity, capacity of attracting private investments for implementing actions. This class of municipalities, became the subject of this PhD project, considering that they account for 84% of all Local Administrative Units (LAUs) and cover 68% of the total area of LAUs among EU27 countries¹.

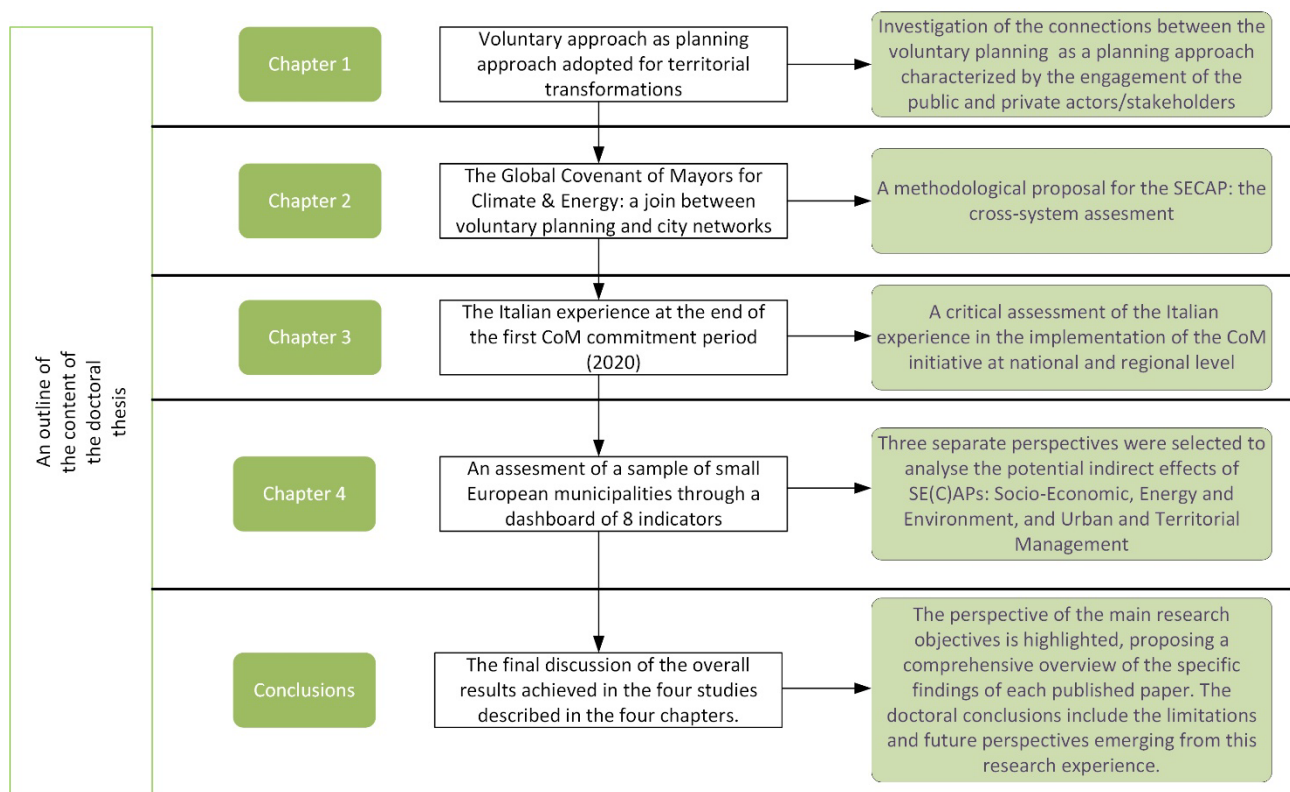
The European Union (EU) policy framework on energy, climate, and environment, currently enshrined in the European Green Deal [5], and supported by the new Leipzig Charter on sustainable cities [6], sets a comprehensive reference for implementing interventions aimed at reducing carbon emissions and driving the "green" transition. Since 2008, the Covenant of Mayors initiative in Europe (CoM) has been supporting local authorities willing to take local action against climate change through a bottom-up voluntary approach. CoM signatories commit to developing and implementing a Sustainable Energy and Climate Action Plan (SECAP) to meet their energy and climate targets, and to report key information and figures from SECAPs. The CoM played a pioneering role in dealing with energy and climate considerations at local level, which were neglected for long by urban planning. Analyzing the role of city networks within the climate-responsive processes (see Chapter 1), the CoM initiative was selected due to the voluntary approach and the relevant engagement of small municipalities (5653, as of December 2023). Specifically, the CoM among the other city networks, it is well defined to translate in practice the commitments of its signatories with a plan, the SECAP.

Against this background, the aim of this research is to define, within the CoM initiative, a reference framework oriented to direct the implementation of sectoral policies (urban development, mitigation of natural risks, social inclusion, economic development and employment, etc.) through the "*engineering of the complexity*", i.e. the principles of sustainable development posed on regional planning and the governance of territorial transformations. In particular, this framework has to refer to territorial and urban development policies (at EU and international level), understood as tools capable of directing and governing the transformations of the territory at the appropriate scales (see Chapter 3). The proposal aims to implement a holistic approach, enabling a context-based systemic view by providing robust decision support systems (DSS) for the implementation of sustainable and climate-responsive actions (see Chapter 2). In the development of the methodological framework, a

¹In these statistics, small municipalities are those with less than 5000 inhabitants, according to the Italian classification.

fundamental role must be assigned to the monitoring phase, which represents the "weak bond" of territorial planning processes, as it is often ineffective in describing a system of actions that explicitly states coherence with the desired scenarios and is accompanied by indicators capable of describing progress and objectives achieved (see Chapter 4). Such a methodological framework also provides an operational perspective in order to address the issue of unsolved dualism between mitigation and adaptation measures, which are sometimes contradictory to each other. The organic approach to which this research looks at would make it possible to identify any conflict situations in order to resolve them at an operational level. This may be achieved through intervention strategies that ensure adequate complementarity since, on a theoretical level, it can be argued that the more effective the mitigation activities are, the less costly the adaptation measures will be.

In the following figure is portrayed the outline of the content of the PhD thesis.



PhD thesis structure

The PhD thesis is structured according to the model of a collection of four published papers, the specific contents of which are described as follows:

Chapter 1 explores the connections between the voluntary planning (VP) as a planning approach characterized by the engagement of the public and private actors/stakeholders, which requires an “urban and green” awareness in order to achieve successful results in terms of investment and interventions within the urban context.

In order to build a comprehensive vision for VP through a conceptual paradigm, the role of city networks in shaping decisions and interventions emerges. In detail, from the authors’ perspective, city networks are the operative component in the design of local experiences and applications to help achieve the global energy and climate targets according to current policies. In this context, successful results of the climate and energy challenge express the degree of the awareness and the commitment achieved by the local communities.

The first research is structured as follows: section 2 explores the role of global and national policies oriented to climate responsive processes, section 3 provides a literature review on the voluntary planning approach, section 4 describes the EU Programmes as meeting points for City Networks, section 5 portrays an overview on 10 city networks while section 6 remarks the link between city networks and foundations. Finally, section 7 and 8 are related to the discussions and relevant results achieved in this research.

Chapter 2 explores the current CoM implementation season (connected with the implementation of the so-called G-CoM - Global Covenant of Mayors for Climate & Energy), which has reinforced the ambitious target of implementing energy efficiency by coupling it with climate adaptation/mitigation actions at a municipal scale. However, the suggested SECAP methodological framework shows some critical weaknesses in creating an integrated approach for urban sustainable planning. Therefore, the aim of this paper is to propose a structured methodology for SECAP design. It represents an innovation for current procedures oriented at reinforcing the strategic planning approach in the SECAP development procedure. This second research, starting from the description of the European policies framework on energy efficiency, CO₂ reduction and climate change from the beginning to European Green Deal (section 2), focuses on the experience of the CoM with particular regard to the SECAP (section 3) considered as an urban planning tool (section 4) widely adopted in Europe to manage the component of urban and territorial transformations generated by the low-carbon transition process. Therefore, in section 4, some interesting case studies deriving from European SECAPs are described, while in Section 5 technical details included in the SECAP supporting tools provided by CoM from the point of view of the planning disciplines, are elaborated. After a critical analysis of the SECAP methodological approach (in section 6) that identifies the strengths and weaknesses of the mayors in terms of process rationality, section 7 provides a methodological proposal aimed at overcoming the SECAP sectorial approach towards a cross-system approach, contributing towards a building and implementing integrated urban sustainable development strategy. Section 8 is related to the conclusions, highlighting the main results of this work.

Chapter 3 points out the critical assessment of the Italian experience in the implementation of the CoM initiative referred to the first deadline fixed set to 2020 targets [7]. In the Italian case, different approaches in the CoM implementation come from main territorial sub-areas: North, Centre and South of Italy. This study formulates hypotheses concerning the causes of such differences and describes comprehensive figures deriving from the classification of the CoM intervention priorities. A regional focus is also presented in order to demonstrate some lack of data in the official CoM Database (DB) and to discuss the thesis theory concerning the local municipality approach towards sustainable energy planning as an alternative to institutional urban planning.[8]. In section 2, a spatial assessment of the Italian signatories and the corresponding SEAPs developed, is presented according to the Nomenclature of Territorial Units for Statistics (NUTS). The investigation of the intervention sectors occurrences represents a second elaboration considered to be useful to deliver a deeper understanding about of the differences in approaches promoted through the development of the SEAPs development in different areas. The Section 3 is structured in three parts: 1) an assessment of the Italian CoM signatories compared to the resident population per NUTS-1 areas and an evaluation of the CoM sectors occurrences among the submitted SEAP, 2) an assessment of the Monitoring Reports (MRs) as a critical stage of COM implementation, 3) a focus on the Basilicata Region (Italy) in order to obtain detailed information at local level on the status of the monitoring phase in the implementation of SEAPs. Section 4 and 5 discuss the main results and outcomes and, based on the regional focus, the resulting critical tendency for Italian municipalities to prefer voluntary planning procedures (“EU CoM- like”) to the traditional urban planning practices regulated by regional and

national laws. This interesting outcome allowed to discuss a critical position concerning the effectiveness of voluntary planning instruments vs institutional planning tools. The Conclusions explains the main results deriving from the investigated CoM DB data, concerning the CoM Signatories, the population resident in the SEAP municipalities, the MRS submitted and the occurrences of sectors among the Italian Signatories.

Chapter 4 aims to assess the potential additional indirect benefits of SE(C)APs on XS municipalities. Three separate perspectives were selected to analyse the potential indirect effects of SE(C)APs: Socio-Economic, Energy and Environment, and Urban and Territorial Management. These perspectives are explored through a set of indicators that supports the evaluation of potential co-benefits that XS municipalities obtain from the implementation of SECAPs, intended also as an opportunity to improve the territorial competitiveness and the environmental/social protection. Moreover, the role of SE(C)AP as a "bridge" that complements traditional planning tools in term of flexibility of planning processes and support for energy and climate efficiency projects is investigated. The sections of this fourth research, delve into the role of SE(C)APs to guide urban planning practice and provide insights into the rationale of the three perspectives and into the related indicators. The outcomes of the application of the indicators to the sample of CoM XS municipalities are presented and discussed. Finally, conclusions and future perspectives are drawn.

Conclusions include the final discussion of the overall results achieved in the four studies described in the relevant chapters. The perspective of the main research objectives is highlighted, proposing a comprehensive overview of the specific findings of each published paper. The doctoral conclusions include the limitations and future perspectives emerging from this research experience.

1. Voluntary planning and city networks: a suitable review addressing current issues for sustainable and climate responsive planning²

Abstract: *Over the years, energy saving and climate change have sparked a challenge in developing innovative spatial and urban planning tools, methods and approaches for urban areas and territorial management. This challenge has pointed out a gap in the traditional planning framework, in tackling energy and climate issues and highlighting the need for renovated spatial planning practices.*

The current effective measures carried out by the complex network of stakeholders (public and private) are fragmented, and it emerged the role of city networks in shaping decisions and interventions. In particular, among the approach for the urban and territorial planning and the development of climate-responsive measures, the research adopts the specific focus of voluntary planning. The authors, through a literature review and an analysis on 10 city networks and two foundations, investigated how this approach was addressed to the energy and climate issues and how it is linked to the city networks in designing investments and interventions within the urban context. From the authors' perspective, city networks are the operative component in designing local experiences and applications in contributing to achieve the global energy and climate targets according to the current policies. In this context, successful results of the climate and energy challenge express the degree of the awareness and the commitment achieved by the local communities. Moreover, the climate and energy goals reached, represent the outcome of the interaction between the (public or private) actors involved and the degree of a climate-responsive city, rather than from a normative constraint or an institutional framework.

Keywords: voluntary planning, city networks, urban planning, climate responsive planning, awareness, commitment

Introduction

“Cities are now acknowledged as a critical arena in which the governance of climate change is taking place” [9]. This statement summarizes, over the last decades, the significant role cities have taken on in incorporating environmental considerations into their urban and territorial planning strategies, towards sustainable development and low-carbon economy targets.

As highlighted by Hooghe et al [10], local authorities have performed local climate change actions in climate protection within an explicit ‘multi-level policy framework’, distinguishing two types of multilevel governance: the first is characterized by jurisdictions at a limited number of levels, bundling together multiple functions, including a range of policy responsibilities according a system-wide architecture. The second is composed of specialized jurisdictions and the governance is fragmented into functionally specific sections, providing a particular local service, solving a particular common resource problem without limits to the number of jurisdictional levels and according a flexible design.

² Santopietro L. & Scorza F. (2023). Voluntary planning and city networks: a suitable review addressing current issues for sustainable and climate responsive planning. Paper under review on *Progress in Planning*

Energy saving and climate change have sparked a challenge in developing innovative spatial and urban planning tools, methods and approaches for urban areas and territorial management. However, this challenge has pointed out a gap in the traditional planning framework in tackling energy and climate issues and a need for renovated spatial planning practices. [11–13]

Specifically, climate action planning has become a top priority for cities to reduce greenhouse gas emissions and strengthen climate resilience, while improving mitigation and adaptation strategies in urban areas as key objectives for sustainable development. [14]

There is a growing recognition that traditional top-down, government-driven, authoritative approaches are becoming less effective due to the shifting of responsibilities and resources across various political-administrative tiers (spanning from the EU down to states, regions, and municipalities. Previous researches [15–19] have observed that the top-down approaches, public-led actions are no longer politically and economically viable, whereas new methods based on public-private partnerships are being progressively adopted.

The trend of retreatment from the role of regulators for the public authorities fostered the involvement of private stakeholders in reaching planning goals (Healey et al., 2002), and public authorities became facilitators in designing new, preferably market-based, actions (Spaans et al., 2011; van der Veen et al., 2010)

Consequently, the resulting approach to the climate and energy issues is fragmented, if compared to the current effective measures carried out by the complex network of stakeholders (public and private). From the perspective of the authors, voluntary planning (VP) is a planning approach characterized by the engagement of the public and private actors/stakeholders, requiring an “urban and green” awareness in order to achieve successful results in terms of investment and interventions within the urban context.

In order to build a comprehensive vision for VP through a conceptual paradigm, the role of city networks in shaping decisions and interventions emerges.

Acuto and Rayner [23] define city networks as “formalized organizations with cities as their main members and characterized by reciprocal and established patterns of communication, policy-making and exchange”.

In detail, from the authors’ perspective, city networks are the operative component in designing local experiences and applications in contributing to achieve the global energy and climate targets according to the current policies.

In this context, successful results of the climate and energy challenge express the degree of the awareness and the commitment achieved by the local communities.

Moreover, the climate and energy goals reached, represent the outcome of the interaction between the (public or private) actors involved and the degree of a climate-responsive city, rather than from a normative constraint or an institutional framework.

The authors have identified four characterizing factors (CF) that have significantly influenced the development of those climate-responsive planning processes: The International Environmental Framework (CF1), climate geographies (CF2), VP approaches (CF3), and membership in city networks (CF4). Among them, it is possible to distinguish between changeless and variable factors. CF2 is a changeless factor, while CF1, CF3 and CF4 are variable factors.

CF2 explain a systematic knowledge of physical phenomena that characterize those places and they can be numerically quantified, while the other aspects are consensus-related. Indeed, they are related to the policy governance priorities on which they work, opening a debate on the selection of the planning processes of the future cities and city network membership.

CF2 have been considered as changeless, a structural condition that does not change over time, because they are representative of those conditions such as geographical location of the cities, climate system, socio-economic conditions and an established well-organized technical support of the planning processes.

CF2 determine the features of the places (the implementation context), combined with multi-level governance and accelerate the development processes of mitigation actions or tools to support the decisions to increase the resilience of the places. Examples related to this are the cap-and-trade system initiated by the city of Tokyo[24], the development of local climate zone maps as a heat stress assessment tool in three Belgium cities [25] or the knowledge systems for urban resilience to cloudburst rain events in USA and Denmark[26].

Furthermore, the geographical location (as a component of CF2) has a relevant implication if it entails energy transition because there is an absolute characteristic of the location (latitude/longitude) and a relative one describing the ‘relational proximity’ of one element in the system to another.[27]. Hence, the heterogeneous selection of renewable energy systems (RES) from several sources (solar, wind, hydro, biomass, geothermal, and ocean) is an open debate at territorial level in achieving the target of a low carbon economy [28–31].

The selection of RES can also be related to the energy network structure in terms of geographical contiguity, connectivity and centralization of capacity and supply decisions, that support the development of an integrated or fragmented energy network, built on the selected RES.

CF1 is a variable aspect, related to the environmental policy of each country, and shaped by international environmental treaties or agreements.

Every country worldwide, over the years has developed specific directives related first to energy efficiency and then facing climate-change implementing international agreements.

The authors have investigated (Section 2) the timeframe progress of international and national legislations related to GHG (green-house gases) reduction and climate change, highlighting how the national directives meet the international ones.

Almost all environmental policies have been introduced since 1979, when the Geneva Conference (World Meteorological Organization., 1979) was held and where the World Meteorological Organization (WMO) evaluated the scientific knowledge available at that time, in order to understand the relation between the GHG concentration and the average annual temperature. Consequently, in 1988 the Intergovernmental Panel on Climate Change (IPCC) was established under the support of the United Nations Environmental Programme (UNEP) and WMO, to share the scientific knowledge within an intergovernmental group.

These two events have started a “worldwide environmental season”, characterized, until the year 2000, by energy efficiency and GHG emission reduction, and implemented, from the year 2000, by the environmental issues related to the climate change.

A fundamental step in this roadmap facing climate change, is the Paris Agreement in 2015[33]. It is a legally binding international treaty on climate change adopted at the UN Climate Change Conference (COP21) in Paris.

Its overarching goal is to contain “the increase in the global average temperature to well below 2°C above pre-industrial levels” and pursue efforts “to limit the temperature increase to 1.5°C above pre-industrial levels.” The threshold of 1.5°C was stated by the UN’s Intergovernmental Panel on Climate Change to avoid the risk of more severe climate change impacts, including more frequent and severe droughts, heatwaves and rainfall.

Today, the Paris Agreement represents a milestone in the multilateral climate change process as, for the first time, a binding agreement bringing all nations together to combat climate change and adapt to its effects.

Consequently, recent developments on the climate and energy targets were included in the report of the International Energy Agency in 2021 [34] with the ambitious target of the climate neutrality. This target became a pillar of the European Green Deal [5] setting the achievement of climate neutrality by 2050.

Moreover, from an international perspective, the Glasgow Pact (United Nations Framework Convention on Climate Change, 2021) recognized that “*reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases*” committed over 140 countries worldwide, thereby covering 90% of global emissions.

CF3, has designed an “additional” approach and it is irrespective of the institutional processes. It has been considered a variable aspect because it is related to the environmental awareness and engagement of the citizens in the urban issues, that are not pursuit likewise worldwide.

This approach enabled working groups to tackle energy efficiency, climate-change and social issues, and additionally it has become mainstream to communicate and share experiences suitable for all (as example Car Free-Day or World Environmental Day). It is a label of the commitment level of the local authorities, that often supports and promotes the establishment of local groups of municipalities in reducing energy, sharing common targets and supporting innovative processes.

Furthermore, the voluntary approach overcomes stiff institutional processes, sharing common targets, but achieving them with more flexible processes. Related to this, are those experiences developed in Denmark integrating climate change in institutional processes [36] or those widely adopted in Europe within the Covenant of Mayors initiative [37,38], and detailed for Italy, where the voluntary approach has unlocked the planning processes in urban areas [39].

Another relevant issue is to consider how the engagement of the stakeholders and citizens involved in the processes plays a fundamental role in achieving successful results in those contexts where there is a complete normative national framework as opposed to a fragmented local one.

CF4 is the last variable aspect found, that explains the aim of being a member of a community offering local authorities with opportunities in terms of policy development, technical support and improvement of their worldwide significance.

This membership aspect, has increased the adoption of (environmental and non-) policies, especially if cities have interests in public health and economic development co-benefits [40], as well as co-benefits deriving from the reduction of air pollution and fossil fuel consumption (as a result of energy

efficiency policies) [41]. Furthermore, it is a significant opportunity for the small cities (i.e. below 5,000 resident inhabitants), where usually the lack of technical skills, locks the development of policies or launches them without additional support, as opposed to the Metropolis or large cities (i.e. with a number of resident inhabitants over 50,000) where technical teams are skilled in developing policies and planning interventions. Small cities, through the support of the city networks, have expressed their contribution to achieve global climate and energy targets and have increased their worldwide significance to be active players just like the larger cities.

On this track, city networks have supported and reduced the gap between large and small cities in developing environmental and non-environmental policies, operating outside institutional processes and fostering the achievement of sustainable development goals and facing climate-change.

Thus, the voluntary approach through this evaluation, can be considered as a tool able to improve the institutional framework, pursuing the sustainability, efficiency and engagement issues and making the institutional processes of local governance, flexible. However, this approach supported the development of several interventions on urban areas that were “missing an urban vision” [42] and operated by non-integrated sectors (i.e. residential buildings, transport, energy etc...). In any case, the voluntary approach should be evaluated as an opportunity for the small cities to develop a sustainable and climate proof policy; but at the same time the need to design an assessment framework able to monitor and evaluate the development of actions and policies undertaken, arises.

The research is structured as follows: section 2 explores the role of global and national policies oriented to climate responsive processes, section 3 provides for a literature review on the voluntary planning approach, section 4 describes the EU Programmes as meeting points for City Networks, section 5 portrays an overview on 10 city networks while section 6 remarks the link between city networks and foundations. Finally, section 7 and 8 are related to the discussions and relevant results achieved in this research.

Global and national policies towards climate responsive planning

The scientific interest on the effects of the GHG on the Earth's climate started in the 1970's with a growing awareness for the potential consequences in a long-term scenario.

In 1979, the First World Climate Conference was held, which was a pivotal event in the early history of international climate science and policy discussions. It represents the first major international effort to bring together scientists, policymakers, and experts from around the world to discuss the emerging issue of climate change. The main objective of the conference was the review of the state of knowledge regarding climate change and its potential impacts and the assessment of the existing climate research programs and data collection efforts.

The conference resulted in several important outcomes, specifically:

The establishment of the World Climate Programme (WCP), a long-term research initiative aimed at improving an understanding of climate dynamics and variability.

The declaration of the need for a global system to monitor and assess climate change and its impacts.

The First World Climate Conference represented a critical milestone in the recognition of climate change as a global issue that required international cooperation and scientific research. Moreover, it

was the groundwork for ongoing discussions about climate change, which ultimately led to the formation of the Intergovernmental Panel on Climate Change (IPCC) in 1988.

The IPCC was established as a scientific response to the growing concerns about climate change and the need for an authoritative and internationally recognized body to assess the scientific evidence, impacts, and potential mitigation strategies related to global warming.

The IPCC provides scientific information related to climate change, supporting the development of international climate agreements, such as the United Nations Framework Convention on Climate Change (UNFCCC) [43]. It was the first international environmental treaty signed in 1992, that established different responsibilities for three categories of signatory states: developed countries, developed countries with special financial responsibilities, and developing countries. The treaty was implemented by the Kyoto Protocol [44], based on the principle of common but differentiated responsibilities: it acknowledged that individual countries have different capabilities facing climate change, economic development, and different obligations to reduce current emissions on developed countries. The Kyoto Protocol is the world's only legally binding treaty to reduce greenhouse emissions below the 1990's levels. The Kyoto Protocol had two commitment periods: the first from 2008 to 2012, the second from 2013 to 2020, specified by the Doha Amendment [45]. In 2015, the Paris Agreement [33] superseded the Kyoto Protocol. It was considered to be not legally binding and included (otherwise Kyoto Protocol) in its member list China and the United States (representing almost 40% of the total global emissions).

In 2021, the Glasgow Climate Pact (United Nations Framework Convention on Climate Change, 2021) proposed to accelerate the efforts supported by the countries in aligning with the Paris Agreement commitments. Furthermore, in the report “Net zero by 2050” [34] for the first time the current ambitious target of climate neutrality was tackled.

This report is the world's first comprehensive study of how to transition to a net zero energy system by 2050, while ensuring stable and affordable energy supplies, providing universal energy access, and enabling robust economic growth. The report also examines key uncertainties, such as the roles of bioenergy, carbon capture and behavioural changes in reaching net zero.

Within this international environmental framework, worldwide countries adopted several approaches in order to develop national policies related to climate-change, energy efficiency and environmental awareness.

The European Union (EU) started its climate policies as part of the environmental policies with the “Single European Act” [46,47], in understanding that environmental issues and pollution were not only the problems of each EU country but went beyond national borders and therefore should be managed at an EU level. During the first few years of the new millennium, the EU brought the climate component, as a relevant action domain, with the energy sector into the European Climate Change Programme (ECCP), aimed at developing and coordinating strategies to reach the Kyoto targets. In March 2007, the European Council in its Presidency Conclusions established a set of three targets known as ‘20-20-20-2020’ [48] concerning GHG emissions, renewable energies and energy efficiency. In 2008, the European Commission introduced the ‘Climate and Energy Package’ and launched the Covenant of Mayors initiative, bringing together thousands of local governments voluntarily committed to implementing EU climate and energy objectives. In December 2019 the European Green Deal [49] entailing an ambitious package of measures to cut GHG gas emissions and striving to be the first climate-neutral continent was introduced. The European Council in March 2020 submitted its long-term strategy [50] to the UNFCCC presenting the European Climate Law draft and

in September 2020 proposed to raise, as part of the European Green Deal EU, the 2030 GHG emission reduction targets to at least 55% compared to 1990.

Other Countries adopted energy and climate frameworks gradually, starting in the same period (from early 1980 onwards). Indeed, in the United States the Clean Air Act has been amended (in 1977 and 1990) to strengthen its effect, including adding regulations relating to acid deposition (to tackle acid rain) and stratospheric ozone protection. The Environmental Protection Agency (EPA) began regulating GHGs from mobile and stationary sources of air pollution under the Clean Air Act for the first time in 2011. In 1990, the Global Change Research Act established the United States Global Change Research Program, which publishes the United States National Climate Assessment once every four years. The purpose of the Global Change Research Program is to understand and evaluate risks to the United States that stem from climate change. This law outlines specific criteria according to which the Global Change Research Program must operate, including its committee structure, funding sources and timeline for compiling reports. In Japan, the Law Concerning the Rational Use of Energy (Energy Conservation Act) (Law No.49 of 1979) is considered the pillar of the Japanese energy conservation policy as well as one of the two key climate laws. It was enacted in 1979 in light of the oil shock with a purpose of promoting an effective and rational use of energy, covering sectors such as energy management in the industrial, commercial, residential and transportation sectors as well as energy efficiency standards for vehicles and appliances. In 1980, the Law Concerning the Promotion of Development and Introduction of Oil Alternative Energy (Law No. 71 of 1980) implemented measures for the development and introduction of alternatives to oil, including renewable energy. The Act on Promotion of Global Warming Countermeasures (Law No. 117 of 1998) stipulates that the State is responsible for implementing necessary measures to introduce Emission Trading Scheme (ETS) in Japan. This Law also provides that the national and local governments are responsible for development and implementation of plans to reduce GHG emissions. The National Government adopted the Plan for Global Warming Countermeasures in May 2016, with the explicit aim to achieve the mid-term target set in Japan's INDC (2015) 26% GHG emissions reduction by 2030 (baseline 2013). In addition, the Plan also sets a long-term goal of 80% GHG emissions reduction by 2050.

African countries have developed their climate laws and policies mainly on the energy efficiency, renewable energy and establishment of national environmental agencies, but in some countries such as Nigeria, the issue of climate change has been tackled achieving long-term social and economic sustainability and resilience following the President's commitment made at the COP 26 in Glasgow of achieving net zero by 2060. In other African countries (i.e. Ethiopia, South Africa or Zambia) the environmental issues have been undertaken with the establishment of disaster prevention and awareness programs and funds, available to manage and plan activities facing risk disaster.

A review on voluntary planning

There is not a clear date, event or agreement able to identify the beginning of the VP related to urban and territorial development; despite that, it is possible to identify the training path, that has supported the establishment of VP related to urban, territorial and environmental issues.

In this perspective, the authors performed a review on the Scopus website of the words “voluntary planning” per title, abstract and keywords, as portrayed in fig.1. The bibliometric analysis was conducted by only selecting published articles in the English language and including subject areas

with a direct relationship with urban planning issues (i.e. excluding medicine, chemistry and biological subject areas). Data-analysis and data-visualization were performed through the open-source software Bibliometrix [51,52].

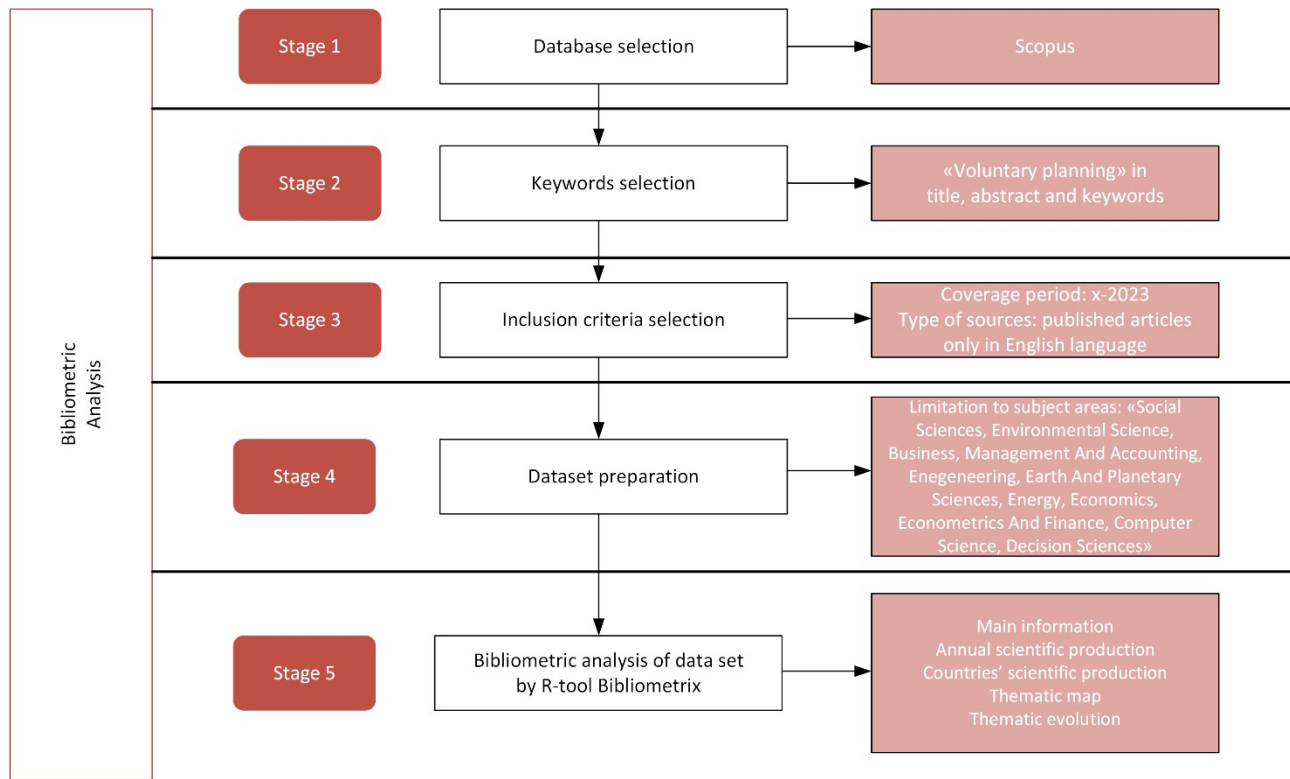


Figure 1 Flowchart of bibliometric analysis

Results from the bibliometric analysis reported 1208 publications covering a timespan of over 80 years, and figure fig.2 shows a comprehensive dashboard of the main information retrieved by the dataset built by the authors.

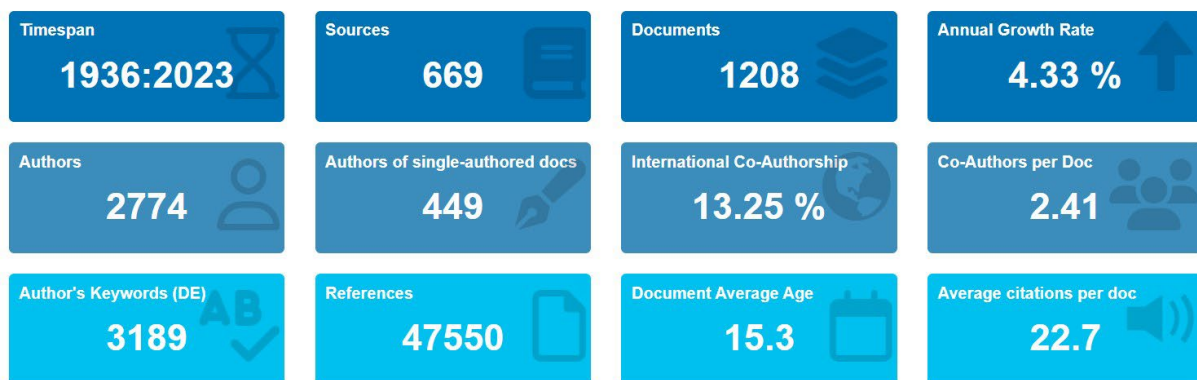


Figure 2 Main features of the dataset investigated (developed using Bibliometrix)

In terms of article’s publication (see fig.3) there is an increasing growth trend over the years, and it is relevant to highlight that after the year 2000, the frequency of published articles is always over 30 per year and a reason thereof could be the development of energy and climate policies at national and international levels, as well as the growing awareness and interest towards voluntary planning.

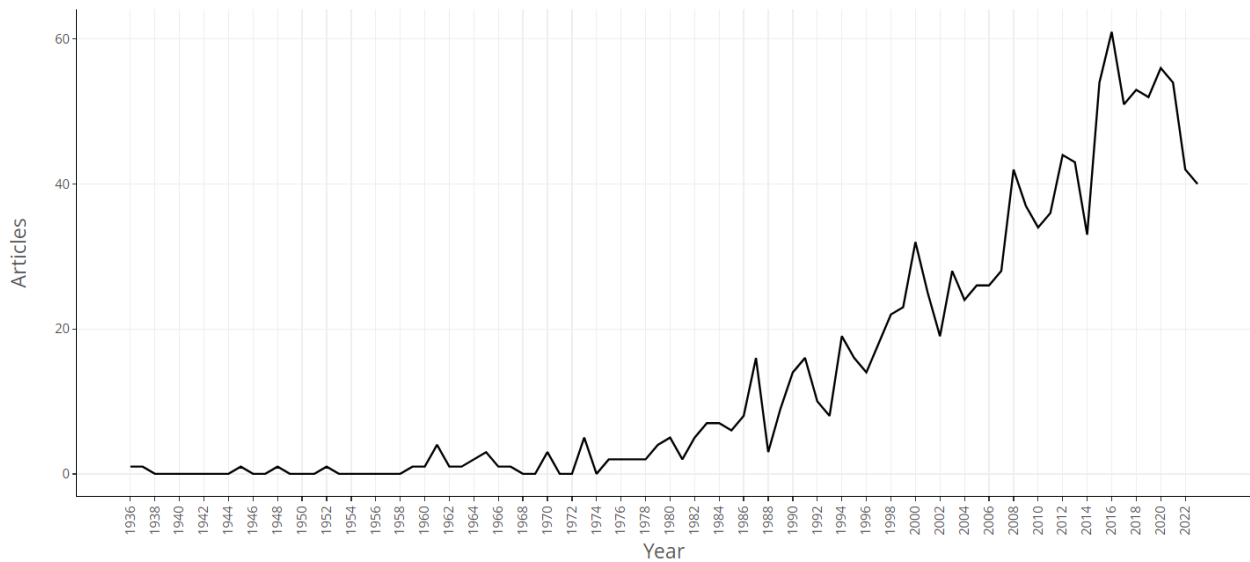


Figure 3 Annual scientific production (developed using Bibliometrix)

Looking at the scientific production of the countries (see fig.4), the first one is the United States of America, followed by the United Kingdom and Australia. The common Anglo-Saxon roots of these three countries provide an insight on the planning approaches tackled in these countries and indicate that the voluntary approach registered a prevailing interest in these countries rather than in others[53,54].

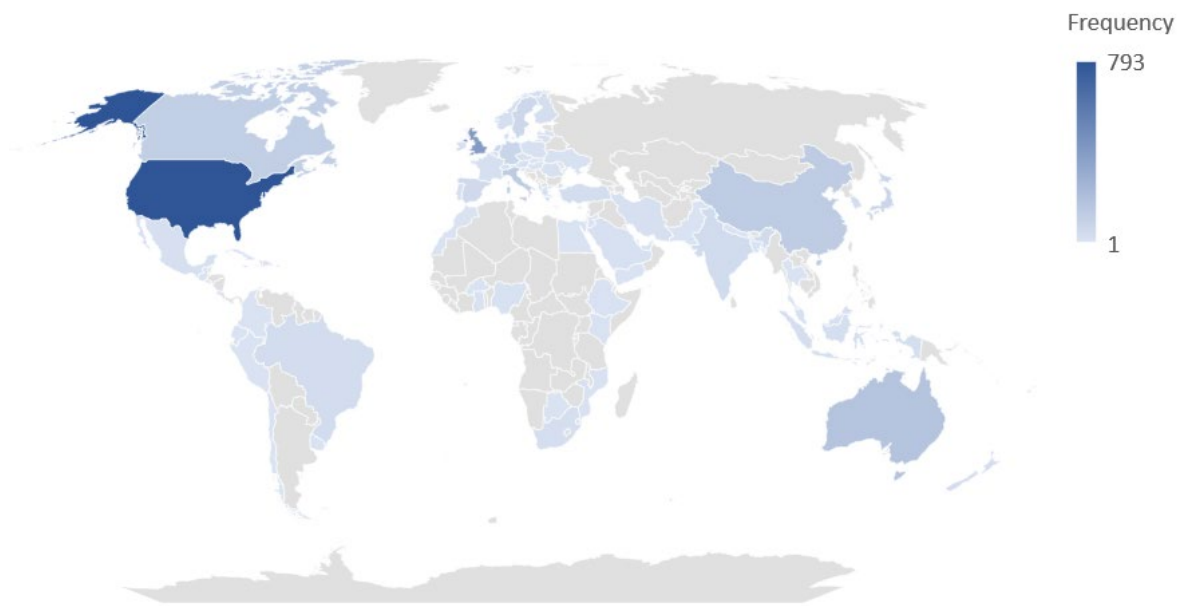


Figure 4 Countries' scientific production

In order to understand the themes that drive (and have driven) the trend of the VP approach, the authors developed a thematic map deriving from the co-word analysis. The co-word analysis indicates the conceptual structure and highlights the link between concepts through term co-occurrences.

A thematic map is a two-dimensional diagram where density and centrality are used in classifying themes [55–57]. Themes are classified in four quadrants: (1) upper-right quadrant: motor-themes; (2) lower-right quadrant: basic themes; (3) lower-left quadrant: emerging or disappearing themes; (4) upper-left quadrant: very specialized/niche themes.

Authors' keywords were selected as field of investigation in developing the thematic map.

The results shown in Figure 5 indicate a link between VP and climate change and sustainable development issues. They represent fundamental issues and are a necessary background to comprehend the VP processes. Another relevant feature relates the VP to the themes of ecosystem services and spatial planning, which are on the borderline between niche and emerging (or declining) themes.

The basics themes in the thematic map, reiterate the relation between “traditional” and “incoming” issues in describing the voluntary planning. Traditional issues are governance, planning and regional planning whereas incoming issues are climate change and sustainable development. Thus, investigating these last two themes allows to better understand the pathway of the VP approach over the years.

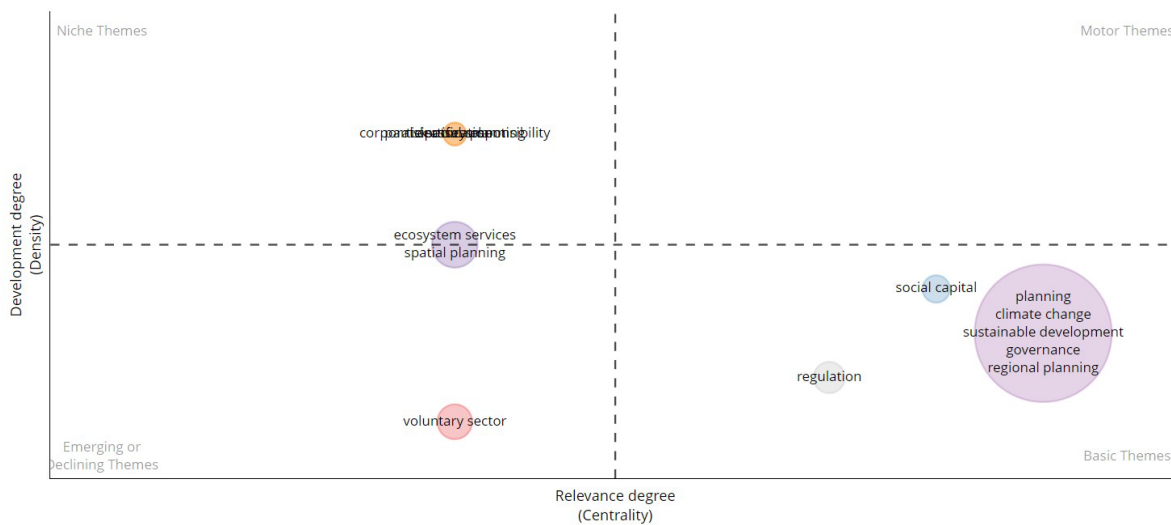


Figure 5 Thematic map (developed using Bibliometrix)

In order to understand how the keywords related to VP over the years, a thematic evolution of the authors' keywords was performed, shown in fig. 6. The year 2015 was chosen as the middle year, because it was the year in which the Paris Agreement was adopted. Before the year 2000, VP was described by three keywords without a direct link to energy or climate issues. The middle time slice (2001-2015) registered a set of 20 keywords describing voluntary planning, including specific reference to climate change and its risks such as droughts, climate policy and risk assessment. Furthermore, through keywords selected by the authors, the voluntary aspect of planning processes emerged, including participatory planning, voluntary environmental processes or voluntary sector.

Considering the last decade, (2016-2023) VP was clearly described by keywords including climate change and voluntary issues. In detail, the keyword “Planning” showed the shift of the researches towards the current issues such as climate change, green infrastructures and collaboration in planning processes. Moreover, in the middle slice, for the first time, the keyword “participatory planning” appeared that was explained better in the last decade through the keywords “indicators” and “public participation”. This last remark provides for an insight on the approaches to voluntary planning, based on the issues of climate and the participatory planning of the processes. Another interesting aspect of VP that emerged in the last decade, is the indicator-based approach that characterizes the current mainstream research.

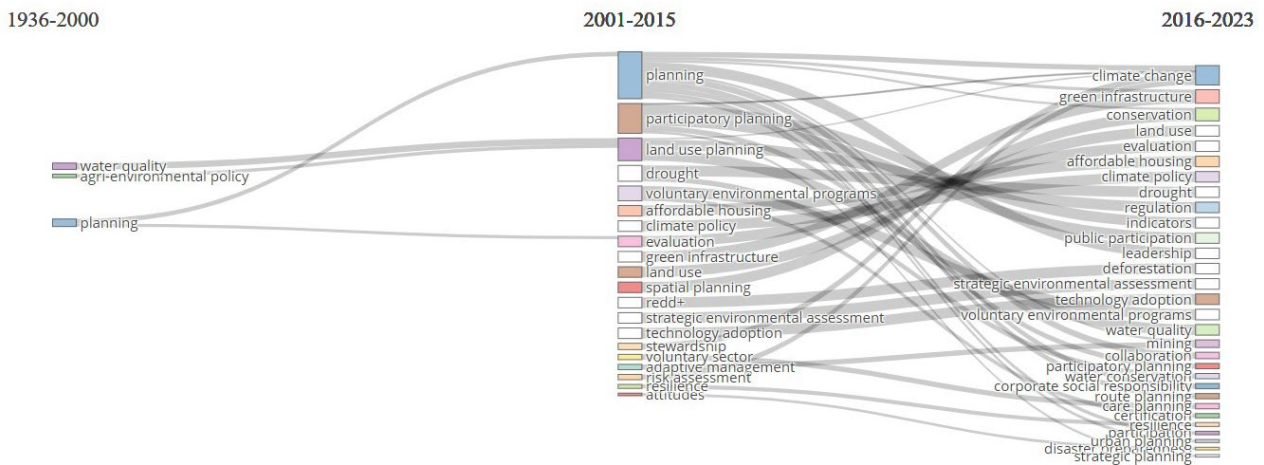


Figure 6 Thematic evolution (developed using Bibliometrix)

Evidences from the review

The VP approach represents a field of research tackled in a scientific article for the first time in 1936, [53] where it is affirmed that “voluntary organization is a peculiarly American institution” and it is not without its counterpart abroad. In the same article, the need for a well-established procedure and operating technique is highlighted, before being incorporated into a government framework. Moreover, the need of a structured framework is pointed out by the fact that both the official planning commission and the VP association are necessary, because each one is fitted to perform certain functions which the other is either not able to perform as well or cannot perform at all [58].

Aiming at finding a specific time start, Beaufoy locates the growth of modern civic consciousness from 1890 to 1920, when citizens began to exercise their right to participate in the planning and design of the urban environment. Research claims that civic consciousness, in that period, shifted from a nineteenth century philanthropic approach to urban reform, advocating a more professional and democratic attempt to attend to the planning of the entire urban environment, by focusing on the relationship between the town planning movement, the local government and a VP and amenity group, the London Society, founded in 1912 [59].

A first geographical (in other words: place-based) approach of VP came back in 1981. In the paper “A small area profile system: its use in primary care resource development” [60], VP was a means to collect and evaluate secondary source data as site testing for the development of rural primary care clinics in order to have a small demographic area with primary care resource profiles. Still in 1981 a second paper, always in medical geography, “VP forestalls excessive competition, regulation” [61] evaluates VP as a aid for institutions to achieve cost containment without undermining long-range goals.

Only in 1983, Errington and Thomas [62] related VP to environmental issues, providing a brief account of a project designed to sensitize people of all ages to the environmental problems and opportunities in their community, within the scenario of modifications in South Wales with the redevelopment of the Cardiff city centre, the slum clearance improvement programme for older housing, and the scrapping of the Buchanan Plan. Always in England, VP operating with aid groups, was the reaction to the reduction of time and resources allocated to the public consultation and

participation from the environmental professions against the outlook of that period; “less planning is better planning” [63].

The 1980’s and 1990’s saw the onset of a period characterized by the establishment of programs (i.e. Water Agency Response Network) and city networks (i.e. Eurocities, Climate Alliance, ICLEI etc..) that operated on a voluntary approach of their members and improved the overall response capabilities of agencies that were experiencing significant damage to their systems through VP[64].

The increasing awareness of environmental issues on greenhouse gas (GHG) emissions and climate change, with the institution in 1988 of the International Panel on Climate Change [65] and “*Acknowledging that change in the Earth’s climate and its adverse effects are a common concern of humankind*” from the United Nations Framework Convention On Climate Change [43], added VP to the environmental key component tackling climate change through a responsive climate planning.

Indeed, since the 1990’s, VP has emerged in voluntary programmes, suitable to address specific urban governance issues and providing a means for taking action in situations in which it is too costly or difficult to implement direct regulatory interventions [66]. Voluntary programmes have become conventional instruments in urban climate governance [67,68], however city governments should consider that urban or territorial problems can be addressed with voluntary programmes, if they are legitimated by the actors and stakeholders engaged therein [69,70].

In this context, there emerged the role of City Networks (and initiatives promoted by private foundations) in designing climate and energy efforts and interventions with a voluntary approach in achieving sustainable development objectives and energy/climate targets.

This voluntary approach has characterized the last two decades, becoming a distinctive label of such city networks as the Covenant of Mayors for Climate and Energy, and has overcome the institutional processes of urban planning.

The initiative developed effective practices, useful technical contributions in selecting intervention priorities and design of feasible project frameworks for public and private investments [39]. On this track, VP has supported actions related to the targets set by the European Community or International Agreements, supporting the urban development processes. Furthermore, it has highlighted the unsuitability of the current normative framework concerning urban development and management to express required performances in promoting actions and tools (the ‘plans’), oriented towards applying sustainable development principles and climate adaptation/mitigation [42].

Hence, in order to understand the current developments and the connections among voluntary planning, climate & energy targets and city networks, the authors have explored in section 4 and 5 some city networks and European initiatives interested in the needs and the developments of the cities related to energy, climate change and social inclusiveness.

EU Programmes as meeting points for City Networks

From the end of the 1970s, integration of EU funds within targeted, multiannual programmes has been tested in ‘Integrated Development Programmes’ and later in ‘Integrated Mediterranean Programmes’. Both marked a radical turn in comparison to what the funds were normally earmarked for: reimbursing existing projects introduced by Member States on an annual basis - a system which was no longer seen as convincing and which was meant to be replaced by a more efficient approach.

In 1975, the EU, with the institution of the European Regional Development Fund, started a new era “from projects to programmes” following key principles as multi-annual programming, strategic orientation of investments and the involvement of regional and local partners.

This shift in approach was driven by a paradigm change in urban and regional development policies and research, advocating for more integrated-oriented strategies in supporting more 'soft' measures rather than physical investments, such as enterprises and infrastructure.

In 1988, the European Council agreed on a regulation [71] which put existing EU funds into the context of 'economic and social cohesion', a term introduced by the Single European Act[46]. Since then, the Cohesion Policy has become one of the most important and most debated EU policies. Under the umbrella of the EU Cohesion Policy, several EU funded programmes were developed to support and enhance a local and sustainable development of cities and territories. The authors selected two of them (URBACT and Interreg) as EU programmes able to promote the cooperation among cities through city networks and produce local impacts through the achievement of energy and climate territorial targets.

URBACT Programme

In 2018, according to EUROSTAT, 39.3% of the population lived in the cities, highlighting their central role in economic growth, employment and competitiveness. Cities can be considered motors of integration, cohesion and cultural development, but at the same time they are affected by significant problems such as uneven urban development, creation of economic and social "sink" areas, environmental degradation. On these aspects, since the 1980's the European Commission has launched several actions with an integrated approach to urban regeneration, to solve the high concentration of social, environmental and economic problems in the cities. Therefore, the European Commission assisted 59 urban pilot Projects and 118 URBAN I programmes between 1989 and 1999. On the tangible improvement in the quality of life in the areas concerned, the Commission launched a new Community Initiative: URBAN II. The aim is to implement innovative strategies for a sustainable economic and social regeneration of small and medium-sized cities or neighbourhoods in crisis within major agglomerations. These areas are characterized by high unemployment, crime and poverty rates, and by an inadequate level of public services. These strategies must build on competent structures in the cities, strong partnerships with the locals, the private sector, services of general interest and other public bodies, on an integrated territorial approach and on consistency between strategies at the level of the neighbourhood in crisis and that of the city as a whole.

URBAN is one of four initiatives within the European Structural Funds, the others being INTERREG, LEADER and EQUAL. Like the other three, URBAN is financed by only one Structural Fund (European Regional Development Fund). All the initiatives prioritized local partnerships and a network for exchange of experience, since the aim is also to strengthen and exchange knowledge of these subjects within the Community.

The URBACT programme was launched in 2002 as a part of the URBAN II Community Initiative. The programme aims at developing the transnational exchange of experience between the stakeholders, whether cities or other partners, URBAN programmes or Urban Pilot Projects, and to capitalize on these projects, drawing lessons from the results, successes and weaknesses noted. URBACT contributes towards improving relevance and effectiveness of actions, tackling the

concentration of economic and social problems in small, medium-sized and large European cities, each with their own specific characteristics.

Leading up to 2006, URBACT was focused on helping the cities that had benefited from URBAN I and II to exchange experience on sustainable regeneration, mostly practiced in small areas of cities. URBACT II ran from 2007-2013 and widened the scope to focus on sustainable urban development across a wide range of policy areas. More than 50 networks, typically of ten cities, were supported in this period. It aims at sustainable integrated urban development in cities across Europe and it is one of the European Territorial Cooperation Programmes along with the European Spatial Planning Observation Network (ESPON), INTERREG Europe (formerly IVc) and INTERACT. URBACT is an instrument of the Cohesion Policy and is co-financed by the European Regional Development Fund. The main mechanism of URBACT is to achieve its objectives through co-financing exchange and learning networks that typically run for 30 months and involve six to twelve cities, depending on 2 types of networks. Each network focuses on a specific theme or challenge. The key output under URBACT II was the production of a local action plan produced by a local support group made up of key stakeholders. Other outputs include case studies and thematic reports. Following the success of the URBACT I and II programmes, URBACT III has been developed to continue to promote sustainable integrated urban development and contribute to the implementation of the Europe 2020 strategy[7].

URBACT III supports the urban dimension of the Cohesion Policy and the integrated approach to sustainable urban development, under Article 7 of the European Regional Development Fund (ERDF) [72], specifically related to the Integrated Territorial Investments as well as participatory approaches through Community Led Local Development and Urban-Rural Partnerships.

URBACT III, taking account the context of the cohesion policy for 2014-2020, is characterized by:

- A focus not only on the action planning phase but also on the implementation phase of integrated urban strategies and actions for more impact in cities and with stronger links with the mainstream programmes;
- More capacity building actions to increase the know-how and the capacities of practitioners-decision makers of cities and of all the stakeholders involved in the URBACT networks;
- More work with national and managing authorities involved in urban development
- A thematic coverage with a balance between thematic priorities and the bottom-up approach of URBACT II which was highly praised by cities
- A result-oriented approach using the Cohesion Policy Logical framework.

The recently created URBACT IV will support the Cohesion Policy in 2021-2027 and promote integrated sustainable urban development through cooperation. According to the Cooperation Programme [73], URBACT IV has three main aims:

- Use transnational networks to improve the capacity of European cities to co-design and implement Integrated Action Plans linked to common sustainable urban development challenges, transfer established urban good practices and design investment plans to replicate elements of Urban Innovative Actions;
- Improve the capacity of urban stakeholders to design and implement sustainable urban development policies, practices and innovations in an integrated, participatory and place-based manner, in line with the new Leipzig Charter [6])

- Ensure that URBACT knowledge and practice is made accessible to urban practitioners and policymakers to feed into local, regional, national and European urban policies, in particular through the European Urban Initiative and contribute to the Urban Agenda for the EU[74]

As declared in the latest version of the URBACT IV Programme Manual [75], cities play a crucial role in achieving sustainable development, especially mitigation and adaptation to climate change, thus special attention shall be given to tackling environmental and climate challenges, notably the transition towards a climate neutral economy by 2050. Moreover, a key challenge for the EU cities is the green transition and URBACT is committed to improving awareness on adaptation to climate change, and a city's capacity to implement solutions. In this context, the objective of URBACT is to improve the capability of cities in achieving their climate neutral target in a low carbon way.

INTERREG Programme

Interreg (or European Territorial Cooperation) is one of two goals of the EU Cohesion Policy [76], that provide a framework for the implementation of joint actions and policy exchanges between national, regional and local actors from different EU Member States.

Interreg operates on three levels of cooperation: cross-border (Interreg A), transnational (Interreg B) and interregional (Interreg C).

The first programming period started in 1990 with Interreg I (1990-1993), succeeded by Interreg II (1994-1999), Interreg III (2000-2006), Interreg IV (2007-2013), the ongoing Interreg V (2014-2020) and the forthcoming Interreg VI (2021-2027).

Every period has been characterized by a set of priorities and thematic objectives, specifically:

- Interreg I (1990-1993), was developed as a Community Initiative covering exclusively cross border cooperation. It supported projects in the context of the completion of the single market, aimed in particular at the economic development and restructuring of border areas;
- Interreg II (1994-1999), supported projects assisting the Community's internal and external border areas in overcoming specific development problems due to their relative isolation, encouraging the creation and development of co-operation networks on either side of internal borders and promoting adaptation of the external border areas to their new role as border areas in an integrated single market;
- Interreg III (2000-2006), supported projects on sustainable development, sustainable mobility, urban regeneration, improving energy efficiency and renewable energy sources and ICT (Information and Communication Technologies) usage. From this programming period onwards, Interreg was integrated into the Structural Funds Regulation and covered transnational and interregional levels of cooperation;
- Interreg IV (2007-2013), supported projects on encouraging innovation and competitiveness in enterprise and business development, promoting tourism cross-border co-operation in policy development and improving access to services to promote the quality of life for those living across all 27 EU states, as well as Norway and Switzerland;
- Interreg V (2014-2020), in line with the Cohesion Policy (2014-2020) supported projects on research and innovation, SME competitiveness, Low-Carbon economy and environment and resource efficiency

- Interreg VI (2021-2027), the forthcoming programming period will develop projects oriented towards climate targets and greater empowerment of local, urban and territorial authorities in the management of the funds with a dedicated policy objective, implemented only through territorial and local development strategies

Interreg VI, for the 2021-2027 period set 7 policy objectives to implement EU priorities across the borders and contribute towards implementing the EU's cohesion policy main priorities. Among the policy objectives, PO2 (A greener, low-carbon transitioning towards a net zero carbon economy and resilient Europe) is specifically referred to the environmental and climate challenge. Interreg VI embeds cooperation supporting more synergies between Interreg programmes, the other cooperation platforms and other EU funding programmes.

City networks: an overview

Over the years, cities have committed targets to solve common issues (such as environment, mobility, disaster risk reduction, climate change, social and economic) that afflict them, designing widespread interventions, able to be improved and replicated in similar territorial contexts. An example of this “imitation game”, can be found at the Copenhagen Climate Summit in 2015, where the mayors involved in the summit on climate change, were impressed by the fact that, despite snow and darkness, one out of three Danes commuted to work on a bicycle in dedicated bike lanes. Seeing this phenomenon, many mayors looked for ways to get more of their constituents out of the car and onto a bike, and mayors from Rio de Janeiro and São Paulo realized that bikes could not only reduce pollution, but also enable people who were too poor to afford public transit to commute to jobs [77].

Other examples in understanding that common issues such as environment and pollution were not only the problems of each country but went beyond national borders, can be found in a number of events that have been raising EU environmental awareness: “acid rain” in the 1980's caused by UK coal-fired power stations damaged forests and lakes in Scandinavia (Grennfelt et al. 2020; Rosencranz 1986; Newbery, Siebert, and Vickers 1990); pollution caused by discharges into the Rhine, the Meuse or the Danube rivers in another country further downstream (Kristensen and Kristensen 1996; Giger 2009; Linnerooth 1990). However, the experiences gained by each local authority cannot be kept alone but should be shared with other local authorities, hence the establishment of the city networks as “hubs” where successful experiences are shared so as to provide support to reach similar results in the same contexts.

City networks gather their members on a specific feature (population size, geographical location, economic conditions...) or because of achieving an objective (sustainable development goals, energy efficiency, climate change adaptation/mitigation...). Considering the first group, city networks can provide a relevant support to small local authorities (i.e., under 5000 resident inhabitants) because they are representative of a larger territorial extension than metropolitan areas, notwithstanding their contribution in terms of CO₂ emission reduction and climate responsive interventions which is small compared to the worldwide volume.

Considering the second group, city networks could play an important role in defining and developing climate-policy at a city level [78], such as the role played by the ICLEI, C40 or Covenant of Mayors members. These aspects have emphasized those territorial contexts where there is not a specific climate commitment at a local level, or there is a lack in technical skills able to adopt policies independently and proactively.

The authors in this section suggested an overview on a limited group of city networks operating inside and outside the European borders, listed per year of establishment (see tab.1). These included also a National Association of municipalities (ANCI) that according to the authors' perspective can be classified as a city network because of its membership organization, where mayors join to connect their city to other municipalities and share good practices and common challenges.

In tab.1 the authors selected six features to describe the city networks selected. The first three (establishment, city population size and number of signatories) are features that provide facts about the operational years of these city networks, the population size that they are referred to and their extension and relevance in terms of signatories. "Targets" explain the main activities and energy, climate, environmental or social issues tackled by each city network.

Network of networks (see fig.7) is a feature defined by the authors in order to provide an overview on the connections among city networks operating at EU and international level. Moreover, this feature, besides highlighting the more connected city network to the others, allows to identify the city networks that share common targets.

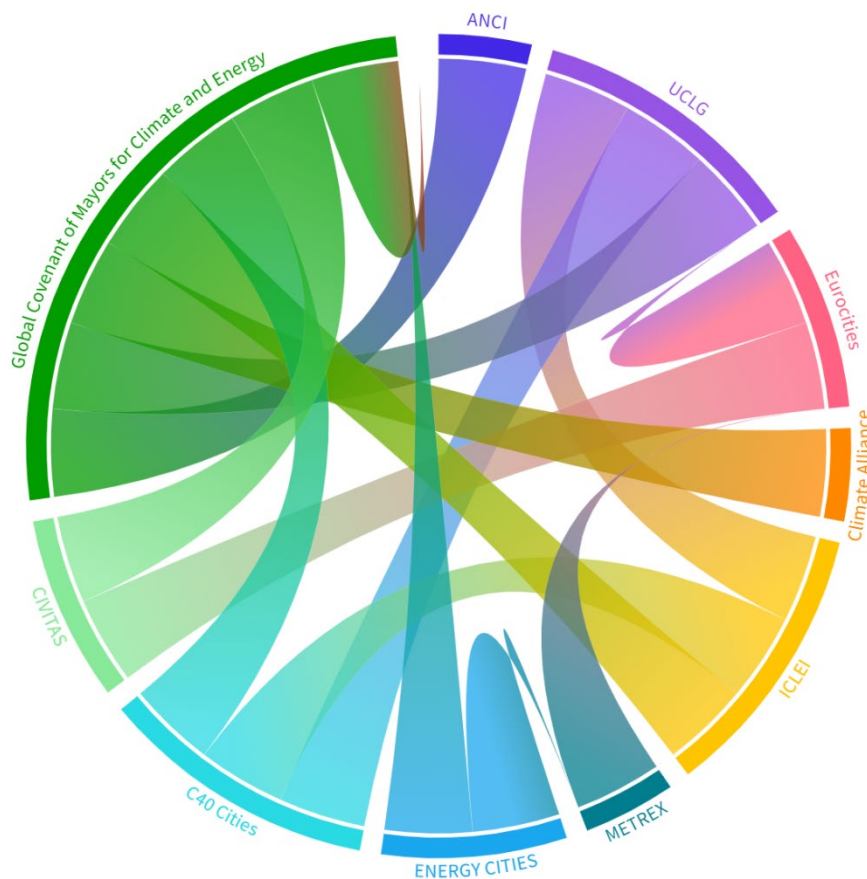


Figure 7 Graphic view of network of networks field (developed using Flourish [...])

The last feature, membership fee rules, is the cost of membership and its rules. It was selected because of the fee payment that could be considered a barrier for some municipalities in the choice of a city network membership. Even if there are open-access city networks, membership fee represents a feature taken into account by municipalities during the selection of a specific city network instead of another.

City Network	Establishment	City population size	No. Signatories (as at 2023)	Targets	Network of networks	Membership fee rules
ANCI (National Association of Italian Communes)	1901	All population sizes	7134	Promotion and organization of training and information initiatives to ensure the professional updating of municipalities, also in collaboration with institutions, universities and other research partners. ANCI also promotes and coordinates the dissemination of best practices among municipalities, their associations, and metropolitan cities, as well as enhancing and supporting the commitment of mayors, protecting their autonomy and responsibility.	Global Covenant of Mayors for Climate and Energy, European Committee of the Regions	Annual fee comprises two components: one is fixed and the other is population-related
United Cities and Local Government (UCLG)	1913	All population sizes	Over 240,000 towns, cities, regions and metropolises and over 175 associations of local and regional governments	Representing interests of local and regional governments worldwide. Advocating for the localization of SDGs and promoting the role of local governments in addressing global challenges such as climate change, urbanization, and sustainable development	Association of Netherlands Municipalities, C40 Cities Climate Leadership Group, Global Covenant of Mayors, ICLEI	Membership fees are based on a calculation that takes into account the number of inhabitants represented by the member and the state of the country's economic development.

<p>Eurocities</p>	<p>1986</p>	<p>Over 250,000 Inhabitants</p>	<p>208</p>	<p>Eurocities represents the voice of cities at EU level, to bring about change on the ground. It shares and facilitates the exchange of knowledge, experience and good practices between cities to scale up urban solutions</p>	<p>TheMayor.EU - the European Portal for Cities and Citizens, CIVITAS, UCLG</p>	<p>Both full and associate members of the Association will be required to pay an annual subscription fee. A city who has not paid its subscription fee will automatically drop out of the members list. The amount of this fee will be proposed by the Executive Committee and formally approved by the Annual General meeting.</p>
<p>Climate Alliance</p>	<p>1991</p>	<p>All population sizes</p>	<p>1969</p>	<p>Reduction of CO₂ emissions by ten percent every five years (equivalent to a half of per capita emissions by 2030 as compared to 1990); reduction of emissions to 2.5 tonnes of CO₂ equivalents per person via energy saving, energy efficiency and the use of renewable energy, promoting climate justice in partnership with indigenous peoples by supporting their initiatives, raising awareness, and abstaining from the use</p>	<p>Global Covenant of Mayors for Climate and Energy, European Committee of the Regions</p>	<p>Fees are moderate and structured so that they are feasible even for the most economically strained municipalities. Local authorities pay just €0.0077 per resident per year. Annual fees are capped at a maximum of €15,000 and a minimum of €231 per member municipality or district. Indigenous</p>

				of unsustainably managed tropical timber		people's organizations are under no obligation to pay fees. The Executive Board decides on annual fees for associated members on a case-by-case basis.
ICLEI	1990	All population sizes	1075 members (including more than 2500 local and regional worldwide governments)	Working alongside local and regional governments to anticipate and respond to complex challenges, from urbanization and climate change to ecosystem degradation and inequity. At national and global scales, pushing for robust policies that reflect the interests of local and regional governments and apply global policies to sustainable urban development strategies at subnational levels.	Global Covenant of Mayors for Climate and Energy, C40, UCLG	ICLEI members pay an annual fee based on the number of inhabitants in the local and national area per capita income. According to four groups classified per Gross National Income Per Capita (local Governments from 100 to 8000 €)
ENERGY CITIES	1990	Municipalities inter-municipal bodies and consortia local energy agencies and municipal companies chaired by an	180 member cities	Sharing of knowhow in the fields of energy management, development of renewable energy sources and reduction of pollutant and greenhouse gas emissions, to contribute to strengthening the role and capabilities of municipalities and local authorities in the areas of energy consumption,	Global Covenant of Mayors for Climate and Energy, METREX	Annual fees are adapted to the specific context of the members. It depends on the number of inhabitants.

		<p>elected member specialized in regional or national associations of municipalities working in the same sector as that of Energy Cities/Energie-Cités.</p> <p>Municipalities located outside geographical Europe may have the status of Associate members</p>		<p>distribution and production, and more generally local energy planning.</p>		
METREX	1996	Metropolitan areas	120 metropolitan regions and areas	Strategic planning and development at the metropolitan level	EUROCITIES	The cost of the fee is related to the membership type
C40 CITIES	2005	Megacities	96 Member Cities	Adoption by the cities of a resilient and inclusive climate action plan aligned with the 1.5°C ambition of the Paris Agreement, and regular updates. In 2024, the city remains on track to deliver its climate action plan, contributing to increased resilience, equitable outcome and halving C40’s overall emissions by 2030.	Global Covenant of Mayors for Climate and Energy, ICLEI, UCLG	C40 member cities earn their membership through action.C40’s most distinguishing feature is that it operates on performance-based requirements, not membership fees.

CIVITAS	2002	All population sizes	Over 340 local authorities	<p>Promotion and implementation of sustainable, clean and (energy) efficient urban transport experiments. Demonstration of integrated packages of technology and policy actions in the field of energy and transport in eight categories of measures. Built up critical mass and markets for innovation by transferring good practices to other European cities</p>	Global Covenant of Mayors for climate and energy, Eurocities	Membership is free and open to all who sign the CIVITAS City Declaration.
COVENANT OF MAYORS FOR ENERGY AND CLIMATE	2008	All population sizes	11820 EU27 signatories	<p>Achieving the climate neutrality by 2050 according to the EU objectives, with the commitment of mid and long-term targets. Developing a climate pact with all players (i.e. citizens, businesses and governments at all levels) engaged in the processes. Networking with fellow Mayors and local leaders, in Europe and beyond.</p>	ANCI, CIVITAS, C40, Climate Alliance, Energy Cities, ICLEI, UCLG	The GCoM is based on a voluntary commitment. Joining the GCoM is fully free of charge

Tab. 1 The dashboard of selected City Networks

A national perspective of city networks: National Association of Italian Municipalities (ANCI)

The National Association of Italian Municipalities (ANCI) is a non-profit association, founded in 1901. 7134 Italian municipalities are ANCI members, representing about 95% of all Italian municipalities. Municipalities (of all population sizes), metropolitan areas, unions or associations of municipalities and local authorities can join ANCI as members, paying an annual membership fee established by the ANCI National Council every year. National Council is constituted by:

- ANCI president;
- 78 members elected by the Congresses of the Regional Associations
- Regional ANCI Presidents;
- President of the Consortium of municipalities of the Autonomous Province of Bolzano (Autonome Provinz Bozen-Sudtiroler Gemeindenverband), the President of the Consortium of the Trentino municipalities and the President of the Consortium of Local Authorities of the Aosta Valley (Consortium des Collectivités locales de la Vallée d'Aoste - C.E.L.V.A.)
- Mayors of the provincial and regional capital municipalities and the mayors of the metropolitan cities
- Members of the State-City and Local Authorities Conference;
- Holders of political proxies and the chairmen of committees;
- Consultants and Coordinators of the Regional ANCI small municipalities;
- Coordinators of the Council of Unions of municipalities and associated managements;
- Coordinators of the Conference of Municipal Councils;
- Members of the Delegation to the Committee of the Regions;
- a quota of members elected by the Assembly to guarantee the principle of political, territorial and gender representation.

ANCI's activities represent and protect the interests of Municipalities before the Italian Parliament, the Government, the Regions, public administration bodies, EU bodies, the Committee of the Regions and any other institution exercising public functions of local interest.

ANCI promotes and organizes training and information initiatives to ensure the professional updating of its members, also in collaboration with institutions, universities and other research partners. ANCI also promotes and coordinates the dissemination of best practices among municipalities, their associations, and the metropolitan cities, as well as enhances and supports the commitment of mayors, protecting their autonomy and responsibilities.

ANCI pursues a territorial approach of its activities through Regional Associations, ensuring specific tools related to the heterogeneous regional contexts and supporting the transition of the municipalities towards energy efficiency and climate neutrality. Furthermore, ANCI supports the transnational cooperation sharing European initiatives and projects such as URBACT and Resilient +. For the URBACT Initiative, it supports the development of participation policies of local actors and, more generally, the improvement of the municipalities' capacity for analysis and governance; while for Resilient +, it is a partner of the project, co-financed by the Interreg MED Program, which aims to foster social innovation in the Euro-Mediterranean area, with particular regard for the employment and development potentials linked to the social economy and its combination with technological innovation (open data, platforms, apps, etc).

United Cities and Local Government (UCLG)

UCLG, as a global network of cities and local, regional, and metropolitan governments and their associations, is committed to representing the interests of local and regional governments worldwide. It serves as a platform for collaboration and cooperation among municipalities, cities, and regions from different countries in addressing global challenges such as climate change, urbanization, and sustainable development.

UCLG was established in 1913, with the launch of Union Internationale des Villes (UIV) at the World Fair in Ghent (Belgium), but in 1928, the UIV changed its name to the International Union of Local Authorities (IULA). After 1950, the International Municipal Movement branched out to new organisations, associations and unions and began to concentrate on specialist topics. In this context, in 1957, the United Towns Organisation (UTO) was set up aimed at multiplying actions and efficiency by becoming involved in global programmes. Le Monde Bilingue, UTO, the Public Administration Caring House USA, among others, worked to reinforce the links between local authorities. The presence of the local level outside of Europe and North America increased with the establishment of regional sections of global networks and development cooperation projects.

In 1985 in The Hague, Netherlands, the UTO Secretariat was established as the international coordinating body for local authorities. At the Conference on the Environment and Development (“Earth Summit”) in Rio de Janeiro in 1992, for the first time, local authorities were recognized as a “major group” and helped draft Chapter 28 of Action 21. From this, The Local Agenda 21 was launched, which swiftly involved thousands of local governments and communities across the world to engage in sustainable development.

In 2004 IULA and UTO were merged, establishing the United Cities and Local Governments (UCLG) with the support of the Metropolitan organization, METROPOLIS. This was a milestone in the coordination of local and regional authorities on the international scene.

Currently, UCGL is the largest organization of local and regional governments in the world, as the result of community collaborations that began more than a century ago. Global solutions need to be built upon local experience, and they can only be achieved if they are integrated into all the planning and policy-making actions. In this perspective, UCLG advocates for a greater role of local and regional governments in international policy development, implementation and reporting. That’s what they call ‘localizing’ the global goals. UCGL, with the inclusion of Goal 11: Sustainable cities and communities into Agenda 2030, aggregates best local practices into action plans, providing regular updates on the progress and proposals to the High-level Political Forums on Sustainable Development.

UCLG strengthens its network enhancing political participation, designing new tools for synchronized action, by renewing partnerships with different actors and ensuring shared ownership among the members, enhancing transparency, democratic participation and accountability. It supports the policy and advocacy of territories at an international level. This includes making proposals concerning the role and perspective of local and regional governments on the definition of the next phase of the global development agendas, and increasing national and international support and recognition for the role of local and regional governments in the implementation process.

UCLG is aimed at fostering and identifying the efforts of its membership to achieve the global agendas at a territorial level. This is supported by the decentralized cooperation, as a key tool of international cooperation and development programmes. Moreover, UCLG is aimed at ensuring that local and regional experience influence the implementation and assessment of the global agendas.

The launch of the Eurocities network can be considered the conference held in 1986 in Rotterdam on ‘the city, the engine behind economic recovery’ [79] where eleven big European cities together with academics and industrials discussed their role in the economic recovery. After three years, in 1989 the city of Barcelona organized a conference “The role of cities in the European construction” in which “second cities” such as Barcelona, Birmingham, Frankfurt, Lyon, Milan and Rotterdam emerged as “*cities which do not have the status of capitals but are nonetheless keen to have a presence on the international stage*” [80]. This core group of cities pursued three key factors: a clear urban focus; sharp political thinking and existing relationships with the European Community institutions. The Eurocities core group, in its third conference in Lyon in 1990, contended the case for an integrated urban policy drawn on the strengths of the traditional European urban model of compact, integrated and organic cities and has updated it, in clear contrast to the extensive US model of urban sprawl. The core group in 1991 adopted a set of rules of association summarized in three simple statements:

- To collaborate as a network of cities to further the mutual interests of member cities in their role as centres of economic, technical, social and cultural development
- To influence the decision-making process of the European Community institutions
- To act as a partner in the European institutional debate in the interests of European cities

The rules then set out the formal criteria of membership “open to major metropolitan cities of the member states of the European Community”, established membership fees, an executive committee and agreed to establish a permanent secretariat to be based in Brussels. In this context, Eurocities emerged as a transnational lobbying association to represent the interests of cities with populations over 250,000 inhabitants and influencing EU policies on urban matters [80–83]. As a matter of fact, eligible full members are all cities or metropolitan areas larger than 250,000 inhabitants of the EU or of the European Economic Area (EEA), while cities located outside the EU or EEA can become associate members. Eurocities offers its members a platform for sharing knowledge and exchanging ideas through six thematic forums, a wide range of working groups, projects, activities and events and since 1996 Eurocities has been answering to the European Commission consultation on the Urban Agenda.

Since the year 2000, Eurocities has launched its activities on migration and integration, coordinating activities on migration more closely to EU after the Amsterdam Treaty held in 1997 [84] and the Tampere Council in 1999. The first stage of Eurocities’ work on migration and integration was based on a coalition of like-minded cities based on a joint commitment towards social inclusion and migrant integration to exchange and showcase local policy developments [85].

Since 2007, Eurocities has been developing a policy framework through its Integrating Cities Charter which, in turn, sets the cities’ commitments on the integration of migrants by providing an overarching framework for work in this area. As policy makers, service providers, employers and buyers of goods and services, the signatory cities of the Charter, the ‘Integrating Cities’, have made a commitment to provide equal opportunities and promote diversity. Over the years, on a voluntary basis, the Charter has become a benchmark against which signatory cities began monitoring policy developments.

Climate Alliance

The Climate Alliance of European Cities with Indigenous Rainforest Peoples is a network of local authorities founded in 1990 and is committed to the protection of the world's climate. In 2020, over 30 years, Climate Alliance (CA) is the world's largest city network dedicated to climate action with over 1800 municipalities from 27 Countries as members. The board of CA is elected both by the membership (European towns, cities, districts and regions) and from within the membership; over the years, national coordination offices have been established in countries with high membership densities and today the network has six National Coordination Offices in Austria, Germany, Hungary, Italy, Luxembourg and Switzerland.

Each CA municipality adopts a local resolution to:

- Reduce CO₂ emissions by 10% every five years (equivalent to a half of per capita emissions by 2030, as compared to 1990);
- Reduce emissions to 2.5 tonnes of CO₂ equivalent per person, through energy saving, energy efficiency and use of renewable energy;
- promote climate justice in partnership with indigenous peoples by supporting their initiatives, raising awareness, and abstaining from the use of unsustainably managed tropical timber.

The principles followed by the CA members are:

- Fair: promoting the wellbeing of all the world's peoples in harmony with the natural world,
- Nature-based: supporting closed-loop systems that replenish and regenerate instead of extracting and depleting,
- Local: thinking globally but acting locally, concentrating on the regional sourcing of goods and energy,
- Resource-saving: using fewer resources by doing more with less and using less to begin with,
- Diverse: Recognizing strength in diversity.

CA has been active in an international context since its establishment, highlighting the role of municipalities in climate action and supporting the participation of indigenous organizations. Since 1995, CA has been an official observer of the annual UN Climate Summits at the Conference of Parties (COP). The role has enabled network representatives to participate and to exchange with international actors. CA is also an official member of Local Governments and Municipal Authorities (LGMA), a Constituency of the UN Climate Secretariat. In 1997, at the COP in Kyoto, CA presented an initial status report on the scope of municipal involvement in climate protection, and at future COPs and other international events, CA drew the attention to the role of the local bodies both in Europe and in the Amazon forest. CA supports and emphasizes the 2030 Agenda with its Sustainable Development Goals (SDGs), due to the fact that cities and towns are also key elements for the 2030 Agenda [86] and its SDGs. The efforts of CA in the field of climate change adaptation, in 2014, e promoted and supported the foundation of Mayors Adapt, a voluntary mayors initiative interested in developing local adaptation actions. Compact of Mayors with Covenant of Mayors in 2017 merged to form the Covenant of Mayors for Climate and Energy becoming a global initiative with local actions. On this track, with an ongoing CA's project, "Climate Protection Strategies of Local Authorities in Europe" [87], CA developed strategic recommendations for municipalities and governments. The project started off with general approaches to municipal climate action. Over the years, with growing experience and expertise, the projects extended their topics (as an example,

climate change adaptation, energy saving, green procurement or sustainable mobility) always striving to foster an integrated and local approach to climate protection.

The Declaration of Wels adopted in 2021 [88], introduced the Climate Alliance Charter to the CA members as a tool aimed at achieving CO₂ emission reductions by at least 95% by 2050 compared to the 1990 levels, in line with both EU climate goals and Paris Agreement reduction targets. The Climate Alliance Charter renews the existing voluntary commitment oriented towards a “continuous reduction of greenhouse gas emissions” (as stated in the Climate Alliance statutes) and expands the individual targets into a target range so as to support Climate Alliance members in their local climate strategies. In this context, the role of local governments in implementing urban planning and transport policies is emphasized, providing incentives and shape building codes to encourage energy efficiency in the building sector focused on the climate challenge. Moreover, it supported the participatory governance and the involvement of citizens as a prerequisite for acceptance and a measure for the accountability and change in consumption patterns.

The International Council for Local Environmental Initiatives (ICLEI)

The International Council for Local Environmental Initiatives (ICLEI) was established by the International Union of Local Authorities and the United Nations Environment Programme to represent the environmental concerns of local governments, internationally [89]. Although ICLEI is an international non-governmental organization, it operates like a city network, providing technical consulting to local governments to meet environmental and sustainability issues. ICLEI membership is structured on all local and regional governments, as well as on their global, regional, national and subnational associations; they pay an annual membership fee that varies regionally and according to population and gross national income per capita. There is no requirement for the membership in terms of population size, only a self-defined commitment to climate protection. ICLEI is led by a Global Executive Committee of Mayors and Municipal officials, appointed by the Regional Executive Committees and the Council every 3 years and is governed by its Charter that contains the statutes and by-laws of the global association. The Strategic Plan is the key steering plan for the global association and is revised every 3 years during the ICLEI World Congress. ICLEI develops and runs a broad range of campaigns and programs, under each strategic goal that addresses local sustainability issues while protecting global common goods, and links local actions to internationally agreed upon targets and goals. These are: sustainable city agenda, resilient city agenda, low-carbon city agenda, biodiverse city agenda, resource-efficient city agenda, smart urban infrastructure agenda, green urban economy agenda, healthy & happy community agenda. ICLEI provides information and training, organizes conferences, facilitates networking and city-to-city exchanges, carries out research and pilot projects, and offers technical services and consultancy. On this track, ICLEI played a coordinating and technical role in establishing the recognition of local governments as a key stakeholder group in the UN Convention processes since the 1992 Earth Summit in Rio de Janeiro. In 1993, ICLEI provided the launching pad for multi-level climate leadership at the Municipal Leaders’ Summit on Climate Change in New York, followed by a second edition in Berlin in 1995, which coincided with the first Conference of Parties (COP1) in the United Nations Framework Convention on Climate Change, UNFCCC. The Summit resulted in the establishment of the Local Governments and Municipal Authorities (LGMA) Constituency, that gathers networks of local and subnational governments accredited to the UNFCCC as observers. ICLEI has been the focal point of the LGMA since 1995, which together with the Local Government Climate Roadmap (since 2007)

has been the main advocacy channel for the input of local and subnational governments into UNFCCC negotiations. The Local Government Climate Roadmap is a coalition and advocacy process that aims at recognizing, engaging and empowering local governments in global climate negotiations. As the focal point of the LGMA in the UNFCCC, ICLEI continues to facilitate the Local Government Climate Roadmap with the support of other city networks. As flagship programs stand, ICLEI supports:

World Mayors Council on Climate Change: an alliance of committed local government leaders advocating an enhanced recognition and involvement of Mayors in multilateral efforts addressing climate change and related issues of global sustainability. There are presently over 80 members of the Council. Membership is open to Mayors and equivalent leaders at municipal levels of government.

Global Alliance for EcoMobility: a cross-sector partnership for the integrated promotion of walking, cycling and use of public transport to improve health, urban environment and mitigate global climate change.

The Bonn Center for Local Climate Action and Reporting – carbon: an ICLEI and United Nations Environment Programme initiative, to facilitate the reporting of city commitment and performance in greenhouse gas emissions and establish a platform for information sharing on urban climate data and actions. Local Governments are invited to register online, create their own City Climate Report and announce their achievements to the world through the Cities Climate Registry, to increase transparency and demonstrate local government leadership.

Future City Leaders forms a unique network of outstanding young municipal leaders who share a strong commitment to make tangible improvements towards global sustainability. The 2-year program aims to catalysing the next generation of municipal leaders while recognizing and supporting exceptional individuals.

Local Action for Biodiversity (LAB) aims to involve local governments in biodiversity conservation. The initiative has created an ICLEI Biodiversity Program which will provide a framework for ICLEI Members to integrate biodiversity conservation into planning, policy and decision.

ICLEI Advocacy work is an action-oriented role ICLEI plays to represent local governments, seeking to build an international policy environment that strengthens and supports local sustainability. To facilitate this, ICLEI has Special Consultative Status with 5 members of the United Nations Economic and Social Council and has close links with the Secretariats of the three Rio Conventions (Climate - UNFCCC, Biodiversity - UNCBD, Desertification - UNCCD) and UN bodies such as the UN Environment Programme (UNEP) and the UN Commission on Sustainable Development.

ICLEI engages at local and global levels, shaping policies and setting off actions to transform urban environments worldwide. It builds connections across government levels, sectors and stakeholder groups, sparking city-to-city, city-to-region, local-to-global and local-to-national connections. By linking subnational, national and global actors, policies, commitments and initiatives, ICLEI strengthens actions at all levels, in support of sustainable urban development.

At the subnational level, ICLEI drives change according to five interconnected pathways (Low emission development pathway, Nature-based development pathway, Circular development pathway, Resilient development pathway and Equitable and people-centered development pathway) that cut across sectors and jurisdictional boundaries. This design enables local and regional governments to develop solutions in a holistic and integrated way, defining change across entire urban systems.

These pathways, mentioned above, were originally released as part of the ICLEI Montréal Commitment and Strategic Vision 2018-2024. The pathways are currently part of the ICLEI Malmö Commitment and Strategic Vision 2021-2027, which conducts the work of the ICLEI network.

METREX - The Network of European Metropolitan Regions and Areas

The Network of European Metropolitan Regions and Areas (METREX) was established in 1996, with the following fundamental aims: integrated strategies for sustainable development, integrated metropolitan land use and transportation strategies, strategies for urban growth, renewal and regeneration, and strategies for environmental renewal. At the end of the Conference, specific key issues were identified, such as the definition and governance of metropolitan areas, their economic competitiveness, social cohesion and sustainability, mobility and accessibility, urban sprawl, quality of life and the relationship between European and metropolitan spatial planning policy. METREX is a network of specialists, namely, politicians, officials and their advisers, concerned with strategic planning and development at the metropolitan level. It is essentially a network through which key European metropolitan decision makers can share their knowledge, experience and expertise (see fig.8). METREX, under the support of the European Commission, provides a means of promoting effective metropolitan governance to manage change at a metropolitan level, and contribute a metropolitan dimension to key European issues, such as competitiveness, cohesion and sustainability. In the European dimension, METREX supports the social, economic and territorial cohesion of greater Europe through the InterMETREX and PolyMETREXplus projects, pursuing the balanced and sustainable development of the EU territory provided by the European Spatial Development Perspective (ESDP) [90–92]. Considering the long-term vision, METREX has developed an ongoing Territorial Cohesion – TERRACOTTA project, that provides a metropolitan interpretation of the Territorial Vision for Europe 2050 – ET 2050 [93] developed by the European Observation Network for Territorial Development and Cohesion (ESPON).

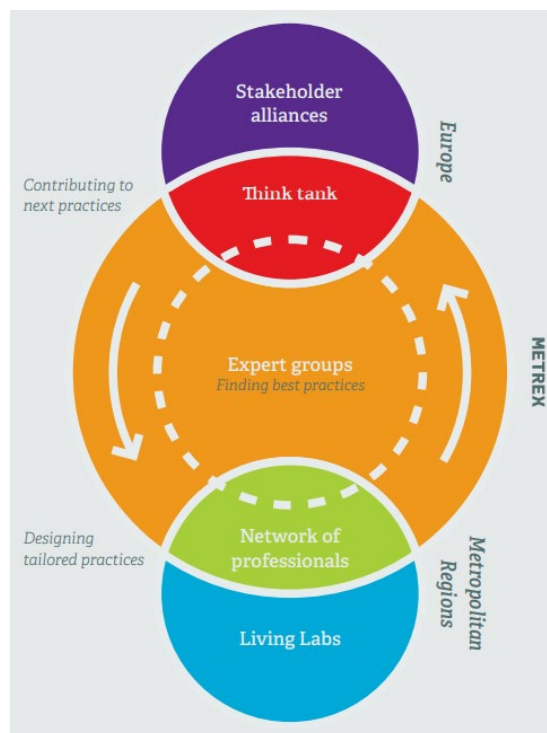


Figure 8 The five METREX Metropolitan approaches (image retrieved by METREX Annual Report 2021 [94])

Since the 10th Anniversary of METREX, at the METREX Madrid International Congress in May 2006, the activities of the network overcame the European boundaries, shaping on an international dimension. The Madrid International Congress highlighted the international interest to the body of experience, knowledge and expertise from all the varied social, economic, physical and environmental circumstances of the European metropolitan regions and areas. METREX focuses on those regions and areas characterized by a metropolitan dimension, where the collaboration among the members prevailed over the local authority borders in order to enhance funding and budgets and their position on the European and/or global level, which often translates to better results for citizens, businesses and institutions. The aim of the collaboration can rely on three issues characterizing the metropolitan dimension:

Governance: metropolitan areas are the level at which many wider European urban objectives can be realized most effectively, and it is not possible with an ineffective metropolitan governance;

Visions: metropolitan areas need to have both long-term and short-term visions, in order to be supported in the implementation of the transformations by the citizens and the stakeholders;

Integrated strategies: metropolitan areas should adopt integrated sustainable and polycentric approaches. The polycentric approach will require an effective metropolitan governance, whereas the sustainable approach requires an integrated social, economic, environmental and spatial strategy at a metropolitan level.

METREX links the metropolitan dimension to policies, programmes and projects on a European scale. It plays an active role to start and coordinate metropolitan developments, considering that many of the METREX challenges can be tackled in coordination with other metropolitan areas in Europe. A tangible example of this, is the METREX contribution to the European Committee of Regions for the position papers and the New Leipzig Charter on the output of member realities.

ENERGY CITIES – The European association of cities in energy transition

ENERGY CITIES – The European association of cities in energy transition, was established as an association of European local authorities in 1990. Members can be all those local and regional authorities willing to engage in the energy transition. There is no limit in terms of the size of the cities, their municipal agencies or companies, as well as regional authorities and their subordinated organizations. Furthermore, national city networks, federations or clusters of local authorities can join as collective members. Currently, the network is made up of 27 members based in two offices, in Brussels and Besançon. The internal organisation is governed by the principles of holacracy, which means decisions are made by the person or “circle” responsible for a role. In an holacratic organization, a circle is a group of people gathered around a common field of activity, who will collectively be in charge of decision making and implementing tasks on topics related to this particular field. ENERGY CITIES, have set up five circles:

- Ecosystem (political governance and foresight)
- Actions (project management)
- Relations (EU policy and communications)
- Management & Support (HR, IT, logistics...)
- General Circle (overall coordination of staff and activities).

All circles operate in an open environment, meaning that people can be in one or several circles at some point (depending on their skills, but also on what they want to share, learn, provide to the organization and to the members of the network). Specific meetings within circles allow us not only to treat tactical issues but also to improve the governance and the decision-making process.

ENERGY CITIES is a non-profit network of cities operating with near-total public funding, where the incomes (according to “Membership Pack” see [95]) come from 20% of membership fees; 30% from grants from national governments and services delivered to cities and third parties, and 60% from EU Funding. It is a learning community for cities engaged in proofing their future economies, built around a “local & sustainable first” approach. There are no conditions to join, other than the ambition and the commitment to share experiences, to reach climate neutrality in the territories by 2050 and to align the local strategic development with the Paris Agreement [33].

ENERGY CITIES acknowledges the central role of cities and regions as drivers of change and connecting hubs, and promotes common interests while calling for cooperation across governance levels. There are five thematic hubs in which it is possible to share knowledge, get feedback from other cities’ experience, debate with EU policymakers on future legislations and learn about support frameworks in other countries. The hubs aim to group together cities with specific objectives and if these objectives are achieved, new hubs will be realized. The hubs are:

- **Local Strategy/Finance hub:** translating the climate neutrality objective into local strategies, and promoting widespread adoption of science-based targets and carbon budgeting in cities and advocating for adequate EU rules & criteria in the EU budget for local governance;
- **The Fossil-Free Heat hub:** empowering citizens and local actors to become real players in the energy market and beyond;
- **The Common Spaces hub:** changing the design of climate change, fostering circularity and breaking up silos, thus promoting multi-actor partnerships for locally-based & resource-wise economies (circular and inclusive);
- **The Community Energy hub:** to considerably increase the local sustainable energy production rate, through energy communities and direct municipal actions on the supply side;
- **The visionary hub:** To put the “unspoken and unthought-of” at the centre of all debates, foster a dialogue on sufficiency and propose policies that aim to reduce our consumption needs without compromising on an adequate quality of life for all.

C40 – Cities

In 2005, a group of 18 representatives of megacities led by the Mayor of London Ken Livingstone, forged an agreement on cooperatively reducing climate pollution, called C20. In 2006, ensuring the balance with the Global South, 22 further mayors were invited to join thereby establishing an organization of 40 cities, known today as C40. Since 2008, C40 member cities have developed broad efforts to build climate action through peer-to-peer knowledge sharing, including climate action planning, buildings, transport, energy and adaptation. During the C40 Summit in Seoul, member cities formally agreed on C40’s unique peer-to-peer learning model. In 2016, C40 made it a standard criterion for membership that all C40 cities commit to deliver an inclusive and resilient climate action plan in line with the 1.5°C ambition of the Paris Agreement [33] by the end of 2020. The C40 mayors, in 2018, developed a series of interventions addressed to reduce emissions and deliver on 2030 targets through green and healthy transport, zero waste, net zero carbon buildings, and equitable climate

action. In 2019 the Global Green New Deal [96] was launched by C40; it is composed of political leaders, investors, businesses, labour unions, young people, civil society and communities disproportionately impacted by the climate crisis and poverty based on a holistic, intersectional approach to climate action, recognizing that climate, social and economic justice can only be achieved together. The principles of the Global Green New Deal are:

- Recognizing the climate emergency;
- Committing to keeping global heating below the 1.5°C goal of the Paris Agreement by curbing the emissions in the sectors that are the greatest contributors to the climate crisis: transportation, buildings and waste;
- Committing to putting inclusive climate action at the center of all urban decision-making, and creating thriving and equitable communities for everyone;
- Inviting the partners-political leaders, CEOs, trade unions, investors and civil society – to join C40 in recognizing the global climate emergency and delivering on science-based action to overcome it.

Global Green New Deal it is not only an implementation of new policies or providing temporary support but also reckoning with, addressing and transforming old policies and systems; thus, a regionally-diverse approach is essential to delivering equitable climate action. In 2020, facing the global COVID-19 pandemic crisis and its profound impacts on the worldwide communities, C40 convened the Global Mayors COVID-19 Recovery Task Force, to develop a plan to help C40 cities rebuild their economies in a way that improves public health, reduces inequality and addresses the climate crisis. These efforts resulting in the Mayors' Agenda for a Green and Just Recovery, which defined a collective vision, put forward concrete policies and initiatives, and called for action by all governments and institutions to support its efforts. The Mayors' Agenda supports a global vision for climate, health and economic benefits for all, investing in the reduction of diseases associated with poor air quality and halving greenhouse gas emissions by 2030, thereby getting on track in keeping global heating below 1.5 degrees, unlike a return to business as usual in which GHG emissions would continue to rise.

Since 2021, the C40 members have adopted the Leadership Standards for 2021-2024 which set the minimum requirements for all member cities and safeguard the integrity of C40 as a network of climate leaders. Membership operates on performance-based requirements, not on fees, and every city in the C40 network is reviewed annually in accordance with the Leadership Standards.

These new mandatory membership criteria set a new global benchmark for climate ambition and leadership. Leadership Standards are grounded in the principles of the Global Green New Deal as the cornerstone of a green and just recovery from the COVID-19 pandemic and the foundation of global efforts to address the climate emergency. C40 Leadership Standards 2021-2024 are:

- Plan: City has adopted a resilient and inclusive climate action plan aligned with the 1.5°C ambition of the Paris Agreement, and updates it regularly;
- Deliver: in 2024, city remains on track to deliver its climate action plan, contributing to increased resilience, equitable outcome and halving C40's overall emission by 2030;
- Mainstream: city uses the necessary financial, regulatory and relevant tools at their disposal to address the climate targets in the most impactful decision-making processes of the city;
- Innovate: City innovates and starts taking inclusive and resilient action to address emissions beyond the direct control of the city government, such as associated with goods and services consumed in their city;

- Lead: mayor and city demonstrate global climate leadership and inspire others to act in support of the Paris Agreement.

Civitas – sustainable and smart mobility for all

CIVITAS (stands for City-VITALity-Sustainability) is one of the flagship programmes helping the European Commission achieve its ambitious mobility and transport goals, and in turn those in the European Green Deal. CIVITAS does this by acting as a network of cities, for the cities, dedicated to sustainable urban mobility. CIVITAS fosters political commitment and boosts collective expertise, equipping cities to put mobility at the centre of decarbonisation. Since its onset in 2002, it has spanned six phases in advanced research and innovation in sustainable urban mobility and enabled local authorities to develop, test and roll out measures via a range of projects. Cities, acting as Living Labs, test an integrated set of sustainable urban mobility measures, whose complementarity helps cities meet ambitious mobility goals. These measures are evaluated to demonstrate the extent of their potential and impact. CIVITAS research projects establish new knowledge or explore the feasibility of a new technology, product, process, service or solution. They use a variety of methods and engage interdisciplinary partners to discover new mobility innovation. Coordination and Support Actions support cross-project coordination, serve as exchange mechanisms and facilitate capacity building – whether for research or Living Lab projects, or focused on certain thematic areas. Thematic areas framed by CIVITAS are:

- Active mobility: Making walking and cycling the preferred travel choices for people in cities;
- Integrated and inclusive planning: Influencing and changing attitudes and travel behaviour through “soft” measures;
- Behavioural change and mobility management: Influencing and changing attitudes and travel behaviour through “soft” measures;
- Public participation and co-creation: Involving citizens and stakeholders in planning to improve the quality and acceptance of urban mobility measures.
- Clean and energy-efficient vehicles: Travel options and infrastructures for cleaner vehicles and fleets;
- Road safety and security: Ensuring the well-being of all those navigating urban environments;
- Collective passenger transport and shared mobility: Using public transport and shared mobility to put reduce use of private cars;
- Smart and connected mobility: Establishing the critical link between new user-friendly transport services and decarbonization;
- Demand and urban space management: Managing urban space and travel demand for the benefit of sustainable modes and people-friendly places;
- Urban logistics: Promoting cleaner urban freight vehicles and more efficient goods distribution.

CIVITAS with its current phase CIVITAS 2030 (2021-2025), supports cities to make smart and sustainable urban mobility and is ensuring that mobility is a driving force behind the building of climate-neutral and resilient cities. The CIVITAS Initiative is currently coordinated by CIVITAS ELEVATE (that is also responsible for the CIVITAS Secretariat). ELEVATE supports the CIVITAS Community to increase its impact on urban mobility policy making and advance it to a higher level of knowledge, exchange, and sustainability. ELEVATE primarily engages in supporting activities to

boost the Europe-wide impact of CIVITAS projects on sustainable urban mobility policy and assist the CIVITAS National Networks. Its main objectives are to:

- Develop the CIVITAS knowledge base and fast tracking the transfer of new knowledge.
- Enrich the current CIVITAS generation and feed future EU initiatives and CIVITAS-type actions.
- Build a European mobility community able to navigate transition.
- Represent CIVITAS on the international stage.

The Covenant of Mayors for Climate and Energy

The Covenant of Mayors (CoM) was launched in 2008 in Europe fostering the ambition to gather local governments voluntarily committed to achieve and exceed the EU climate and energy targets [97]. The main distinguishing feature for CoM initiatives among all city networks, is a voluntary commitment and an entirely free of charge membership. Every CoM Signatory, commits to submitting a Sustainable Energy Action Plan (SEAP) outlining the key actions within two years following the local council decision to join the Covenant and reporting every two years on the progress of its implementation. In 2014, the European Commission launched the Compact of Mayors Initiative, focused on the adaptation to climate change and support in developing and implementing local adaptation strategies. In October 2015, the Covenant of Mayors and the Mayors Adapt Initiative merged into the Covenant of Mayors for Climate & Energy. Its goals were defined with cities through a consultation process, implementing the EU 2030 GHG-reduction target [98] and adopting an integrated approach: energy and climate change mitigation/adaptation.

Concerning “the first implementation phase” related to the CoM experience (2008-2020), recent studies for Italy [39,99] have highlighted that 49% of Italian Municipalities (out of a total of 7903 Municipalities) have signed up to the CoM, and the SEAP process worked until a qualified technical structure provided the necessary assistance in defining the action plans.

In June 2016, the CoM entered a relevant new phase of its history by joining with another city initiative, the Compact of Mayors which is an agreement among city networks to support the reduction of city-level emissions and reduce vulnerability to climate change by developing resilient cities [100–102].

The resulting “Global Covenant of Mayors for Climate and Energy” (GCoM) is the largest global alliance for city climate leadership, built upon the commitment of over 10,000 cities and local governments to tackle the challenges of climate change. GCoM can be considered as “the second implementation phase” of the CoM initiative and it is fully in line with the UN Sustainable Development Goals [86].

GCoM gathers cities and local governments of all population sizes worldwide, mobilizing and supporting cities to plan ambitious, measurable, climate and energy action in their communities. GCoM operates with city/regional networks, national governments and other partners to achieve its shared vision. The core principles of the Global Covenant of Mayors include:

Local Governments as Key Contributors: GCoM works to organize and mobilize cities and local governments to be active contributors to a global climate solution.

City Networks as Critical Partners: Local, regional and global city networks are core partners, serving as the primary support for participating cities and local governments.

A Robust Solution Agenda: Focusing on those sectors where cities and local governments have the greatest impact, GCoM supports ambitious, locally relevant solutions, captured through climate action plans (including mitigation, sustainable energy and adaptation measures) that are registered, implemented, monitored and publicly available.

Reducing Greenhouse Gas Emissions and fostering Local Climate Resilience: The Global Covenant of Mayors emphasizes the importance of climate change mitigation and adaptation to a changing climate, as well as increased access to sustainable energy.

GCoM is based on three pillars:

- Climate change mitigation (reduction of greenhouse gas emissions)
- Adaptation to climate change impacts
- Access to clean and affordable energy

It also follows different steps, from assessing greenhouse gas (GHG) emissions and identifying climate risks and vulnerabilities, setting and meeting mitigation targets and climate change adaptation goals for the whole community, to developing local climate action plans implementing mitigation, sustainable energy and adaptation measures.

As at October 2023, the GCoM counts 11820 EU27 Signatories, where each Signatory can adopt a Sustainable Energy Action Plan (SEAP) and move on towards the development of the Sustainable Energy and Climate Action Plan (SECAP).

Therefore, SECAP has to be considered an urban planning tool, because climate adaptation planning “is well suited to local levels of governments, as citizens can participate in creating targeted adaptation strategies that address the important regional impacts, and these strategies will provide tangible benefits to local residents” [103]. A recent study [104] points out that adaptation plans developed by the European cities involved, focused on the energy sector by concentrating mostly on energy saving, energy efficiency and renewables; preferring a broader approach and mentioning occasional concrete measures on sectors such as urban planning and management, water management and awareness raising. SECAPs in this context, represent tools able to develop tangible adaptation actions on the territories through a standard set of sectors concerning environmental, social and urban themes. They became tools useful to the territorial governance under the perspective of “the green responsibility” helping the local administrators to manage the urban and territorial transformation processes. The SECAP could fill the lack of Local Climate Plans among European cities where skills and resources of local governments are missing [105]. This is the case of many Southern and Eastern European countries and cities [106,107], where national or regional guidelines are absent and where the CoM thus became the breakthrough to fill the gap in terms of climate planning. Moreover, SECAP is to be considered as an evaluation tool in order to produce a measure of the transition towards a low-carbon economy and European climate-proof cities.

The CoM experiences among the European cities have highlighted the planning role of the SECAP, that produced a new perspective in rebuilding cities and shaping territories, contributing to improving the quality of life and the city welfare according to SDGs [74,86].

Starting from these last observations, the SECAP could couple a double effect:

1. developing adaptation actions on urban areas against climate-change and improving the resilience of cities in perspective of the EU 2050 climate-neutral target[108];
2. supporting the recovery of the cities' economies after the COVID-19 crisis through “green investments”, with effects not only on urban areas but also on the wellbeing of the citizens.

City networks meet Foundations

Some of the city networks have been supported in the engagement of the cities and their challenges by foundations, providing technical support and specific expertise. These foundations have supported the creation of a ‘clean growth’ of the cities through the service provision by funding that enables a movement organization to grow and maintain staff, offices, means of communication and other key elements in mobilization [109]. In these section two foundations, operating an active role with city networks, have been described, highlighting a common approach in tackling climate interventions, urban resilience and improving social conditions by their members.

100 Resilient Cities - Rockefeller Foundation

In 2013 as part of its Global Centennial Initiative, The Rockefeller Foundation pioneered 100 Resilient Cities (RC) to help more cities build resilience to the physical, social, and economic challenges that are a growing part of the 21st century. The fundamentals of the 100RC are based on urban resilience, meant as the capacity of a city's systems, businesses, institutions, communities, and individuals to survive, adapt, and grow, no matter what stresses they experience. Urban resilience requires a holistic approach to evaluate the risks and the capacities of the cities, searching for their most vulnerable areas. Thus, cities are not considered as structured by siloed sectors, quite systems where planning in a place-based, integrated, inclusive, risk-aware, and forward-looking manner. Solutions developed through resilience approaches will allow cities to enjoy multiple benefits, reducing and even helping to prevent the impact of shocks and stresses on the city's people, economy, and physical environment, and improving quality of life.

Cities in the 100RC network have been provided with the resources necessary to develop a resilience roadmap along four main pathways:

- Financial and logistical guidance to establish an innovative new position in city government, a Chief Resilience Officer (CRO), who will lead the city's resilience efforts;
- Expert support for the development of a robust Resilience Strategy;
- Access to solutions, service providers, and partners from the private, public and NGO sectors who can help them develop and implement their Resilience Strategies; and
- Membership of a global network of member cities who can learn from and help each other.

To date, more than 1,000 cities have applied, and 100 cities have been selected, to join the Network—representing more than one-fifth of the world's urban population. Between 2020 and 2022, the network accepted ten new members in specific regions and geographies, to expand the resilience agenda at the regional and national levels. Member cities need to commit to:

Create a permanent Office of Resilience within city administration.

Implementing resilient initiatives derived from a citywide resilience agenda.

Participate in regional and global network activities.

All new members are required to possess minimum criteria such as: create and institutionalize an Office of Resilience and a CRO position; develop a holistic, multi-stakeholder Resilience Strategy; implement resilient initiatives derived from the Resilience Strategy and participate in regional and global network activities. The network establishes strong partnerships with the local governments of the member cities, and their local stakeholders, under the principle of co-funding. Members are not expected to pay membership fees, and furthermore member cities may have access to potential funding from the network partners in the context of specific thematic programs.

The Resilient Cities Network provided the new members with: a customized capacity-building program comprising training and advice on resilience, technical support for the development of a holistic Urban Resilience Strategy, project prioritization and preparation, support in the identification and training of a CRO and Resilience Office team; network services, global communications, and access to all relevant multi-city programs and partnerships.

Bloomberg Philanthropies

Bloomberg Philanthropies is a philanthropic organization operating with the mission “Ensuring better, longer lives for the greatest number of people”. The organization focuses its activities on five key areas (Arts, Education, Environment, Government Innovation, and Public Health) and it has also defined five program areas (Arts, Cities, Education, Environment, and Public Health). The Bloomberg Philanthropies approach looks for unmet needs that can be addressed with proven solutions, relies on data and continually measures progress, does not hesitate to address controversial issues, utilizes advocacy when others are not willing to act, identifies and engages strong partners, remains flexible to invest boldly and quickly in order to maximize impact and focuses on cities to drive progress. The organization with the Climate & Environment program, supports the global efforts to fight climate change and protect the environment across a key array of issues, from driving the transition to clean energy and supporting climate action in cities, to preserving ocean ecosystems. In detail, Bloomberg Philanthropies supports and collaborates with mayors and local partners to ensure cities have the resources they need to raise their ambition, share learnings, and make progress in the transition to a sustainable, healthy future. The organization, supporting sustainable cities, is:

A strategic founder of C40 providing critical support and strategic insight to help advance the mission and deliver on programmatic goals and the climate action taking place across the C40 network;

A partner of the Global Covenant of Mayors for Climate and Energy (Co-chaired by Mike Bloomberg), that is a large-scale, determined response to climate change from metropolitan leaders around the world.

Relevant experiences retrieved

In this section, in retrieving the relevant bibliography, some critical highlights are reported in order to qualify the results and lessons obtained that stem from the interaction between strong stakeholders representing the social commitment of major economic drivers (the foundations) and the city

networks intended as a community of beneficiaries engaged in applying sustainable development targets through a collaborative approach.

Fitzgibbons and Mitchell [110] analysed the social equity interventions tackled by the 100RC city network. The authors assessed the results of the financial and human resources, provided to cities by 100RC, needed to explore social equity and justice in their strategies. They did not find evidence that the 100RC program offerings are what encouraged those cities to emphasize justice, with a possible exception in Dallas, USA. Furthermore, they identified a number of threats to social equity and justice that appear in the program itself, and its resulting City Resilience Strategies. In particular, they reported that the 100 Resilient Cities are heavily concentrated in wealthier countries and among the strategies analysed, only a few offers marginalized residents an opportunity to self-identify their needs, priorities and portrayal.

Roberts et al. [111] explored the resilient journey of Durban, a 100RC member. They recognize the role of 100RC as a facilitator in building a global practice of urban resilience among governments, NGOs, the private sector, and individual citizens. Moreover, they highlight the opportunity for Durban as a 100RC member, to be innovative within its own city space, engaging with its politicians, officials and citizens in developing strategies from below, learning from other cities, sharing and co-producing knowledge, oriented towards tackling the complex field of urban resilience

Hofmann et al.[112] conducted research focused on analyzing the resilience policies developed to support the disaster risk reduction and to assess whether the 100RC program emphasized vulnerability and risk narratives in its disaster risk reduction approaches. Each member city provided one or more shocks and stresses related to natural hazards and disasters, as highlighted by the 100RC program. There were numerous strategies benefiting from the 100RC program and Platform Partners system and many cities (e.g. Buenos Aires, Can Tho, Mexico City) identified the use of 100RC Platform Partnerships. Aside from the development of the 100RC Platform Partnerships, some member cities, as with the case of Rotterdam, were able to develop an additional network in order to export services from their local private sector partners. The strategy development process and the 100RC program itself are embedded within disaster resilience at multiple scales. For members, this involved the self-identification of disaster shocks and stresses, using the 100RC preliminary assessment framework and plan development in partnership with Arup (a private consulting firm).

Galderisi et al. [113] provided a comparative analysis of two case studies, Rome and Athens, in retrieving the main strengths and weaknesses of the cities' resilience-building processes developed under the 100RC Initiative. They highlight involvement in the 100RC network as an opportunity to create synergies with other projects or initiatives aimed at enhancing urban resilience, such as Smart Mature Resilience (SMR) financed under the Horizon 2020 Program developed for the period 2016-2018. The involvement in the 100RC Initiative has represented an opportunity to address some critical issues related to different urban dimensions (society, economy, environment and governance), to develop a shared vision for future development, and to systematize new and on-going actions already included in different tools (e.g. climate plans, urban regeneration projects, etc.), into a common frame. Moreover, the engagement in the 100RC Initiative contributed to improve decision-makers' and citizens' awareness about the existing and emerging challenges they have to cope with and to test new governance models, based on more participatory and cross-sectoral approaches to decision making processes.

Spaans and Waterhout [114] in their research, assess the concept of urban resilience, introducing Rotterdam as one of the first cities to participate in the 100 RC Programme. The authors show the novelty of the 100RC Programme as its broad approach to resilience. In asking cities to assess and

address their stresses and shocks, 100RC also highlights opportunities in including diverse and marginalised communities, engaging city stakeholder groups to leverage private and civil sector resources. In addition, they highlight that the 100RC Programme can provide the preparations for, and responses to, the future challenges, making cities better at adapting to all kinds of shocks and stresses and transforming them into opportunities for growth.

Discussions

This work is based on two topics: the role of city networks in energy and climate adaptation policy implementation and the VP approach in planning on such subjects.

City networks supported climate action planning. It became a top priority for cities to reduce greenhouse gas emissions and strengthen climate resilience, while improving mitigation and adaptation strategies in urban areas as a key objective for sustainable development. Moreover, city networks can be intended as the operative component in designing local experiences and applications scaling the global energy and climate targets according to the current policies. In this perspective, cities considered as ‘delivery agents’ of EU policies, as provided by Energy Cities impact report 2022, report the current operative connection between policies and city networks. We may refer to this role as a peculiar “skill” of the cities engaged in such policies, it derives from scaling down global solutions on local experience. It is demonstrated that such targets can only be achieved if they are integrated into planning, policy-making and action. However, the approach to the climate and energy issues under the umbrella of VP is fragmented, if compared to the current effective measures implemented by the complex network of stakeholders (public and private).

From the perspective of the authors, VP is a planning approach characterized by the engagement of the public and private actors/stakeholders, requiring an “urban and green” awareness in order to achieve successful results in terms of investments and interventions within the urban context. In this perspective, the role of city networks emerges in shaping decisions and interventions that allows for a comprehensive vision for the VP through a conceptual paradigm. Moreover, the challenge of energy saving and climate change requires innovative tools in spatial and urban planning, and at the same time, pointed out a gap of the traditional planning framework in tackling energy and climate issues and the need for renovated spatial planning practices. [11–13].

In this challenge, the authors identified that those topics had a significant relevance in the climate-responsive planning processes. Four characterizing factors (CF) were identified: The International Environmental Framework (CF1), climate geographies (CF2), VP approaches (CF3), and membership in city networks (CF4). These factors allowed to point out a portrait of the features that characterize the cities, highlighting the strengths and barriers (financial or technical) for each one.

The overview on the city networks shown in tab.1, carried out a first assessment on connections between policy objectives and city networks operating within the voluntary planning domain. Moreover, the feature “network of networks” allowed to better explain the connections among the city networks highlighting the more “social” city network and the connections due to common or shared targets.

Among the specific features of the city networks assessed in this research, there emerged some significant highlights.

The Italian experience of ANCI provided the perspective of a national network supporting the development and the dissemination of best practices among municipalities. The territorial approach pursued by ANCI allows to have a local impact of the network in supporting the transnational cooperation sharing European initiatives and projects such as URBACT and Resilient.

Despite being limited to the national level, ANCI gathers municipalities of all population-size and ensures specific tools according to the heterogeneous regional contexts.

UCLG, as a global network of cities and local, regional, and metropolitan governments and their associations, is committed to representing interests of local and regional governments worldwide. It serves as a platform for collaboration and cooperation among municipalities, cities, and regions from different countries in addressing global challenges such as climate change, urbanization, and sustainable development. UCLG strengthens its network by enhancing political participation, designing new tools for synchronized action and renewing partnerships with different actors. Moreover, UCLG is aimed at fostering and identifying the efforts of its membership to achieve the global agendas at a territorial level. This is supported by the decentralized cooperation, as a key tool of international cooperation and development programmes.

Eurocities is one of the EU city networks with a specific threshold in terms of population-size. Metropolitan areas larger than 250,000 inhabitants are eligible signatories, and the targets are related to population size. Actually, among the targets there is the promotion of measures that contrast the urban sprawl towards the models of compact, integrated and organic cities and during the last years, with the Integrating Cities Charter, they have set commitments on the integration of migrants, providing an overarching framework for work in this area. In this perspective, Eurocities represents a city network strongly involved in the social issues and provides equal opportunities in promoting diversity, recognizing cities as policy makers, service providers, employers and buyers of goods and services.

Climate Alliance is the first city network tackling the climate issues with a specific focus on the local level. It emphasized the role of the municipal involvement in climate protection, and considered cities and towns as key element in the implementation of the 2030 Agenda with its Sustainable Development Goals. The introduction of the Climate Alliance Charter, boosted the voluntary commitment of the signatories in their local climate strategies, oriented towards a “continuous reduction of greenhouse gas emissions”. Moreover, it promoted and supported the urban planning and transport policies given that participatory governance and the involvement of citizens is a prerequisite for acceptance and a measure for the accountability and change in consumption patterns.

ICLEI works like a city network, providing technical consulting to local governments to meet environmental and sustainability issues, despite the fact that it is technically an international non-governmental organization. The self-defined commitment to climate protection represents the only requirement to the membership, and there is not a limitation in terms of population size. This allows for the engagement from local to global levels, shaping policies and sparking actions to transform urban environments worldwide. It builds connections across levels of government, sectors and stakeholder groups, sparking city-to-city, city-to-region, local-to-global and local-to-national connections. By linking subnational, national and global actors, policies, commitments and initiatives, ICLEI strengthens action at all levels, in support of sustainable urban development. Larger expressions of these international connections are represented by the Local Government Climate Roadmap that is the main advocacy channel for inputs of local and subnational governments into UNFCCC negotiations. The Local Government Climate Roadmap is a coalition and advocacy process that aims to recognize, engage and empower local governments in global climate negotiations. In this

context, ICLEI facilitates the Local Government Climate Roadmap with the support of other city networks.

METREX is a city network designed specifically for the metropolitan regions and areas. Its fundamental aims are related to integrating strategies for sustainable development, metropolitan land use and transportation, urban growth, renewal and regeneration, and strategies for environmental renewal.

METREX works to enhance funding, budgets and the position of its signatories on the European and/or global level, which often translates to better outcomes for citizens, businesses and institutions. It contributes the metropolitan dimension to policies, programmes and projects on a European scale. It plays an active role in starting and coordinating metropolitan developments, considering that many of the METREX challenges can be tackled in coordination with other metropolitan areas in Europe. In this scenario, the contribution of METREX to the European Committee of the Regions for the position papers and the New Leipzig Charter is expression of the role of the European metropolitan regions and areas in EU policies and programme challenges.

ENERGY CITIES is a city network that includes local and regional authorities but also municipal agencies or companies, as well as regional authorities and their subordinated organizations, willing to engage in the energy transition. A key feature of ENERGY CITIES, is the internal organisation governed by the principles of holacracy, which means decisions are made by the person or “circle” responsible for a role. Ambition and commitment to share experiences are required by the signatories, in order to reach climate neutrality in the territories by 2050 and to align the local strategic development with the Paris Agreement. Furthermore, ENERGY CITIES acknowledges the central role of cities and regions as drivers of change and connecting hubs, and promotes common interests while calling for cooperation across governance levels.

C40 Cities, is a city network exclusively related to megacities aimed at the cooperative reduction of climate pollution. C40 member cities have developed broad efforts to build climate action through peer-to-peer knowledge sharing, including climate action planning, buildings, transport, energy and adaptation. Over the years, C40 members were committed to deliver inclusive and resilient action plans according to the progressive reduction of emissions according to the Paris Agreement and 2030 targets. The Global Green New Deal launched in 2019, by its composition and holistic, intersectional approach to climate action, recognizes that climate, social and economic justice can only be achieved together. It also recognizes that a regionally-diverse approach is essential to delivering equitable climate action.

CIVITAS, as well as ICLEI; acts as a network of cities, for cities, with a specific focus on sustainable urban mobility. It supports the European Commission in achieving its ambitious mobility and transport goals, according to the European Green Deal. CIVITAS fosters political commitment and boosts collective expertise, supporting the development of policies related to the mobility towards decarbonisation processes. The current phase of CIVITAS 2030 (2021-2025), supports cities to make smart and sustainable urban mobility and ensures that mobility is a driving force behind the building of climate-neutral and resilient cities.

The Covenant of Mayors (CoM) initiative was launched in Europe fostering the ambition to gather local governments voluntarily committed to achieve and exceed the EU climate and energy targets. The approach pursued by CoM signatories is bottom-up and currently CoM counts over 10000 signatories thereby becoming the largest global alliance for city climate leadership. It is relevant to highlight that among the CoM signatories, 63% of them have a population below 10000 inhabitants.

Each signatory develops a SECAP transforming into practice its commitments and policies towards climate neutrality through a standard set of sectors concerning environmental, social and urban themes. SECAPs represent tools that are useful to drive the territorial governance under the perspective of “the green responsibility” helping the local administrators to manage the urban and territorial transformation processes towards a low-carbon economy and European climate-proof cities. Furthermore, SECAPs could fill the lack of Local Climate Plans among European cities where skills and resources of local governments are missing [105]. In this perspective, CoM experiences among the European cities, have highlighted the planning role of the SECAP, that produced a new perspective in rebuilding cities and shaping territories, contributing to improving the quality of life and the city welfare according to SDGs.

Lastly, the participation in a city network is an opportunity for cities and local communities to achieve common challenges with a well-structured support, learning from each other, and sharing good practices [113]. In this context, the city network deriving from the 100RC Initiative can be considered a remarkable example of how “knowledge co-production amongst cities and city-networks could bring about new urban solutions applicable across scales and across geographies for urban resilience and urban sustainability” as remarked by Elmqvist et al.[115].

Conclusions

The research has identified the VP approach as an expression of the awareness and commitment gained by the municipalities. This approach can promote bottom-up processes that allow the local community and local players to express their views and needs for the local sustainable development in line with the SDGs.

The framework of the VP also introduces a new urban planning paradigm: energy efficiency and climate challenges require a new generation of planning tools, and SECAP (suggested by the CoM) is such a candidate for the production of relevant changes to the complex system of EU Municipalities integrating specific urban issues and the wider territorial sustainable objectives [42]. In this perspective, the SECAP approach intended as a tool to facilitate decision-making processes in energy and climate local actions, is very flexible if compared to other institutional planning processes and could fill the gap of traditional urban planning tools concerning the objectives of GHG reduction and climate adaptation/mitigation. These plans can be considered as indications of the planning platform of European cities, thereby making the European cities approach in managing climate adaptation and energy sustainable transition, comparable across the EU as it is based on a common planning approach, a common planning scheme and common evaluation metrics.

A holistic approach, as suggested by the CoM, ICLEI, C40 or 100 Resilient Cities, could be the solution to design and compare similar experiences among the municipalities, towards building an effective adaptation/mitigation strategy facing the climate-change challenges for future sustainable cities, included in the low-carbon transition process.

The holistic approach, together with the bottom-up approach, could represent a suitable mix for VP in:

- Better orienting the decisions and initiatives taken on by the Municipalities;
- Better evaluating the experiences done, improving the interventions in accordance with the local needs towards a sustainable development

- Better defining the contribution to the climate and energy challenge from the “small” to the “major” municipalities.

The role of city networks in designing and shaping interventions, coupled to VP can underpin those weak municipalities, where awareness and commitment are effective but are opposed by technical and financial barriers. This is the case of the small municipalities (i.e. below 10000), that are strongly aimed at joining the energy and climate challenge but encounter several barriers (technological, financial, logistic) as opposed to bigger municipalities. Moreover, the meeting of the Foundations with the city network could be an opportunity to improve the local development with ad-hoc investments and enhance engagement processes of public and private actors involved in planning processes. We can confirm that this produces a higher awareness in local communities towards planning as a process to address local needs in a strategic and integrated long-term view.

A relevant component, to be included in a further development of this research, is the involvement of citizens [116] and the engagement of stakeholders in the SECAP design process. This is a grey area and it requires effective participation methods [117–120] (such as public consultation, working groups, forums, workshops) in order to produce improvements to the plan without affecting the effectiveness of the process.

2. A systemic perspective for the Sustainable Energy and Climate Action Plan (SECAP)³

Abstract: *The voluntary-based initiative Covenant of Mayors (CoM) focused on the active role of local authorities and increased its targets by 2016, through the Sustainable Energy and Climate Action Plans (SECAPs) in terms of GHG reduction from 20% to 40% by 2030. In actual fact, the SECAP, intended as an urban planning tool, has the potential to improve the resilience of the EU Municipalities to climate-change, developing adaptation/mitigation actions and increasing the “environmental awareness” of the involved actors. From a planning point of view, we affirm that the CoM started a new season of urban planning in Europe that covers the planning demand in the domain of implementing sustainable territorial development objectives. It unlocks the current ineffective planning systems and represents a remarkable practice promoting feasible framework projects for public and private investments. In this paper, we propose a methodological proposal to exploit this spread of SECAPs in the EU, including the systemic strategic planning approach in the process of SECAP design and ensuring an integrated vision of city development over the list of actions per sector required by the Global CoM procedures. Besides the methodological proposal, a review of the major EU energy policies is provided and relevant Best Practices are presented.*

Keywords: energy planning, SECAP, Covenant of Mayors, urban planning, climate change, European Climate Policies

Introduction

In the field of environmental protection, the European Union (EU) has shown its highest expression of multilateralism and after 30 years from the “Single European Act” [46,47], the EU has an almost complete set of legislations that address environmental protection of air quality, water, waste and biodiversity. The EU climate policies started as part of the environmental policies, in understanding that environmental issues and pollution were not only the problems of each EU country but went beyond national borders and therefore should be managed at EU level. Examples of these are in a number of events raising EU environmental awareness: the “acid rain” in the 1980’s caused by UK coal-fired power stations damaged forests and lakes in Scandinavia [121–123]; pollution caused by discharges into the Rhine, the Meuse or the Danube rivers in another country further downstream [124–126]. Thus, after the Single European Act in 1987, in the 1990’s the EU started its climate policy focusing actions mainly on the reduction of CO₂ submitting the Kyoto Protocol [44] and adopting several programmes based on energy efficiency and promotion of renewable energies. Only in the 2000’s the climate component, as a relevant action domain, was coupled with the energy sector within the European Climate Change Programme (ECCP), aimed at developing and coordinating strategies to reach the Kyoto targets. In the last years, the EU has strengthened the link between CO₂ emission reduction and climate component, introducing the adaptation to climate change through policies, directives, laws and volunteer initiatives. On this track, the European Commission has

³ Scorza, F., & Santopietro, L. (2021). A systemic perspective for the Sustainable Energy and Climate Action Plan (SECAP). *European Planning Studies*, 1–21. <https://doi.org/10.1080/09654313.2021.1954603>

organized and participated in initiatives within the EU and at an international level, addressing cities as beneficiaries:

- Urban Development Network (UDN): it supports information exchange between cities involved in integrated Sustainable Urban Development and in Urban Innovative Actions. The UDN promotes the dialogue on Sustainable Urban Development between the Commission, cities and other stakeholders.
- Smart Cities: Technological solutions bringing together different policy fields help cities to reduce their environmental impact and offer citizens better lives. Smart cities and Communities are supported through various EU instruments, such as European Structural and Investment Funds, Horizon 2020 and the European Innovation Partnership on Smart Cities and Communities (EIP-SCC)
- Covenant of Mayors for Climate and Energy: Since 2008, it has brought together local and regional authorities who voluntarily commit to implementing the EU's climate and energy objectives on their territory.
- Living-in.EU Movement: This is a collaborative platform for cities and communities to accelerate their digital transformation the 'European way' (citizen-centric, ethically and socially responsible data usage, open and interoperable standards). The aim of Living-in.EU is to work together to scale up the use of data technology to tackle a range of interconnected challenges, including urban mobility, energy efficiency, and digital public services, while ensuring environmental sustainability in line with the European Green Deal.
- International urban policy: On the global level, the EU supports sustainable urban development. It participated in the Habitat III, the United Nations Conference on Housing and Sustainable Urban Development, where the New Urban Agenda was adopted by UN member states. It cooperates with countries from the Southern and Eastern shores of the Mediterranean and provides funding for city-to-city cooperation.

This work focusses on the Covenant of Mayors (CoM). It represents the operative side of the EU policies on energy efficiency and climate adaptation, introducing an “alternative” planning tool at a municipal level: The Sustainable Energy Action Plan (SEAP) for the first season of CoM implementation (2008-2015) and today the Sustainable Energy and Climate Action Plan (SECAP) (characterizing the second season of COM implementation).

Recent studies analysed the implementation magnitude of CoM in European and/or National contexts [39,107,127–129] and reported a generalized success of this policy both in terms of an effective contribution towards achieving the UE 2020 emission targets and in terms of commitment of local administrations and local communities towards EU policies objectives.

From a planning point of view, we affirm that the COM started a new season of urban and territorial planning in Europe according to a volunteer approach in developing planning tools[130,131] out of any normative obligation deriving from any planning law (national/regional). This is representative of the high planning demand in the domain of implementing sustainable territorial development objectives [74,86,102,132]. On the contrary, it is a measure of the unsuitability of the current normative framework concerning urban development and management to express required performances in promoting actions and tools (the “plans”), oriented towards applying sustainable development principles and climate adaptation/mitigation.

In the perspective of the authors, the impact of CoM enriched the institutional planning framework through: effective practices, useful technical contributions in selecting intervention priorities, design of feasible project frameworks for public and private investments (also promoting EU Cohesion Policies by Regional Operational Programs). The new CoM season (connected with the implementation of the so-called G-CoM (Global Covenant of Mayors for Climate & Energy)) reinforced the ambitious target of implementing energy efficiency coupling it with climate adaptation/mitigation actions at a municipal scale. However, the suggested SECAP methodological framework shows some critical weaknesses in creating an integrated approach for urban sustainable planning. Therefore, the aim of this paper is to propose a structured methodology for SECAP design. It represents an innovation for current procedures oriented at reinforcing the strategic planning approach in the SECAP development procedure.

This study, starting from the description of the European policies framework on energy efficiency, CO₂ reduction and climate change from the beginning (Single European Act, 1986) to European Green Deal (section 2), focuses on the experience of the CoM with particular regard to the SECAP (section 3) considered as an urban planning tool (section 4) widely adopted in Europe to manage the component of urban and territorial transformations generated by the low-carbon transition process. Therefore, in section 4, we collect some interesting case studies that derive from European SECAPs, while in Section 5 we elaborate on the technical details included in the SECAP supporting tools provided by CoM from the point of view of the planning disciplines.

After a critical analysis of the SECAP methodological approach (in section 6) that identifies the strengths and weaknesses of the mayors in terms of process rationality, section 7 provides a methodological proposal aimed at overcoming the SECAP sectorial approach towards a cross-system approach, contributing towards a building and implementing integrated urban sustainable development strategy. Section 8 is related to the conclusions, highlighting the main results of this work.

European Climate Policy: history of “green certainties” against the cuts of the crisis

According to the environmental approach pursuit from the EU, we review the main stages of the EU climate policies that support urban and regional development and their adaptation to climate-change, in order to identify the policy development path that generates the current European Green Deal. This has been a complex process, that was affected by the crisis of 2008 and the resulting austerity measures adopted in the EU between 2008 and early 2015, that pushed the European Countries to cut public budgets, with consequences for the EU climate and energy policies [133,134]. Notwithstanding these cuts, the EU budget for low-carbon growth as part of the 2014-2020 EU Budget was protected as well as the funds spent on climate-related projects and policies. Moreover, after 2008, despite the strong increase of the EU expenditure to support economic or financial sectors, the EU had not dismantled the environmental policies and managed to rebuild a credible position on climate change [135,136].

In the post 2008 crisis era, the first season of CoM implementation (2008-2015) could be seen as the trigger to recover former performance in growth and development for the EU regions: the relevant growth of the SEAPs submitted by Municipalities ([39] represents a measure of the increasing funding opportunities, the improvement of local quality of life and economic and employment growth.

Similarly, the ongoing COVID-19 pandemic crisis has reduced confidence in developing long-term projects and plans (see also [137]) considering the EU 2030 greenhouse gas (GHG) reduction target. Despite this, the EU in December 2019 started the ambitious European Green Deal defining a priority roadmap for the period 2019-2024, striving to be the first climate-neutral continent by 2050 without GHG emissions. Turning climate-change into opportunities for investments and innovations toward a low-carbon economy, could be a scenario to an economy revival that should occur at all institutional levels (local, regional, national and international). The following section reports the relevant steps that characterize the EU path towards Green New Deal.

European Climate Policy: from Global climate policy response to European Green Deal

The EU started its climate policy in the late 1970s as a reaction to international negotiations [138] such as the Conference of World Meteorological Association (WMO) of Geneva in 1979. In 1991 the European Commission (EC) published its first strategy to reduce CO₂ emissions and increase the energy efficiency [139]; that same year, the "Specific Actions for Vigorous Energy Efficiency" (SAVE) programme [140] started to facilitate and promote the implementation of energy efficiency policies and programmes. Under the SAVE programme, with Council Directive 93/76/EEC [141] in 1993 all Member States were requested to limit GHG emissions thereby improving energy efficiency. The limit of this directive was linked to two features: the absence of quantified targets at a European level and a fragmented responsibility of the Member States in designing national energy policies.

Concerning the promotion of the renewable energies, a general target was introduced in Europe by the ALTENER programme in 1993: every European State was encouraged to include it within their national policies (see [142]).

The Kyoto Protocol (1998), for the first time, set quantitative GHG emission targets, by at least 5 per cent below the 1990 levels in the commitment period 2008 to 2012 (at the time called "*first commitment period*") to distinguish it from the "*second commitment period*" established by The Doha Amendment [45]). According to the Kyoto Protocol, the EC committed an 8% reduction of a basket of six GHGs (compared to 1990 levels) in the first commitment period and established The European Union Emissions Trading Scheme (EU ETS). Starting from the Kyoto Protocol, the EU addressed the development of environmental policies to International protocols shaping domestic policies, such as the carbon market in the framework of global challenges. [143]

In 2000 the ECCP was launched which examined an extensive range of policy sectors and instruments with the potential to reduce GHG emissions and develop common and coordinated strategies to fulfil the Kyoto targets. Under the ECCP, the deadline for policies and measures to meet the Kyoto Protocol targets were moved from 2008 to 2012 for the first commitment period, and from 2013 to 2020 for the second commitment period in preparation for the EU2020 target.

In March 2007, the European Council in its Presidency Conclusions fixed a set of three targets known as "20-20-20 to 2020" [48] concerning GHG emissions, renewable energies and energy efficiency. In 2008, the EC introduced the "Climate and Energy Package" and launched the CoM initiative, bringing together thousands of local governments voluntarily committed to implement EU climate and energy objectives. This integration between EU and local policies has pushed climate-change awareness and the development of low-carbon technologies for sectors with economic relevance such as energy, transport or industry. Furthermore, the EU has developed an adaptation strategy that encourages and assists Member States in developing adaptation plans and policies, launching the

Climate-ADAPT web-based platform in order to promote knowledge-sharing and best practices. Within the EU policy framework, the CoM for the first time explained the relations between the size of the territory and the commitments related to the GHG reduction and the climate change adaptation. According to the EU multilateralism approach, CoM has engaged European Municipalities on voluntary bases to reach the common target of GHG.

On 11th December 2019 the European Green Deal [49] was presented. This entailed an ambitious package of measures to cut GHG gas emissions, striving to be the first climate-neutral continent. The European Council in March 2020 submitted its long-term strategy [50] to the United Nations Framework Convention on Climate Change (UNFCCC) presenting the European Climate Law draft, an important component of the European Green Deal. The aim was to make the goal of EU-wide climate neutrality binding by 2050 and create a common roadmap up to 2050 for all EU policy areas.

The 2030 climate and energy framework [144], as part of the European Green Deal, in September 2020 proposed to raise the EU 2030 GHG emission reduction targets (to at least 55% compared to 1990).—According to the objective climate-neutral by 2050 - an economy with net-zero GHG emissions – the European Green Deal is fully in line with the EU's commitment to global climate action under the Paris Agreement [33].

A European volunteer movement for energy and climate-change policies: The Covenant of Mayors experience

The CoM was launched in 2008 in Europe fostering the ambition to gather local governments voluntarily committed to achieve and exceed the EU climate and energy targets [97]. On October 2015, the new Covenant of Mayors for Climate & Energy was launched. Its goals were defined with cities through a consultation process, implementing the EU 2030 GHG-reduction target and adopting an integrated approach: energy and climate change mitigation/adaptation.

Concerning “the first implementation phase” related to the CoM experience (2008-2020) for Italy, recent studies [39,99] highlighted that:

- 3901 out of 7903 Italian Municipalities (corresponding to 49% of all the Municipalities) have signed up to the CoM;
- SEAP process worked until a qualified technical structure provided the necessary assistance in defining the action plans.

In June 2016, the CoM entered a relevant new phase of its history joining with another city initiative, the Compact of Mayors which is an agreement among city networks to support the reduction of city-level emissions and to reduce vulnerability to climate change by developing resilient cities [100–102].

The resulting “Global Covenant of Mayors for Climate and Energy” (G-CoM) is currently the largest movement of local governments committed towards going beyond their own national climate and energy objectives.

The G-CoM represents “the second implementation phase” of the CoM initiative, it will be the world's largest coalition of mayors promoting and supporting voluntary action to combat climate change and to promote a low-carbon economy transition. Fully in line with the UN Sustainable Development Goals [86], the G-CoM will tackle three key issues:

- climate change mitigation,

- adaptation to the adverse effects of climate change,
- universal access to secure, clean and affordable energy.

As at April 2021, the CoM for Europe counts 10614 Signatories, where each Signatory can adopt a Sustainable Energy Action Plan (SEAP) and move on towards the development of the Sustainable Energy and Climate Action Plan (SECAP).

SEAPs as voluntary plans, in the last years have influenced urban development sometimes out of the normative and spatial framework defined through urban plans. This “second implementation phase” further increases the provisions linked to urban policies through the introduction of the SECAPs.

These plans can be considered as evidences of the planning platform of European cities ,thereby making the European cities approach in managing climate adaptation and energy sustainable transition comparable across the EU as it is based on a common planning approach, a common planning scheme and common evaluation metrics.

G-CoM represents the requested database of comparable urban development policies worldwide and its potential is not only under the GHG targets but also on the methodological aspect, fostering and planning a pervasive practice. We can affirm that it produces a higher awareness in local communities towards planning as a process to address local needs in a strategic and integrated long-term view.

SECAP as an urban planning tool

SECAP has to be considered an urban planning tool, because climate adaptation planning “is well suited to local levels of governments, as citizens can participate in creating targeted adaptation strategies that address the important regional impacts, and these strategies will provide tangible benefits to local residents” [103]. A recent study [104] points out that adaptation plans developed by European cities involved, focused on the energy sector by concentrating mostly on energy saving, energy efficiency and renewables; preferring a broader approach and mentioning occasional concrete measures on sectors such as urban planning and management, water management and awareness raising. SECAPs are on this track, and represent tools able to develop tangible adaptation actions on the territories through a standard set of sectors concerning environmental, social and urban themes. They became tools useful to the territorial governance under the perspective of “the green responsibility” helping the local administrators to manage the urban and territorial transformation processes. The SECAP could fill the lack of Local Climate Plans among European cities where skills and resources of local governments are missing [105]. This is the case of many Southern and Eastern European countries and cities [106,107], where national or regional guidelines are absent and where the CoM thus became the breakthrough to fill the gap in terms of climate planning. Moreover, SECAP has to be considered as an evaluation tool in order to produce a measure of the transition towards a low-carbon economy and European climate-proof cities.

The CoM experiences among the European cities highlighted the planning role of the SECAP, that produced a new perspective in rebuilding cities and shaping territories, contributing to improving the quality of life and the city welfare according to SDGs [74,86].

Starting from these last remarks, the SECAP could couple a double effect:

- developing adaptation actions on urban areas against the climate-change and improving the resilience of cities in perspective of the EU 2050 climate-neutral target;

- supporting the recovery of the cities' economies after the COVID-19 crisis through “green investments”, with effects not only on urban areas but also on the welfare of the citizens.
- According to these, the following section collects some experiences that arose from SECAP implementation in EU countries.

Selected CoM Flagship Examples

Since G-CoM was launched in 2016, some interesting case studies have developed in terms of improving adaptation to climate change and increasing resilience to extreme weather events. The authors, in this perspective, have chosen some of those cases (Climate ADAPT website and [145]), covering different SECAP Standard Sectors (SSS) among different geographical locations.

“Trees for living. Barcelona Tree Master Plan 2017-37”, Barcelona, Spain.

Barcelona City Council has drafted a 20-year plan for planning, managing and conserving its urban forest. SSS interested in this action are “Biodiversity, Public health and Land-use planning” with impacts on droughts, extreme temperatures, flooding and water scarcity. The aims of this action are the evaluation of the entire tree population for services and beneficial effects, but also disadvantages like allergies and littering, the use of an urban forest-effects computer model to statistically quantify urban forest structures and their benefits, as well as the evaluation of the trees from cultural, ecological, climatic and economic perspectives (see [146]). In 2016 the number of trees was 311000, the planned results set a growth of city tree coverage from 5% to 30%, planting more climate-resistant trees with a growth of urban forest stock from 30% to 40% and improving tree biodiversity so that no single species accounted for more than 15% of the urban forest. Considering the interactions between mitigation and adaptation, tree population acts as a carbon sink and isolates the GHG emissions from the atmosphere, providing benefits directly to the city by moderating temperatures, reducing energy costs, improving air quality and protecting citizens from adverse climate effects.

The Cloudburst Management Plan, Copenhagen, Denmark

The city of Copenhagen was afflicted in the period 2011-2016 by four major rainfall events with severe damages that were expensive to repair. The city decided to draw out its own Cloudburst Management Plan with the aim to reduce the impacts of flooding from heavy rains. The Cloudburst Management Plan was developed during 2013 and to date includes 300 surface projects. It is intended that these projects will be implemented on an average of 15 projects per year for the next 20-30 years. The projects are prioritised according to the level of flood risk, a socio-economic assessment and the availability of co-benefits. SSS included in this plan are “Urban and Water Management” with impacts on flooding and storms.

The plan included an assessment of the costs of different measures (traditional versus new options including adaptation measures), the cost of the damage despite the measures and the resulting financial impact. The results showed that by continuing to focus on the traditional sewerage systems, would result in a communal loss compared to the alternative solution (see also [26,147,148]). The alternative adaptation measures aim to store or drain excess water at ground level. The plan consists of four surface solutions as well as pipe-based solutions, including:

- storm water roads and pipes that transport water towards lakes and the harbour, e.g. in the built-up area of central Copenhagen;
- retention roads for storing waters;

- retention areas to store very large volumes of water, e.g. parks that could turn into lakes during flood events;
- green roads to detain and hold back water in smaller side streets.

Adapting to heat stress in Antwerp (Belgium) based on detailed thermal mapping

The city of Antwerp, in order to better understand the problem of heat stress, commissioned the research organization VITO to map the current and future temperatures and thermal comfort in the city. The research results indicated that the urban heat island of Antwerp exacerbates the impact of climate change on the urban population as the amount of heatwave days in the city increases twice as fast as in the rural surroundings (see [25,149]). The SSS interested in this intervention are “Buildings, Disaster Risk Reduction, Health, Urban” with impacts on extreme temperature. To tackle the problem of heat stress in the city, adaptation measures at three different scales (city-wide, local and the individual citizen) are put forth. At the city-wide scale, the installation of green roofs is made mandatory for new or renovated buildings with a suitable roof, as are permeable and green parking lots. The regulations also aim to increase the albedo of public buildings. On a local scale, the thermal comfort is improved by installing fountains and ponds, planting trees and creating parks in public spaces that are renovated, while involving inhabitants through citizen science measurement campaigns. Lastly, a dedicated heat forecast and warning system is put into place to minimize the health impacts on individual citizens. Research on heat stress and climate change for the city of Antwerp started in 2013 and is still ongoing. Several components (e.g. heat stress maps, measurement campaigns) were performed in dedicated time frames, typically taking a few months to a year.

Supporting SECAP design at a municipal scale

What makes SECAPs comparable at an EU level is the common planning scheme proposed by CoM and accompanied by specific toolkits that support the development of the plan.

The CoM effectively asked for a simplified approach, facilitating a technical analysis and decision-making process along the SECAP implementation (see[127,150]).

If we choose the planning perspective to assess this framework and in particular if we want to exploit the potential of G-CoM in promoting effective planning practices in the scope of EU countries, we can highlight some critical points that refer to the lack of integration among the SSS, considering an integrated approach in planning as a prerequisite of “good planning practices” (see [151–154]).

In this section, we try to demonstrate how the different methodological approaches deriving from the CoM toolkit do not fully go in the direction of an integrated planning approach. This opens to a potential improvement at a methodological level in SECAP procedures and our proposal, developed on the case study of the Potenza Municipality in Italy described in previous works [155–158], contributes towards highlighting how to achieve the integrated assessment of SSS by matching intervention typologies that produce effects on multiple components of urban environment. In the next section we describe, in detail, the methodological proposal, here we collect the G-CoM toolkit available.

The G-CoM toolkit includes:

- **guidelines developed by the CoM and Mayors Adapt Offices** [159] in collaboration with the EC’s JRC. They provide to seek Signatories with step-by-step guidelines throughout the

reporting process. Guidelines are structured in three sections and are enriched with some practical recommendations and concrete examples

- **Urban Adaptation Support Tool (UAST).** The aim of UAST is to assist cities, towns and other local authorities in developing, implementing and monitoring climate change adaptation plans. The UAST was developed as a practical guidance for urban areas, in recognition of their importance in the European economy. The UAST outlines all the steps needed to develop and implement an adaptation strategy and makes references to valuable guidance materials and tools. The tool offers valuable support to both the cities that are just starting on adaptation planning and to those more advanced in the adaptation process.
- **Benchmark of Excellence (BoE),** they are actions which local authorities have successfully implemented and that have led to significant benefits. They are relevant examples of initiatives which Covenant Signatories, Coordinators and Supporters feel particularly proud of, and moreover endorse as useful actions for other local authorities, provinces, regions or networks to replicate. Only ongoing and completed actions can be considered as BoE. The BoE is available online on the CoM website in the catalogue of Benchmarks of Excellence.
- **Quick reference guides.** This tool is oriented towards offering practical guidance and examples on topics such as monitoring an action plan, the joint approach to develop an action plan and the financing opportunities available for the implementation of action plans.
- **E-Learning platform.** It is announced to provide practical guidance, recommendations, examples and virtual demonstrations related to the preparation, implementation, monitoring and financing of action plans, including both mitigation and adaptation.

It is really important to point out that from the previous list, tools 1, 2 and 4 exist online and are available for users and CoM Signatories while 3 and 5 are partially but still not fully available. Without a doubt, for 3, the “Benchmarks of Excellence catalogue” website is down, but it is also remarkable to point out that the BoE are raising from 4741 at the end of 2016 (see [160]) to 7130 in February 2021 available on the CoM official website.

Whilst, for 5 in March 2021, the CoM will start the “Peer Learning Programme” giving local authorities the possibility to participate in exchanges with the aim of increasing their capacities to mitigate and adapt to climate change.

Missing an integrated urban vision?

The selected CoM Flagship Examples in section 4 on the European CoM Municipalities, highlight the prevailing sectorial approach that is distinctive of the SECAP design process. This SECAP approach, intended as a decision-making process, is very flexible if compared to other institutional planning processes. Moreover, it could fill the gap of traditional urban planning tools concerning the objectives of GHG reduction and climate adaptation/mitigation.

In our view, the main weakness of the current SECAP approach, is to enhance a sectoral view of the plan, separating urban components such as transport, environment, energy, water management etc., without offering any integration between actions that cover multiple sectors. As declared in the SECAP Guidebook [161]: “*The SECAP should be elaborated based on a sound knowledge of the local situation in terms of energy and greenhouse gas emissions, as well as of climate hazards, vulnerabilities and impacted policy sectors.*”. Even if the CoM Signatories acknowledge that their commitment requires “*A cross-sector and holistic territorial approach*”, the SECAP finally lists a

number of actions, divided in sectors and without any assessment of the potential integration in terms of benefit in multiple sectors, that available technologies or intervention typologies could bring in a specific context.

Thus, we can affirm that the SECAP is based on a sectorial approach, and it lacks an integrated urban vision that represents a prerequisite for an effective urban planning practice.

The benefits directly connected to such a sectorial approach are linked to the ability of the Municipalities to develop a detailed schedule of the actions provided with information concerning the allocated budget, the stakeholders involved or the expected timeframe. Moreover, a distinctive feature of the SECAP approach is the certainty of the timeframe of the action that derives from the commitment of each Municipality that declares, as a Signatory, to respect the CoM procedure and self-defined actions. This represents a considerable boost for the local administrator in choosing a planning approach oriented towards results and performance in energy/climate objectives. According to recent studies [30,162], the sectorial approach could unlock the implementation of planning tools in urban areas particularly for Countries with complex and fragmented planning laws.

Furthermore, we recognize a “patchily intervention”: which means that actions are presented as a fragmented patchwork on the city without any integrated urban vision defined within the SECAP. The best option is that the strategic view of the city comes from other planning tools (i.e. Municipal Masterplan) but in most SECAP implementation cases (medium/small cities), this is not the standard condition, so the SECAP according to the current methodological structures, missed the opportunity to contribute such integrated urban vision.

The strengths and the weaknesses identified are synthetically presented in table 1.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Specific actions strongly related to SECAP sectors • Certainty of the actions’ implementation • Detailed planning of the actions including: budget, identification of the the responsibilities for the implementation, timeframe, stakeholder involved, risks/vulnerabilities, outcomes in terms of CO₂ emissions reduction. • Unlocking planning tools implementation in urban areas 	<ul style="list-style-type: none"> • Exclusive focus on the relation action-sector without any systemic evaluation • Restricting intervention priorities only to selected SECAP sector • Patchly intervention: actions are implemented with patchy intervention on the urban areas without an integrated urban vision and the evaluation on possible consequences (positive or negative).

Table 1 Strengths and weakness of the SECAP approach

Overall, in the perspective of the authors, the SECAP approach is based on the development of actions according to a pre-defined standard set of sectors, preferring the implementation of specific actions related to sectors in a one-on-one relation and neglecting the possible impacts of the single actions (positive or negative) on the whole urban system.

However, the cities should be considered as a set of systems (such as green spaces, waterproofed soils, energy system [163], active mobility (Francesco Scorza and Fortunato)etc.) where the implemented actions could affect several systems (as occurs with the SSS) at the same time, therefore those actions should be planned according to an integrated urban vision.

A new methodology for SECAP: The cross-system assessment

Each G-CoM Signatory has to compile a SECAP worksheet composed of the following parts:

1. **Energy and climate strategy declaration:** the vision, the general objective of reducing CO₂ emission, the adaptation objectives, the allocation of financial and human resources and the involvement of stakeholders and citizens;
2. **Emission Inventories:** the amount of final energy consumption and the relative CO₂ emissions recorded by energy carrier and sector during the year of reference;
3. **Mitigation actions:** the list of main mitigation actions to implement the overall strategy, including timing, allocation of responsibilities, budget and estimate of the effects;
4. **Risks and Vulnerability:** climate vulnerability, threats, impacts and related evaluations;
5. **Adaptation Actions:** Action Plan(s) and individual actions (key), including various relevant parameters (i.e. sector, time frame, stakeholders and costs).

Every two years from the date of submission of the SECAP (following local adoption at Municipal level), a Monitoring Report should be drawn up in order to evaluate the implementation status of the actions. However, it is necessary to develop a full report every four years, i.e. a Monitoring Report that includes at least one Monitoring Emission Inventory (MEI). In figure 9 we suggest a graphic scheme that summarizes the steps on the SECAP design according to the CoM basic requirements.

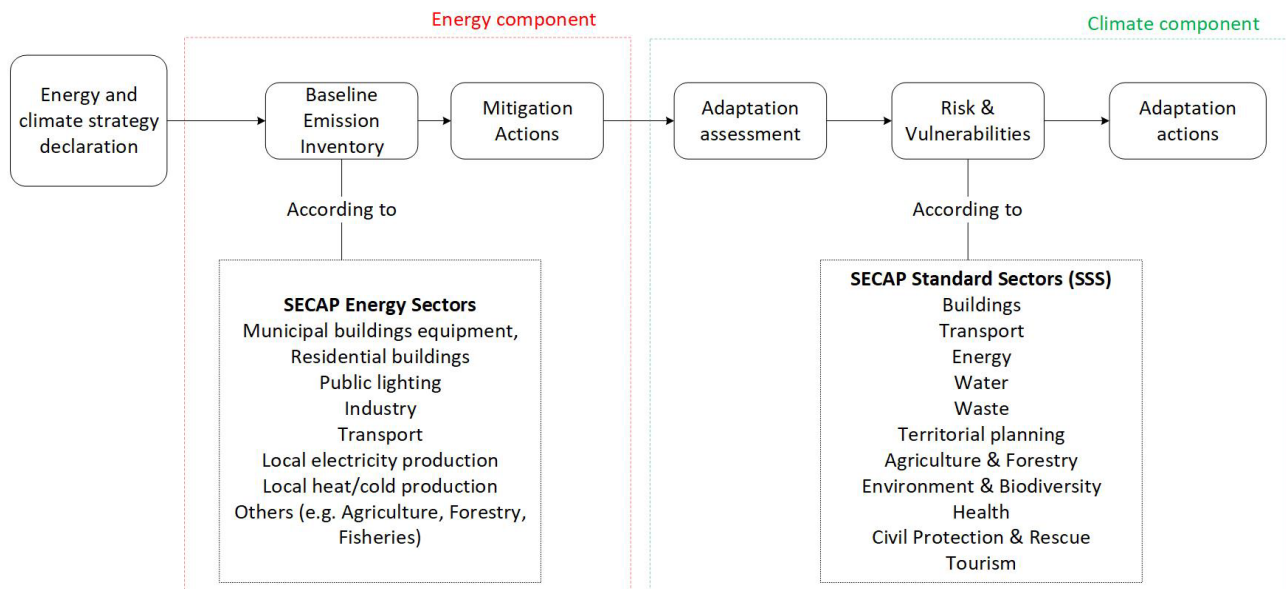


Figure 9 Steps in the SECAP design: the CoM requirements

In the SECAP design the check of the relations between the proposed actions and the SECAP Standard Sectors (SSS) appears as a weak process from a territorial point of view. Without a doubt, it does not highlight the relations between the actions and the context and therefore does not facilitate (or prepare) the monitoring phase required by the CoM procedures.

The methodological proposal developed in this research (see fig.10) is oriented towards a systemic approach: to integrate the SECAP sectors through an integrated urban vision based on a cross-sectorial assessment of effects of selected actions.

In fact, if the planning knowledge is represented per territorial system (i.e. through mapping activities, data collection, spatial analysis), the SECAP approach organizes the plan in standard sectors that are subsets of the planning systems. It is necessary to structure the relations between planning systems and SSS.

It is remarkable to affirm that those relations depend strongly on the local context characteristics.

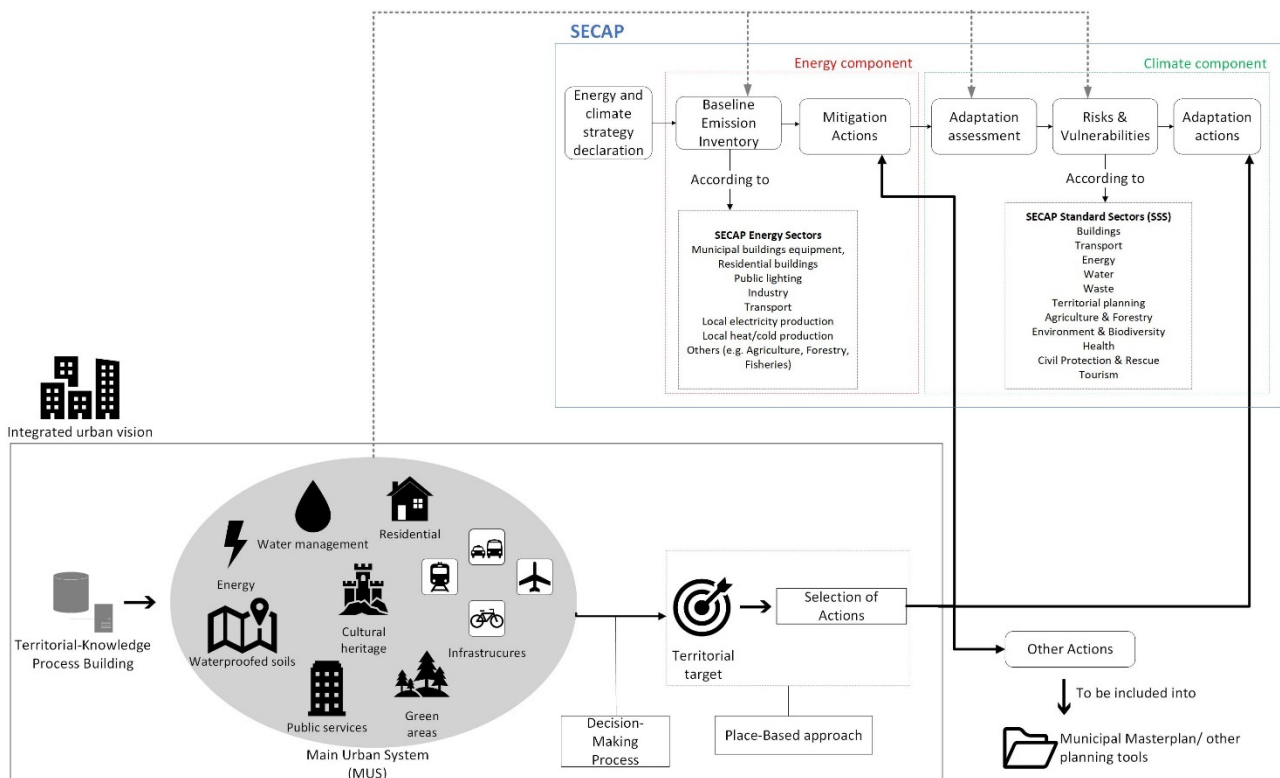


Figure 10 The methodological proposal

Our methodological proposal is based on four steps:

- 1) Knowledge of the city based on its natural and artificial components such as water, soil, air, waterproofed soils or infrastructures. This first step allows to evaluate suitable areas for interventions i.e. areas requiring energy restoration, places affected by extreme events (i.e. floods, landslides, droughts or heat islands), sites included in the local hazard maps developed by Public Environmental Agencies. The method has to be very flexible and not only tied to a limited set of critical issues (natural or not), because every city shows different requirements.

The results of this step, are Suitability Maps (SM) supporting the process of defining territorial objectives and actions (mitigation, adaptation or other).

- 2) Starting from the SM, it's possible to define the overall territorial objectives and typologies of actions which represent homogeneous groups of interventions related to the territorial objective.
- 3) On every SM the “territorial target” has to be identified, i.e. real elements of the city on which the planned actions are implemented. Concerning territorial targets, a set of objectively verifiable indicators is needed in order to measure, over time, the results obtained.
- 4) Defining the adaptation actions for territorial targets. Each action specifies intervention typology, territorial target and accountability variables of the design (budget, timeframe, stakeholders, etc.). These actions should be defined at a neighborhood level (detailed scale). The actions identified by the methodological proposal, will be included and detailed in the SECAP sections: “Mitigation Actions” and "Adaptation Actions".

It's remarkable to point out an additional link connecting actions – territorial targets – SECAP standard Sectors (SSS): a specific action belonging to a SSS, produces effects on multiple urban components (multiple SSS) and this should be assessed through the systemic approach declared in the beginning. The following figure shows basic connections between SSS and Main Urban Systems (MUS) (see fig. 10). These are the bases to verify if and how a specific action produces effects on several SSS and thus contributes to a MUS.

This scheme was developed for a specific case study: Potenza Municipality, described in previous works [155,156,165].

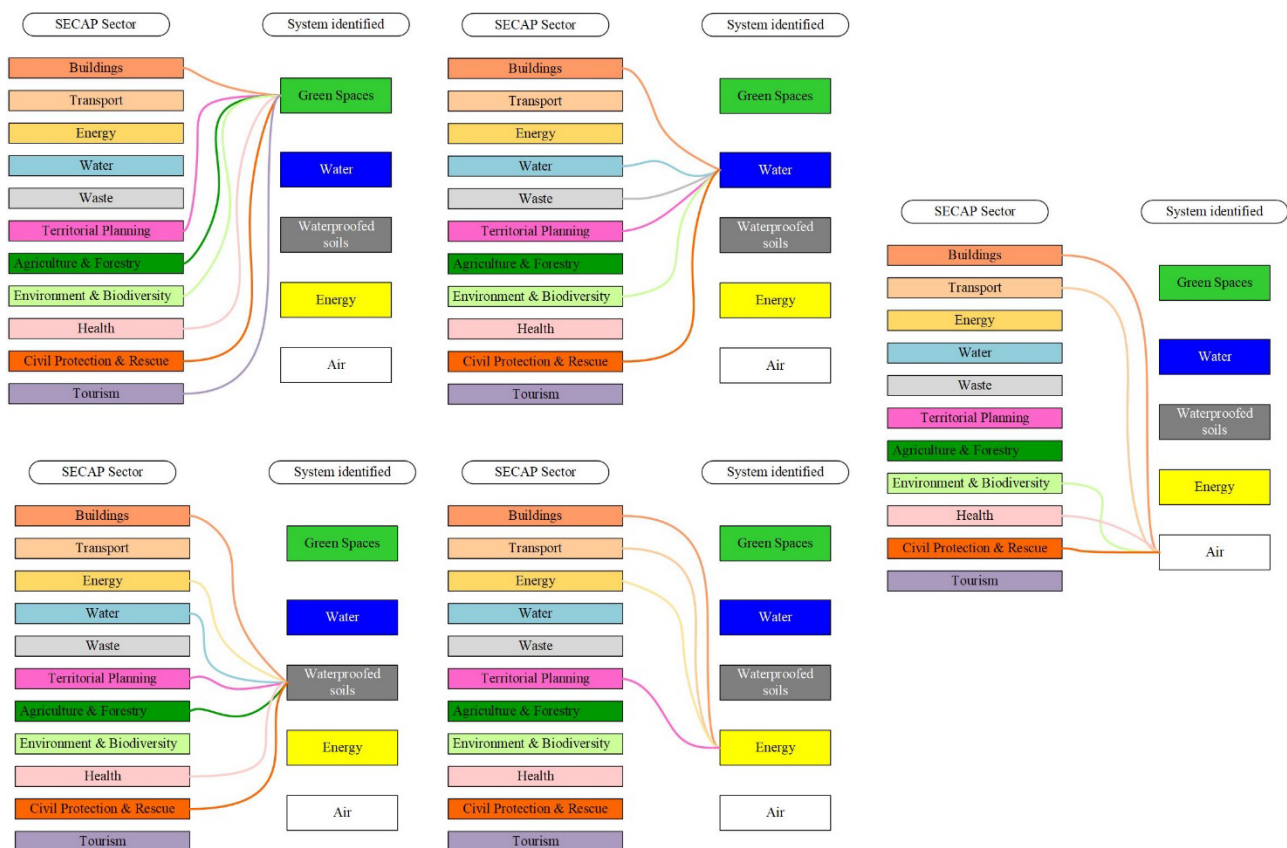


Figure 11 Relations between SEAP sectors and systems identified

Steps 1 and 2 of the proposal, similarly to the SECAP methodology, consist in a knowledge process of the city and the hazards (natural or not). These steps represent the core of the whole proposal,

because they help the decision-making process to establish objectives and intervention priorities on those areas with the highest vulnerability.

Knowledge of the city through the MUS, allows to achieve a comprehensive vision of the city, where the relations among different systems are clear and easier to understand. This vision by systems allows to overcome the sectorial SECAP approach, according to a relational scheme with a comprehensive view of the all components that constitute the urban context.

Step 3 adds an innovative element to the SECAP methodology: the “territorial targets”. In the SECAP approach the lack of “territorial targets” generally produced a set of actions that were not coherent with territorial features and therefore not implementable nor effective. We call “territorial targets” those real elements or parts of the city that are recognizable into the MUS, on which it is possible to fit the actions. The usefulness of the “territorial targets” is explicit in the relation between the territorial dimension [166,167] and the SECAP interventions.

Step 4 highlights how this proposal does not want to dismantle nor replace the SECAP sectorial approach, instead, it is oriented to reinforcing the SECAP approach with the urban planning discipline principles (systemic approach).

Moreover, the introduction of the “territorial target” will improve the development of the SECAP actions in order to achieve an integrated urban vision.

Conclusions

The SECAP has the potential to improve the resilience of the EU Municipalities to climate-change, developing adaptation/mitigation actions and increasing the “environmental awareness” of the actors (citizens, local administrators, stakeholders etc.).

Data deriving from the first season of CoM implementation (2008-2015) is encouraging thanks to the continuous increase of CoM Signatories (only in the last five years the average annual number of new CoM Signatories has reached 487), furthermore these Signatories are principally (67,38% of the whole CoM Signatories at April 2021) the so called “small” Municipalities (i.e., under 10000 inhabitants), that look at SECAP as a supporting tool in the struggle against climate change.

The methodological proposal discussed in this work steers the SECAP approach towards the systemic view of urban planning. On this track, the key elements are the “territorial targets”. Their elicitation allows to “spatialize” the actions we classified as adaptation, mitigation or other (see fig. 2).

Among the typologies of actions, those defined as nature-based solutions [168–170] represent a valuable benchmark towards building an effective adaptation/mitigation strategy facing the climate-change challenges for the future sustainable cities, included in the low-carbon transition process.

Thus, the methodological proposal introduces a new urban planning paradigm: energy efficiency and climate challenges require a new generation of planning tools, and SECAP is such a candidate for the production of groundbreaking changes on the complex system of EU Municipalities integrating specific urban issues and the wider territorial sustainable objectives. A relevant component, to be included in a further development of this research, is the involvement of citizens [116] and the engagement of stakeholders in the SECAP design process. This is a grey area and it requires effective participation methods [117–120] (such as public consultation, working groups, forums, workshops) in order to produce improvements in the plan without affecting the effectiveness of the process. Currently, a promising perspective of this study comes from the application of the methodological framework in a series of case studies. In particular, we are engaged to demonstrate the performance

of applying such an approach in a small Municipality adapting the SECAP design process to the specific needs of such a context where the development strategies, in all relevant planning sectors, are strongly affected by the weaknesses of the socio-economical structure and have to consider peculiar environmental protection principles, sometimes conflicting with the effectiveness of the plan.

3. The Italian experience of the Covenant of Mayors: a territorial evaluation⁴

Abstract: *European Climate Policy since the 90's, has developed incrementally and supported programs, plans and actions for sustainable, clean and secure energy. Additionally, climate-change adaptation issues have been tackled through Mayors Adapt since 2016. The Covenant of Mayors (CoM), a volunteer movement of local administrators - established in 2008, fixed a 20% reduction of CO₂ emissions by 2020 a reduction of 20% of CO₂. The CoM has launched a new season about on energy planning in Europe based on Sustainable Energy Action Plans (SEAPs), defining actions for selected intervention sectors. The aim of the work is to evaluate the state of the art of the Italian CoM signatories, assessing the results achieved in terms of the municipalities involved (CoM signatories), the SEAPs developed and the Monitoring Reports submitted. Specifically, the analysis on the Monitoring Reports data represents a relevant step in order to propose some critical appraisals concerning the performance level of the CoM adoption at a national scale, in terms of commitment level, goals achieved and the actions completed or in progress. The paper also compares national figures with the regional detailed survey developed for the Basilicata Region. It represents the benchmark useful to interpretate the general results deriving from the CoM official data and a marker to point out suggestions to improve the GCoM adoption procedures.*

Keywords: SEAP; Covenant of Mayors; energy plans; voluntary based planning; European policies; climate-change; CO₂ emission reduction

Introduction

The Covenant of Mayors (CoM) was launched in 2008 in Europe fostering the ambition to gather local governments voluntarily and committed to achieving and exceeding the EU climate and energy targets[171]. On In October 2015, the new Covenant of Mayors for Climate & Energy has been launched. Its goals were defined with cities through a consultation process and are ambitious and broad-ranging: signatory cities are now committed to actively supporting the implementation of the EU 40% GHG-reduction target by 2030 and agree to adopt an integrated approach to climate change mitigation and adaptation and to ensure access to secure, sustainable and affordable energy for all. In the same year 2015, the EU signed the Paris Agreements[33]. This global strategy integrates energy and climate policies including the so-called 20/20/20 targets[7], namely the reduction of carbon dioxide (CO₂) emissions by 20%, the increase of the market share of renewable energy's market share to 20%, and a 20% increase in energy efficiency. In June 2016, the Covenant of Mayors entered a relevant new phase of its history joining with another city initiative, the Compact of Mayors.

The Compact of Mayors is an agreement by between city networks – and then by their members – to undertake a transparent and supportive approach to reduce city-level emissions, to reduce vulnerability and to enhance resilience to climate change[100–102], in a consistent and complimentary manner with respect to national level climate protection efforts. The Compact of Mayors builds on the ongoing efforts of the Mayors - i.e. an elected Senior elected representative of a city-level and/ or the City Council (if this is required for a commitment) - that represents a city administration and may agree to such a commitment that increasingly sets ambitious, voluntary city

⁴ Santopietro, L., & Scorza, F. (2021). The Italian experience of the covenant of mayors: A territorial evaluation. *Sustainability (Switzerland)*, 13(3), 1–23. <https://doi.org/10.3390/su13031289>

climate commitments (intended to align with relevant significant and internationally recognized approaches) or targets for greenhouse gas (GHG) emissions reduction and to address climate risk[172]; report on progress towards achieving those targets by meeting robust, rigorous and consistent reporting standards (as established through City Networks); and make that information publicly available by reporting through a recognized city platform, such as carbonn Cities Climate Registry, CDP Cities.

The resulting “Global Covenant of Mayors for Climate and Energy” (GCoM) is actually currently the largest movement of local governments committed to going beyond their own national climate and energy objectives. More than 10000 cities committed to the GCoM have a major collective potential – and if fully realized – these city and local government actions could account for 2.3 billion tons of CO₂eq of annual emissions reduction in 2030, matching yearly passenger road emissions from the U.S., China, France, Mexico, Russia, and Argentina combined.

With an annual emissions reduction expected to reach 4.2 billion tons of CO₂eq in 2050, GCoM cities are showcasing the massive urban opportunity that national governments can harness to accelerate action and progress towards the Paris Agreement goals – simultaneously safeguarding the health and prosperity of their citizens.

Fully in line with the UN Sustainable Development Goals such as affordable and clean energy, climate action and sustainable cities/communities [173,174], the GCoM will tackle three key issues:

- climate change mitigation,
- adaptation to the adverse effects of climate change,
- universal access to secure, clean and affordable energy.

In October 2020 the Covenant of Mayors for Europe counts counted 10355 signatories, each signatory adopted a Sustainable Energy Action Plan (SEAP) and all of them are able to develop a Sustainable Energy and Climate Action Plan (SECAP) with new ambitious goals: the EU 40% greenhouse gas-reduction target by 2030 and the adoption of a joint approach to tackling mitigation and adaptation to climate change[127,132].

Such widespread commitment of local authorities in pursuing performance objectives under a “green responsibility” in urban and territorial management represents a relevant result under a double perspective:

- the extensive pervasiveness of climate and sustainable goals in local communities as a result of global movements[30];
- the success of voluntary based planning processes in order to tackle current issues in urban and territorial planning compared with traditional planning practices and tools that are considered to be mainly inadequate to close up and adapt to new intervention domains and practices (see also [128]).

Apart from the extensive success of the CoM initiative, it is relevant to underline the un-effective components that arise if the focus goes moves towards the second stages of implementation: the monitoring reporting phase.

The year 2020 is the first term of the CoM, considering regards the CO₂ commitments assumed taken on by the signatories, and it’s a reference point to do a checklist about check on the number of CoM signatories and SEAPs developed, choosing Italy as study area.

Before starting to achieve an assessment of the CoM implementation, we considered some authors [128,129,175] who reported the status and the progresses about of the response of European Countries and cities to in developing action plans facing climate change issues. In this domain, Reckien et al. [128], have been suggested a classification of local climate plans, finding and found three types of stand-alone local climate plans:

- type A1, autonomously produced plans,
- type A2, plans produced to comply with national regulations,
- type A3 plans developed for international climate networks.

This classification is based on the analyses of the local climate plans in 885 cities across the 28 EU-28 countries screened through an Urban Audit, and doesn't allow to report a comprehensive assessment of the signatories to CoM signatories or anyway cities with a local climate plan for every EU country. Despite Regardless, that, this work represents an assessment of the linkages between European climate planning development and the major reference framework policies such as: EU CoM, C40 Cities Climate Leadership Group (C40), the Local Governments for Sustainability (ICLEI), and the United Cities and Local Governments (UCLG).

Among the different approaches, the case of Denmark represents an example of national legislation (LBK no. 523 [176] and LOV no. 716 [177]) driving the municipalities to include climate change adaptation into Municipal spatial plans, a requirement integrated into the Danish planning law since February 2018. Moreover, Denmark is among the few European countries with a Ministry of Climate [178] which was created in the wake of the UNFCCC Conference in Copenhagen in 2009[179].

Differently, the analysis produced by Aguilar et al.[175] refers to the identification of Local Adaptation Strategies (LAS), considering which include all adaptation strategies and plans at the municipal level. Municipalities are intended as political units with local governments, such as cities, towns and villages, which also encompass small settlements and their rural areas, including metropolitan areas and small counties.

They recognize 147 LAS that cover the 28 European Union countries and the three European Free Trade Association (EFTA) countries: Iceland, Liechtenstein, and Norway. In this whole entirety of practices classified as LAS, it is not possible to recognize aggregated or national features, the useful outcome of the research is mainly identified in the following features:

- i. the most of LAS have been developed at a local level (municipalities, interest groups and private organizations) under the support of governmental stakeholders (i.e. State Administrations, Regional Authorities etc.). The main barrier for the implementation to of adaptation plans, is lack of financial and human resources, highlighting the dependence on external financial support for a local adaptation,
- ii. In specific geographical areas, it is possible to recognize some pushing factors that started the process of LAS development such as:

Coastal areas and disaster risk reduction for Northern regions, related to vulnerabilities and hazard risks of territories. In this group, as example can be considered the municipalities of Malmö or Copenhagen can be considered as examples. Malmö introduced the concept of sustainable urban drainage already in the late 1980's. This was mainly a result of Malmo Water's active interest in finding new technical solutions for detaining peak flows in the urban runoff from new settlements. In the late 1990's the city of Malmö drew up a policy document describing the general principles for managing storm water in a new sustainable way manner [1]. Copenhagen, after the intense storm on

the 2nd of July 2011, has developed its Climate Adaptation Plan suggesting two measures in order to mitigate flooding in case of extreme events: a long-term plan changing the current combined sewer network to a separate network, and using public surfaces with low sensitivity (e.g. parks, sport fields and open spaces) for the temporary storage of storm water.

Business and services for Eastern Europe, related to prioritizing the importance of managing commercial risks, in addition to climate vulnerability and hazard risks. In this group, examples are Bratislava or Budapest. Bratislava in its plan has chosen to protect the most vulnerable groups of the urban population (the elderly people, the homeless people, children in age up to the age of 6 years, lonely living pensioners living alone, etc.); minimizing the carbon footprint of the city— housing/building, transport, and waste treatment, and implement green and soft adaptation measures to maximize the use of rainwater and green infrastructure. Budapest has developed an integrated urban development strategy, implementing, for 2030, a long-term urban development concept. In this framework, a primary goal set fixed is to increase the efficiency of use, to increase the proportion of renewables and to reduce greenhouse gas emission. In addition, it is important to decrease energy loss that occurs during the usage and transfer of resources, as well as to reduce energy demand.

Adaptation for Tourism, Energy and Agriculture for Southern Europe, related to prioritizing the import tourism sector through the improvement of energy efficiency and reduction of GHG emissions. In this group, examples are Barcelona or Padua. Barcelona's PECQ (Energy, Climate Change and Air Quality Plan of Barcelona) is a plan hosted promoted by Barcelona's City Council aimed at providing the Public Administration with strategic tools in order to improve citizens' health, as well as to improve the Planet health by increasing energy efficiency and reducing greenhouse gas emissions together with other local effect pollutants. Padua has articulated its methodology for the Adaptation Plan in six fundamental phases through which, the Municipality has identified, in order to adapt the urban areas to the effects of climate change, vulnerable areas with the aim of studying the type of shock, and then increasing the capacity to react to shocks generated by ongoing climate change.

As reference for this study, we selected the approach conveyed by Coelho [129] and applied in the case of the Portuguese experience of COM implementation. This research assessed the local community reaction to SEAPs in Portugal by investigating 124 Portuguese municipalities in terms of emission reduction measures included in the SEAP and Baseline Emission Inventory. A relevant indicator is the percentage of resident population covered by SEAP: major cities contribute more to this appraisal while 65% of the total municipalities cannot be considered under any energy planning regulation.

The aim of this work, is to point out the critical assessment of the Italian experience in the implementation of the Covenant of Mayors referred to the first deadline fixed set to 2020 targets [7]. In the Italian case, different approaches in the CoM implementation come from main territorial sub-areas: North, Centre and South of Italy. This study formulates hypotheses concerning the causes of such differences and describes comprehensive figures deriving from the classification of the CoM intervention priorities. A regional focus is also presented in order to demonstrate some lack of data in the official CoM Database (DB) and to discuss the thesis theory concerning the local municipality approach towards sustainable energy planning as an alternative to institutional urban planning.[8].

Our analysis took into consideration the SEAP Monitoring Reports. Through the elaboration of such information the “state of the art” of CoM implementation is structured (section 1)

In section 2, a spatial assessment of the Italian signatories and the corresponding SEAPs developed, is presented according to the Nomenclature of Territorial Units for Statistics (NUTS) 1. The investigation of the intervention sectors occurrences represents a second elaboration considered to be useful to deliver a deeper understanding about of the differences in approaches promoted through the development of the SEAPs development in different areas.

The Section 3 is structured in three parts:

- the first, gives an assessment of the Italian CoM signatories compared with to the resident population per NUTS-1 areas and an evaluation of the CoM sectors occurrences among the submitted SEAP,
- the second part looks at the Monitoring Reports (MRs) as a critical stage of COM implementation. In the perspective of the authors, they are a fundamental step in order to produce information on the overall CoM impact at different scales. The MRSs are related to a quantitative evaluation of the implemented actions and account of for the differences between intervention sectors included “a-priori” in the SEAP and the effective sectors implemented at the end of the monitoring period (in other words, the adaptation capacity of the SEAP to the local context feasibility of investments)
- the third part provides a detailed check for the Basilicata Region in order to obtain local detailed information about of the status of the monitoring phase in the implementation of the SEAPs implementation. Such analysis is oriented towards revealing some missing information in the CoM open-database and the hypothesis concerning the criticalities in the local procedures of the SEAPs management.

Section 4 and 5 discuss the main results and outcomes and, on the basis of the regional focus, we discuss the critical tendency, on behalf of the by Italian municipalities, to prefer voluntary planning procedures (“EU CoM- like”) to the traditional urban planning practices according to regional and national laws. This interesting outcome allowed to discuss a critical position concerning the effectiveness of voluntary planning instruments vs institutional planning tools.

The Conclusions explains the main results about deriving from the data investigated from the CoM DB, regarded the relevant CoM Signatories, the resident population under the SEAP municipalities, the MRS submitted and the occurrences of sectors among the Italian Signatories. Additionally, it takes into account the forthcoming season of GCoM characterized by the challenge of Climate-Change with the development of mitigation/adaptation strategies at an urban scale and the ambitious 40% reduction of 40% of CO₂ emissions by 2030.

Materials and Methods

The data collected derives from the official website of the Covenant of Mayors for Climate & Energy Europe [180]. In the website are available all the Action Plans submitted by the Covenant signatories, either already accepted or currently under assessment by the European Commission's Joint Research Centre, and the list of Monitoring Reports submitted by signatories, are available. To evaluate the progress made towards their objectives, a Covenant of Mayors signatory is requested to submit a MRs every two years after the adoption of its Action Plan related to the intended mitigation and adaptation

actions planned, and at least every four years the emission inventory if the action plan is updated, so as in order to verify the progress related to resilience to climate change, reduction of emissions and energy consumption. Information about on Italian signatories and concerning the availability of the MRs has been spatialized into a GIS environment. Such Data deriving from the CoM website were collected in a csv table and merged with the resident population data as at 1st January 2020 from ISTAT [181] in order to be able to perform basics statistics identifying per-capita impacts.

The data are collected for all Italian regions, classifying how many municipalities per region have submitted a SEAP or not a SEAP.

From the CoM website, selecting Italy as country, have been selected signatories according to the CoM classification have been selected, and which will be spatialized in the GIS environment. This approach to locate every signatory and not only reporting only the picture from the CoM website characterized differentiated this work from others [127,128]. They have been divided per commitment in three classes (see table 2):

- **2020:** towns, cities and regions voluntarily commit to reducing their CO₂ emissions beyond 20%, below 1990 levels by 2020 describing mitigation actions in a SEAP template. The SEAP includes energy related actions tackling the largest emitting activity sectors in the city towards an increase of energy efficiency and the use of renewable energy sources (RES). They represent the highest number (2747) in term of signatories per commitment with 85% on of the total signatories;
- **2030 & ADAPTATION:** the initial greenhouse gas emission reduction commitment and integrating adaptation to Climate Change were strengthened around three pillars: mitigation (at least 40% emission reduction target by 2030), adaptation to Climate Change and a secure, sustainable and affordable energy. Label ADAPTATION is related to the initiative Mayors Adapt initiative that supports local authorities to develop and implement local adaptation strategies. This class, also if it contains the lowest number in terms of signatories (82) with only 3%, represents the youngest signatories in terms of number signed up per year (from 2016 to today);
- **2020,2030 & ADAPTATION:** this class includes the signatories that signed up to CoM and strengthened their commitments decreasing CO₂ emissions from 20% by 2020 to 40% by 2030 with the development and implementation of local adaptation strategies. This class, with 470 signatories (15% of the total signatories), is meaningful because it represents those signatories who intending to improve their commitments submitted.

Table 2 Country: Italy	
Commitment	Signatories
2020	2747
2030 & ADAPTATION	82
2020, 2030 & ADAPTATION	470
TOTAL	3217

Table 2 Italian Signatories per Commitment

Figure 13 has reported a flowchart of the research process, highlighting input data sources, the procedural approach and the analytical phases towards conclusions.

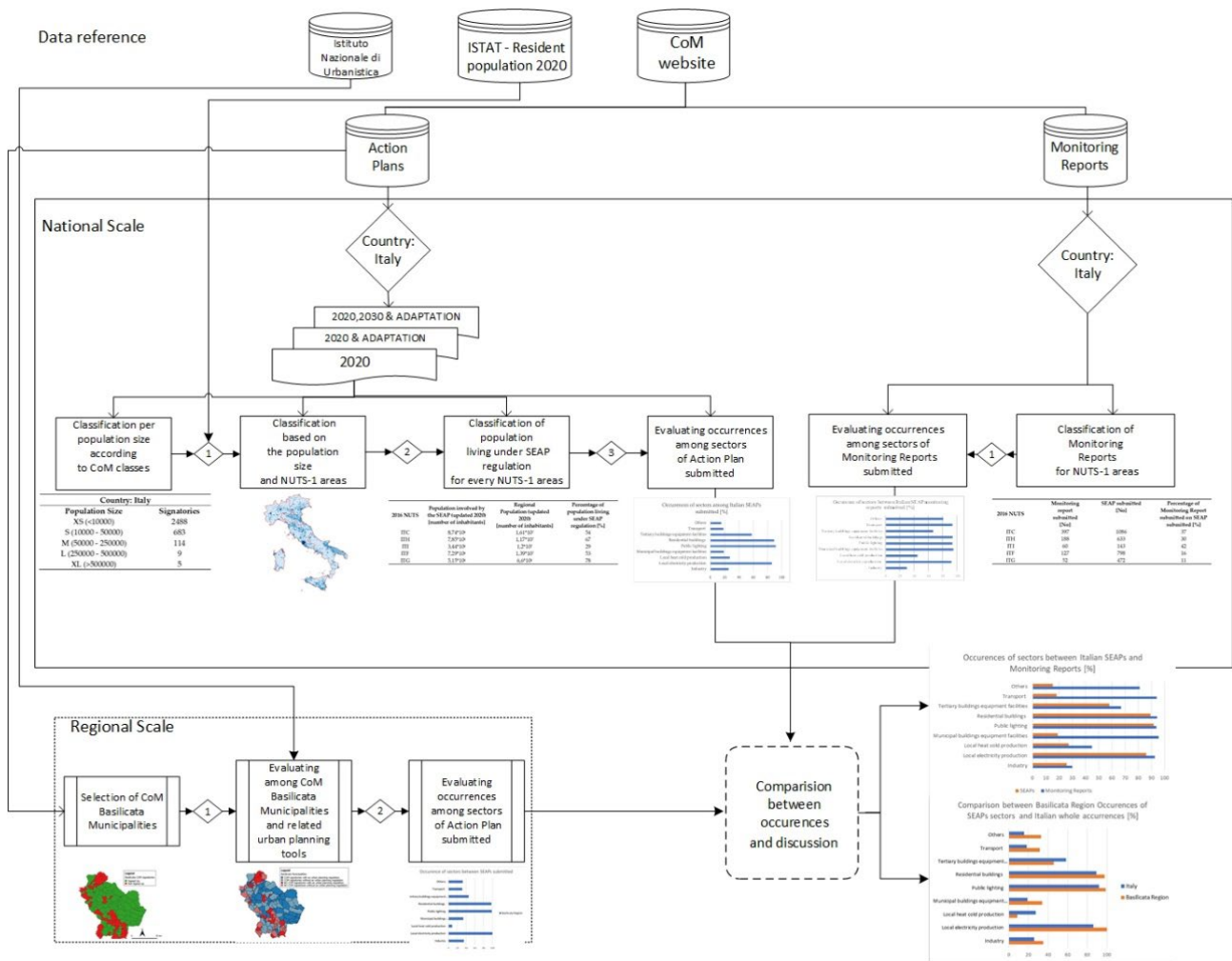


Figure 12 Methodology flow chart for the research process

After this overall assessment in terms of signatories, always from the CoM website it is possible to investigate how many signatories have developed a MR, collecting information about on sectors included and computing basic statistics such as the most recurrent sectors.

It is interesting, following the trend of the CoM signatories in terms of membership and comparing it with key dates mentioned above, to know if there is the intention to increase the number of the CoM signatories supported by these initiatives or not.

Evaluation of territorial membership to CoM compared to the resident population allows us to understand the impacts of European policies on the resident population, referring to population size suggested by the CoM and the geographical distribution of the CoM municipalities.

Starting from the official CoM DB, it is possible to estimate the occurrence of the main areas of intervention allowed in SEAP for the entire national database. Some statistics are proposed to understand how the municipalities have organized the interventions on the territory and select the most recurrent areas of action between the sectors in the SEAPs.

In order to compare the institutional planning provided by the law as opposed to European plans about on climate or energy such as SEAP, data concerning institutional urban planning derived from the report of the Italian Urban Planning Institute (Istituto Nazionale di Urbanistica (INU)) [182], are merged to information about the CoM signatories, considering as case study the Basilicata Region.

Results

The results are divided into three sections, investigating the Italian CoM experience with related Monitoring Reports (MRS) and a final focus on the Basilicata Region selected as the study case. The first section explores the Italian CoM experience (2008-2020) evaluating: the number of Italian signatories and SEAPs submitted, the size of signatories in term of resident population as at 2020, the resident population at 2020 under SEAP regulation as at 2020 and the occurrences of the sectors in the Italian SEAPs. The second section, is related to the MRS considered as a fundamental step evaluating the SEAPs. Data about on the MRS available on the CoM website, in terms of sectors occurrences, has been reported and compared to the Italian SEAPs submitted. The third section is a zoom on the Italian experience through the case study of the Basilicata Region, where CoM signatories are 64% of the total Basilicata municipalities.

The Italian CoM experience (2008-2020)

In order to analyse the status of the CoM experience in Italy (on a national scale) we compared the trends of the signatories to CoM signatories and to the SEAPs submitted for the period 2008-2020, labelling the relevant Policy Making Milestones (PMM):

- **2008 Launch of the Covenant of Mayors (CoM)**, that is the mainstream European voluntary movement involving local authorities in the development and implementation of sustainable energy and climate policies. Since its launch in 2008, the initiative has progressively grown into a worldwide city movement, extending first to Europe's eastern and southern neighbouring countries and then to Sub-Saharan Africa
- **2013 Launch of Mayors Adapt**, based on the same principles as the CoM, this initiative focused on adaptation to climate change, inviting local governments to demonstrate leadership in adaptation, and supporting them in the development and implementation of local adaptation strategies.
- **2015 Launch of the Covenant of Mayors for Climate & Energy**, signatory cities actively support actively the implementation of the EU 40% GHG-reduction target by 2030 and agree to adopt an integrated approach to climate change mitigation and adaptation, and to ensure access to secure, sustainable and affordable energy for all. In the same year, 196 state parties adopted **The Paris Agreement** [33], an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) with the aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.
- **2016 Launch of the Global Covenant of Mayors for Climate and Energy (GCoM)**, that merges the Covenant of Mayors for Climate and Energy and Compact of Mayors, into an international alliance of local governments with a shared long-term vision of supporting

voluntary action to combat climate change and move to a low-emission and resilient society. In the same year, was launched in May 2016, with the **Pact of Amsterdam** was launched: The Urban Agenda for the EU [74]. It represents a new multi-level working method promoting cooperation between Member States, cities, the European Commission and other stakeholders in order to stimulate growth, liveability and innovation in the European cities of Europe and to identify and successfully tackle social challenges.

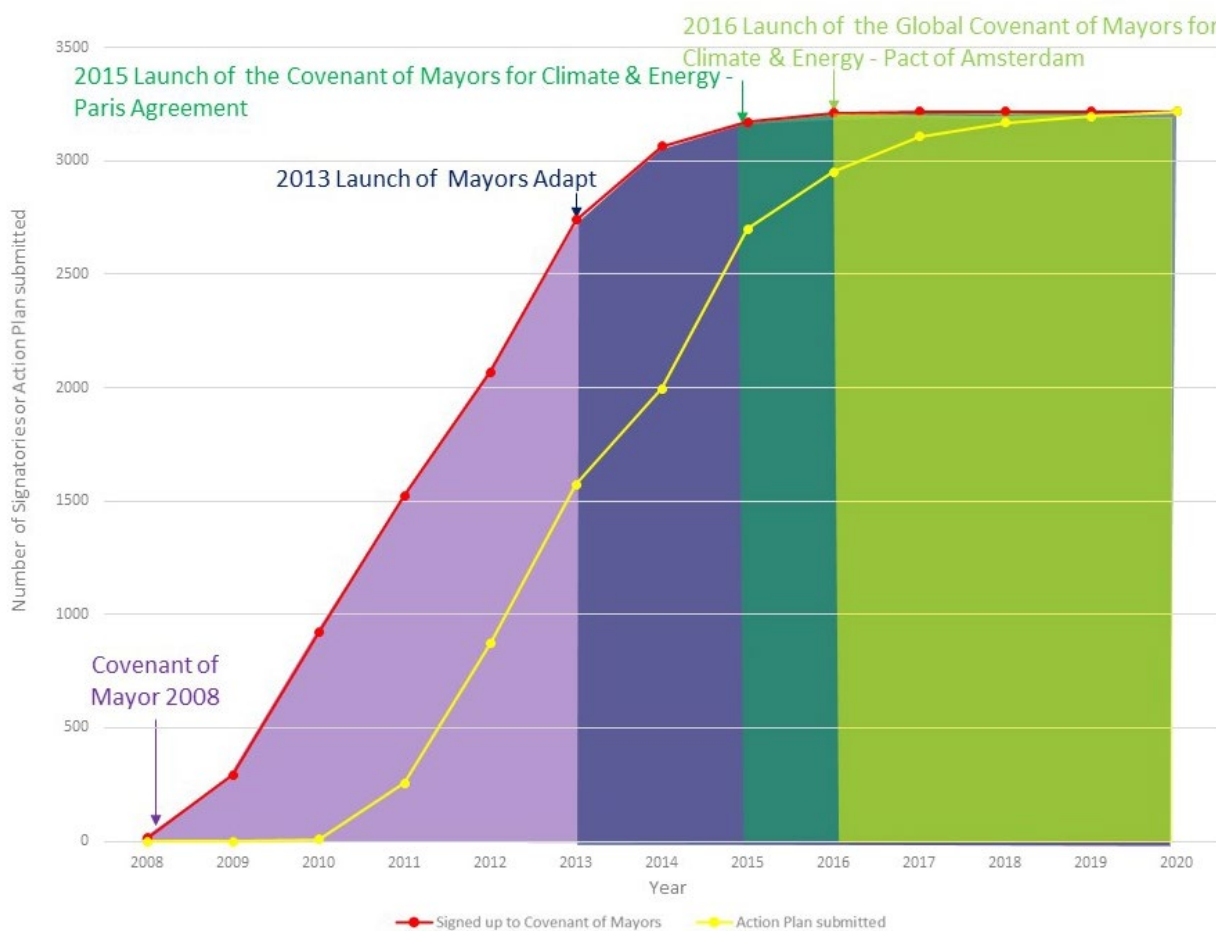


Figure 13 CoM Signatories compared to Action Plans submitted for the period 2008-2020

From a temporal point of view, it is possible to affirm that those PMMs didn't affected the evolution of CoM implementation. As a matter of fact, it is possible to recognize a logistic curve starting from the CoM Launch in 2008 which reaches the plateau around 2016 in terms of Signatories and in 2019 in terms of the Submitted Action Plan. If the GCoM took on the objective to extend the numbers of participant municipalities taking part, some specific actions are needed in order to increase the trend overcoming the logistic plateau.

According to the CoM general indicators, the signatories are classified, per resident population, in five classes from XS to XL. (see table 3). This classification doesn't take into account the fact that the population size of the signatories in Italy could be at the same time referred either to a single municipality or to a group of municipalities. It is the case of unions/associations of those small municipalities with a population under 5000 inhabitants, called "*piccoli comuni*" by the National Association of Italian municipalities. This represents a discrepancy between the number of signatories on the CoM website and the real actual number of municipalities that are committed in to the SEAP

implementation: we have a larger number of municipalities committed in the CoM implementation than the number of the submitted SEAPs. In the Italian case we have 3299 CoM signatories (see fig.13), which include 104 unions/associations of municipalities. The municipalities included in those 104 unions/associations is comprise 706 small municipalities (representing 21% of the total CoM signatories) therefore the total number of Italian municipalities implementing a SEAP regulation is 3901 (about 49% of the Italian municipalities).

Country: Italy	
Population Size	Signatories
XS (<10000)	2488
S (10000 - 50000)	683
M (50000 - 250000)	114
L (250000 - 500000)	9
XL (>500000)	5

Table 3 Italian Signatories per Population Classes (source: CoM db)

In table 4 the percentage of the CoM municipalities per NUTS1 are reported. NUTS1 classification subdivides Italy in 5 areas as following:

- ITC - NORTH-WEST
- ITH - NORTH-EAST
- ITI - CENTRE (IT)
- ITF - SOUTH
- ITG – ISLANDS

It is important to point out that the higher percentage ITG sub area, with the highest percentage, that includes Sicily and Sardinia Regions, while whereas the central part pf the country has the lowest contribution in terms of Signatories.

Country: Italy				
2016 NUTS	Signatories with SEAP submitted [no.]	No CoM municipalities [no.]	Total municipalities per NUTS [no.]	Percentage of SEAP submitted on in total [%]
ITC	1086	1909	2995	36
ITH	633	755	1388	46
ITI	143	828	971	15
ITF	798	985	1783	45
ITG	472	295	767	62

Table 4 SEAPs submitted or not, and related total percentage on total for Italy NUTS1

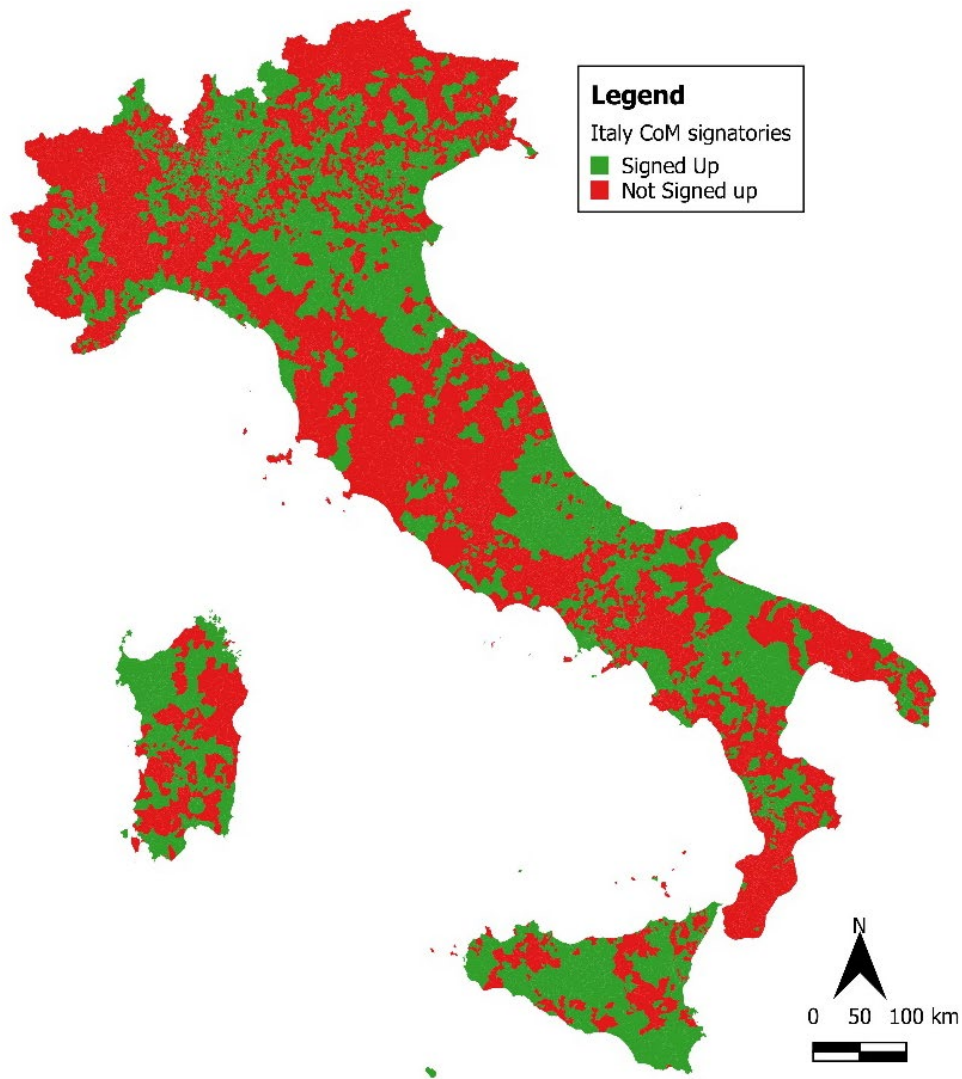


Figure 14 Italian CoM signatories 2020

Furthermore, it is interesting to consider the updated resident population data (2020) in order to assess the share of inhabitants living in a SEAP Municipality and therefore the beneficiaries of the actions included in the action plans (see fig.14). It is possible to affirm that for the ITF and ITG areas, generally identified as the South of Italy, the coverage of the population by SEAPs is characterized by a high percentage (ITF: 53 %; ITG: 78%) on of the total of regional population. The high population percentage Northern Italy high percentages of population involved by in the SEAPs are is reached thanks to the contribution of those municipalities with a M or L population size (for population size see tab.5), mostly concentrated in the Eastern Italy. The following table represents the spatial distribution of those variables.

2016 NUTS	Population involved by in the SEAP (updated 2020) [number of inhabitants]	Regional Population (updated 2020) [number of inhabitants]	Percentage of population living under SEAP regulation [%]
ITC	$8,74 \cdot 10^6$	$1,61 \cdot 10^7$	54
ITH	$7,85 \cdot 10^6$	$1,17 \cdot 10^7$	67
ITI	$3,44 \cdot 10^6$	$1,2 \cdot 10^7$	29
ITF	$7,29 \cdot 10^6$	$1,39 \cdot 10^7$	53
ITG	$5,15 \cdot 10^6$	$6,6 \cdot 10^6$	78

Table 5 Population involved by in the SEAP for Italian NUTS1

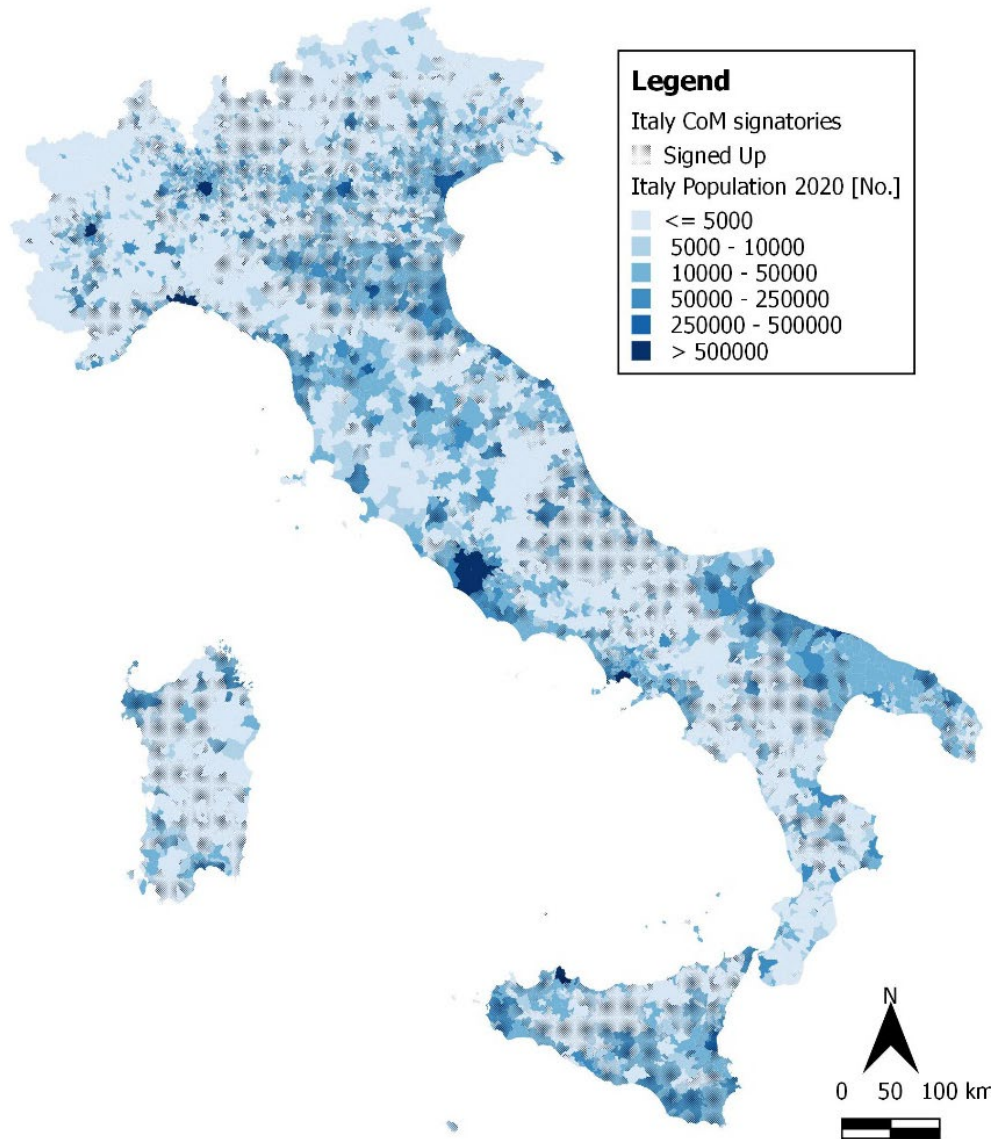


Figure 15 Resident Italian population (2020) living in CoM municipalities

The structure of the SEAPs is based on three main features:

1. Overall strategy
2. Baseline Emission Inventory (BEI)
3. Sustainable Energy Action Plan

In the second and third features are the “sectors” included in the SEAP structure: industry, local electricity production, local heat/cold production, municipal buildings, equipment/facilities, public lighting, residential buildings, tertiary buildings, equipment/facilities, transport, others. Therefore a “sector” represents an intervention area characterized by specific actors, emissions, actions. For these sectors every CoM signatory defines actions and investments. We investigated the occurrence of these sectors among the Italian SEAPs submitted, in order to recognize the occurrences and, consequently, obtain a comprehensive national picture of the sectoral specialization of the SEAPs (see figure 16).

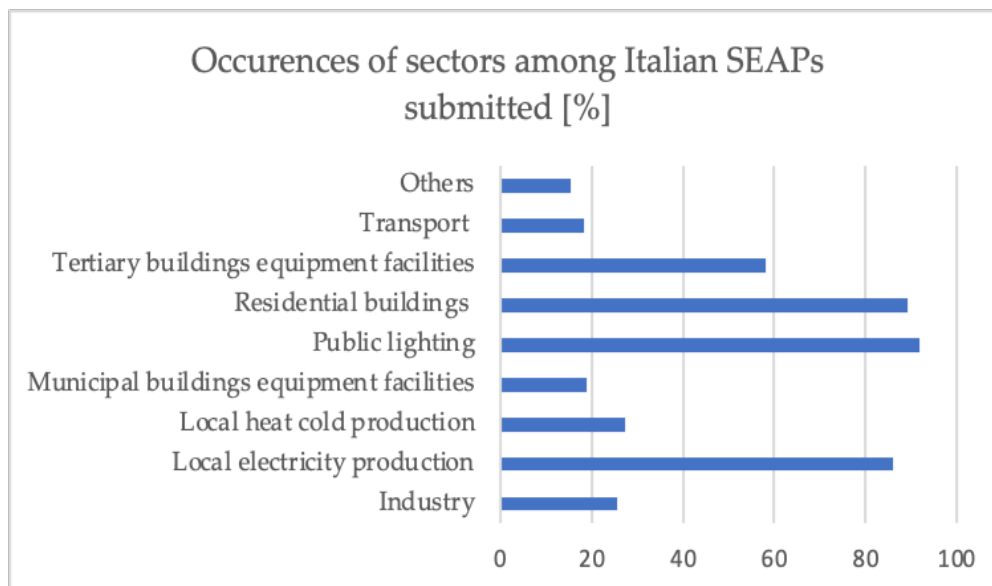


Figure 16 Occurrences of sectors among the Italian SEAPs submitted

Monitoring Reports: a fundamental step to evaluate the SEAP

Monitoring Reports (MRs), represent an important step to know what the quantitative progresses of the planned actions are, and a point of evaluation of the performance reached. They are a part of the CoM commitments, which allow to measure progress towards the targets set in the action plan. Reports can be of two types: a qualitative MR, at least every second year after submission of the action plan and a full quantitative implementation report, at least every fourth year after submission of the action plan, for evaluation purposes. Covenant Signatories have to compile a Monitoring Emission Inventory (MEI) every 4 years in order to compare the Baseline Emission Inventory (BEI) created with the SEAP, and the progress in terms of CO₂ emission reduction. Monitoring energy consumption and CO₂ emissions allows to understand whether the signatories are on track towards reaching the target or, if not, to identify factors that affect the results. In brief, MRs allow to evaluate:

- any changes to the overall strategy as well as updated figures on the attribution of staff and financial capacities;
- the amount of final energy consumption and associated CO₂ emission by energy carrier and by sector in the year under observation – the main objective is to monitor the evolution of CO₂ emissions over time;
- monitor the implementation status of the key actions.

In the section “Progress” of the CoM website, data on the signatories that uploaded a MR are presented. In tab.6 and tab.7 we reported the data of the available MRs for Italy. Comparing the number of submitted SEAPs and the number of submitted MRs, it is possible to highlight that the

percentage of monitored SEAPs doesn't exceed 32%: a very low share of the total number of Action Plans.

We calculated the occurrences of the SEAP sectors (industry, local electricity production, local heat/cold production, municipal buildings, equipment/facilities, public lighting, residential buildings, tertiary buildings, equipment/facilities, transport, others). The occurrence of the sectors in fig.17, indicates significant differences between the SEAPs and the MRs. This is pertinent information to understand that in the implementation phase many changes occurred on the overall strategy. This may reflect the flexibility of the SEAP as an urban development program in adapting the implementation on local issues that emerge in a specific implementation sector, on the other hand it could also be an indicator of the un-robustness of the ex-ante evaluation and planning phases based mainly on the BEI assessment and targets, but not considering the relation of such framework with the context feasibility of the envisaged actions. The SEAPs, during the implementation phase, undergo an adaptation procedure that effectively connects the implementations with specific requirements of the places: this brought to a change in the sector share of the investments. Additionally, changes in the implementation phase come about mainly in those sectors that are characterized by public management: the "transport" sector occurrence presents an increase between the planning and implementation phases of about + 70%; "Municipal buildings, equipment and facilities" + 70%. Different indications come from those sectors in which the private actions/investments are characterizing: "Local electricity production" increased between the planning and implementation phases by about + 8%; "industry" + 5%.

The figures reported below, allow also to observe that from the planning phase to the monitoring phase, the occurrence of the intervention sectors increased entirely. This means that Municipalities undergo a process of extending the scope of each plan by probably including on-going local actions and investment trends in energy saving. This is not fully coherent with a rational planning approach [130] but mainly with a strong governance oriented towards achieving declared targets.

SEAPs submitted [No.]	Monitoring Reports submitted by signatories [No]	Percentage of Monitoring Reports on SEAPs submitted [No]
3217	1035	32

Table 6 Monitoring Reports available on the CoM website versus the SEAPs submitted

2016 NUTS	Monitoring reports submitted [No]	SEAPs submitted [No]	Percentage of Monitoring Reports submitted on the SEAPs submitted [%]
ITC	397	1086	37
ITH	188	633	30
ITI	60	143	42
ITF	127	798	16
ITG	52	472	11

Table 7 Monitoring reports submitted compared to the SEAPs submitted for the NUTS regions

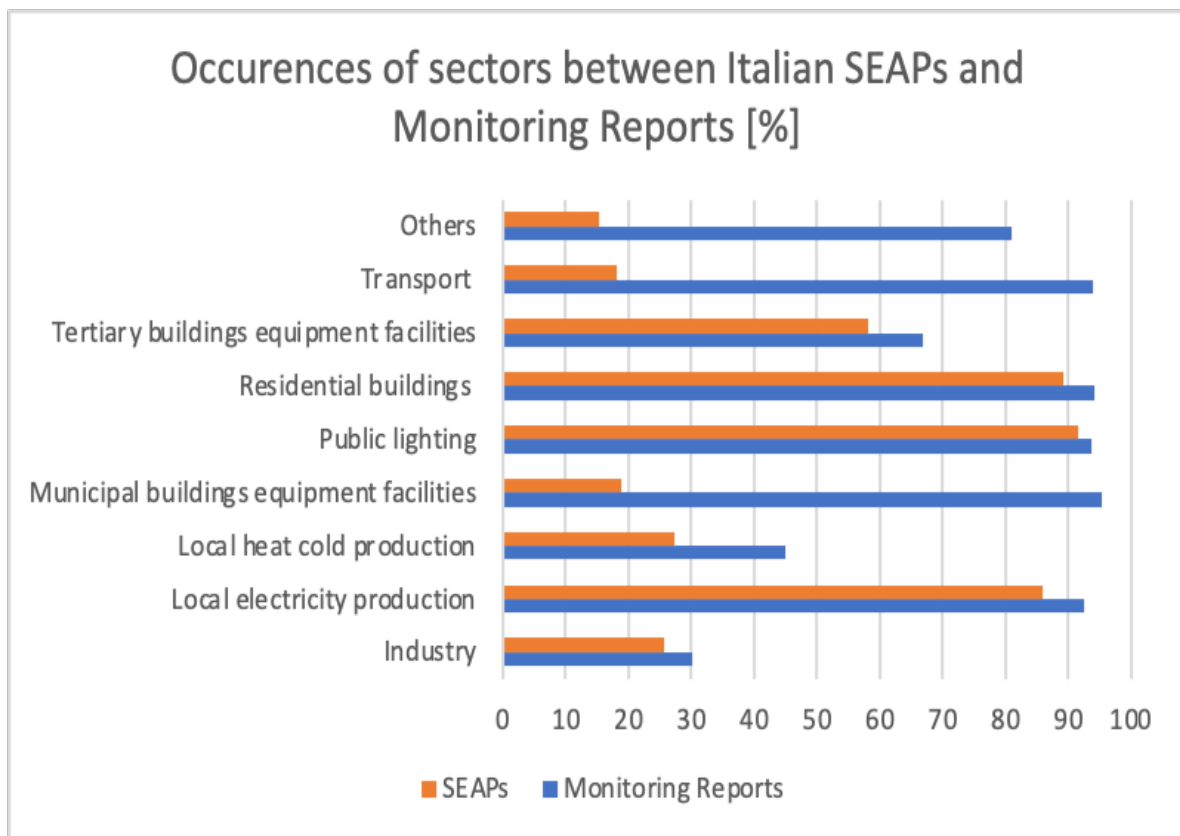


Figure 17 Comparison of the occurrence of the sectors between Italian Monitoring Reports and SEAPs

A zoom on the Italian SEAP experience: the case study of the Basilicata Region

If we consider the share of signatories on the total number of Municipalities, the experience of the CoM in the Basilicata Region has given satisfying results: of 133 municipalities, 83 have presented a SEAP (corresponding to 64% of the total Basilicata Municipalities) and this large adhesion was achieved thanks to a fruitful institutional collaboration that links the Municipalities to a public services company: the Lucana Energy Company (SEL) under the supervision of the Potenza Province (Covenant Coordinator). SEL is called upon to "support regional energy policies", implementing "actions aimed at improving the management of energy supply and demand, promoting energy saving and efficiency and promoting a better use of local, conventional and renewable energy resources, also operating in the electricity and gas markets". SEL, among its projects, promotes the initiative of CoM and has supported municipalities from a technical perspective for the entire process of the CoM sign-up, and a technical development of the SEAPs according to a regional Baseline Emission Inventory (BEI) (2009). In tab.8, the number and relative percentages of the Basilicata CoM signatories distinguished by the two Provinces, are reported: Potenza and Matera. The data that emerges, reports that the signatory Municipalities of the Province of Matera, reach only 24% of the Basilicata municipalities covered by the CoM. Data is also then spatialized in fig.7 in terms of CoM signatories or non-CoM signatories.

Today it is relevant to highlight the collaboration between UNIBAS-SI and SEL promoting research [165] and technical-scientific support for Public Authorities under the specific "Low Carbon Economy transition partnership" cooperation agreement [11–13].

Basilicata Province	CoM signatories [No]	Total Municipalities per Province [No]	Percentage of signatories of total Basilicata Municipalities [%]
Potenza	52	100	40
Matera	31	31	24

Table 8 Basilicata CoM signatories

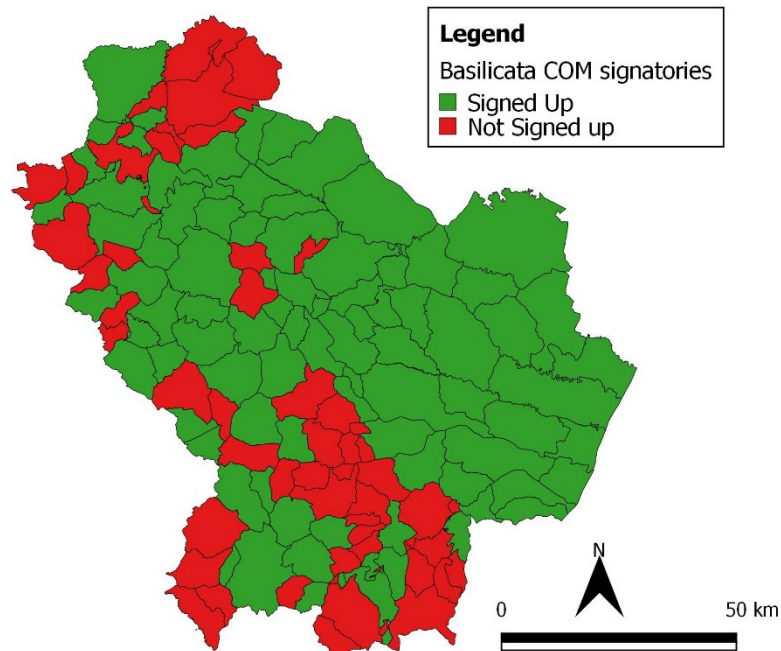


Figure 18 Basilicata CoM signatories

Concerning the urban planning framework in the Basilicata Region, in 1999 the Basilicata Regional Urban Planning Law was approved [183]. It is a structured framework of rules and tools for multi-level territorial planning: plans at different scales (Regional, Provincial and Municipal) and processes to manage the development of urban planning (in fig.19 a summary flowchart is proposed). Every Municipality has to develop its own Urban Plan and manage the evolution of the urban settlements, the implementation of infrastructures (such as streets, highway, railways), the implementation of environmental protection measures; the land-use according to resident population trends and strategic development perspectives. In 2020, only 57 of 131 Municipalities adopted an Urban Plan in line with the Regional Urban Planning Law (44% of the total Basilicata Municipalities) [182]. This is not representative of a high implementation level of the Regional Planning Law especially in consideration of the fact that since 1999 (the date of approval of the Regional Law) the Municipalities have had ample time to implement the complex process of urban planning according to the specific requirements defined by the legislator. Moreover, it represents a compulsory task for local Municipalities and, those who don't approve the Municipal Plan should be placed under receivership. We also have to say that such an option has never been adopted and this is another indicator of the fragility of the urban planning system at a regional level.

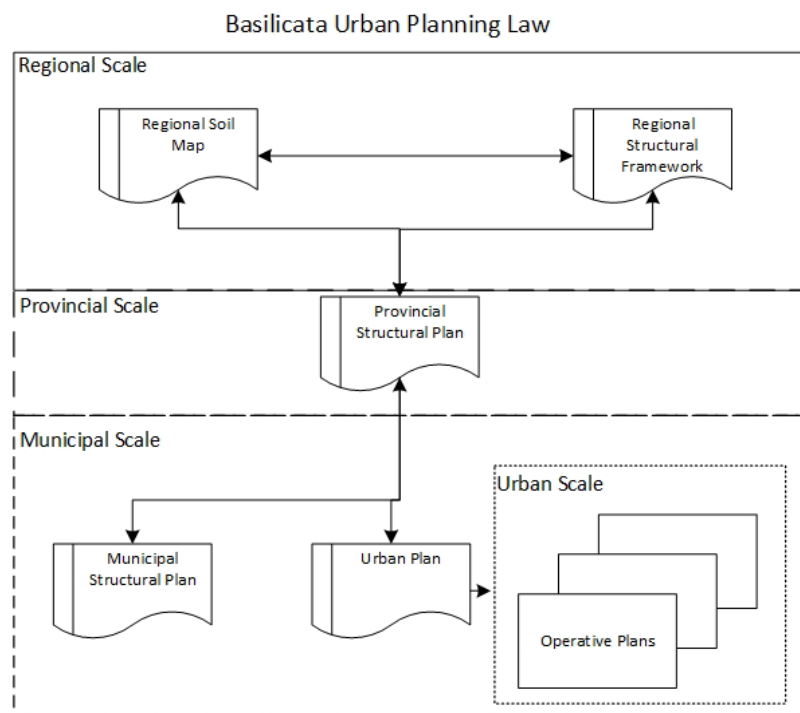


Figure 19 Flowchart of the Basilicata Urban Planning Law

Among the Municipalities that adopted the Urban Plan (57 over 131), 41 are also CoM signatories; this means 31% of the total Basilicata Municipalities. It's interesting to highlight that the CoM signatories without an urban planning regulation are 42 (almost the same in number as the previous group). Additionally, the Municipalities that are not CoM signatories and which have not approved an Urban Plan under the current regional planning law, represent a relevant percentage: 25% (32 Municipalities out of 131).

In tab.9 and fig.20 the numbers and related percentages of those categories are represented.

Basilicata Municipalities	Number of Municipalities	Percentage total Basilicata Municipalities [%]
COM signatories with an urban planning regulation	41	31
COM signatories without an urban planning regulation	42	32
NON- COM signatories with an urban planning regulation	16	12
NON- COM signatories without an urban planning regulation	32	25

Table 9 Basilicata Municipalities in relation to urban planning tools

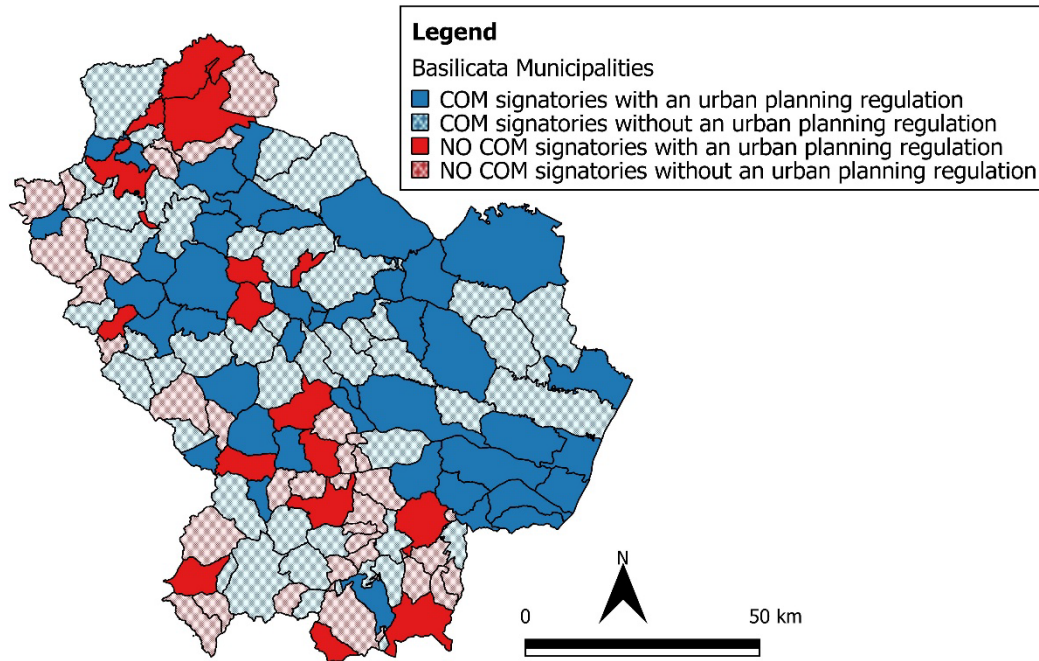


Figure 20 Municipalities signed up to the CoM with/without an urban planning regulation

It is possible to affirm that a relevant share of Local Administrations addressed the SEAPs operative issues that are related to the organization of urban development projects and the interventions in the sector of energy efficiency. In those Municipalities, the SEAP becomes an alternative to the more complex process of urban planning according to the current Regional Planning Law. The perception is that the SEAP substitutes the urban plan according to its capacity to impact and promote severe urban transformations connected to the mainstream of EU policies and funding.

From the disciplinary perspectives it is necessary to underline that such processes are realized without a systemic assessment of the urban structure and strategic vision including all the components of the “Urban Plan” that better allow to assess the impacts (positive or negative) of such implementation. Moreover, the place-based [167] or context-based [166] approach promoted by the EU in the New Cohesion Policy framework [184,185] becomes weak in its connection with a comprehensive territorial assessment that we refer to as the new planning rationality [102,130,186].

In investigating the sectors of the SEAPs of the Basilicata Municipalities, and comparing their occurrences with the corresponding occurrences at a national scale (see fig.21), some differences arise:

- sectors such as “local electricity production”, “residential buildings” or “public lighting” have an occurrence close to 100% while sectors such as “transport”, “industry” or “others” have an occurrence 50% greater than the Italian trend, this underlines a strong interest to plan investments and search funding, supported by European policies from public and private stakeholders
- the “transport” sector has an occurrence close to 50% more than the Italian trend, but the interventions provided don’t take into account the development or implementation of sustainable transport policies, but instead, the replacement of the old vehicle fleet with low-emission vehicles or economic support to buy electric vehicles;

- sectors such as the “local heat/cold production” or “tertiary buildings, equipment/facilities” have an occurrence that is lower than the Italian trend, it highlights that investments in these sectors are realized not by choosing the SEAPs but via other institutional ways (i.e. Ministry of Economy, ERDF funds or other European Funds)
- considering the overall sectors and the typologies of the interventions provided for the Basilicata Municipalities, it is noted that there is strong support of the European policies by the Municipalities probably due to the certainty of the implementation of the interventions and a more flexible process with a high level of accountability compared to the institutional processes of urban planning.

Despite the fact that 64% of the Basilicata Municipalities have submitted a SEAP, only 1 Municipality in 83 has correctly made available their MRs on the CoM website. This is a very critical point, because in the circular progress of the CoM, every signatory has to publish its MRs after 2 years from submission of its SEAP. In the Basilicata case, through the investigations on the websites of the Municipalities and direct survey on the technical structures responsible for the SEAP process, we discovered that 2 Municipalities delivered their MRs but they didn't complete the CoM procedures. Reasons for these very low numbers in terms of MRs compared to CoM signatories, are due to:

- technical support in the second phase of the CoM process was not provided to the Municipalities after the initial stage when the Province of Potenza (Covenant Coordinator), in using regional funds, delivered a subsidiary technical function by the SEL company. The capacity of the Municipalities to manage the follow-up of the SEAP submission was very low and this delayed the evaluation of the SEAP implementation;
- the non-publishing of the MRs is also representative of the general condition of the non-implementation of the actions included in the SEAPs due to the lack of specific funding, the technical capacity to promote public tenders and procurements, and low interactions with private investors and local stakeholders.

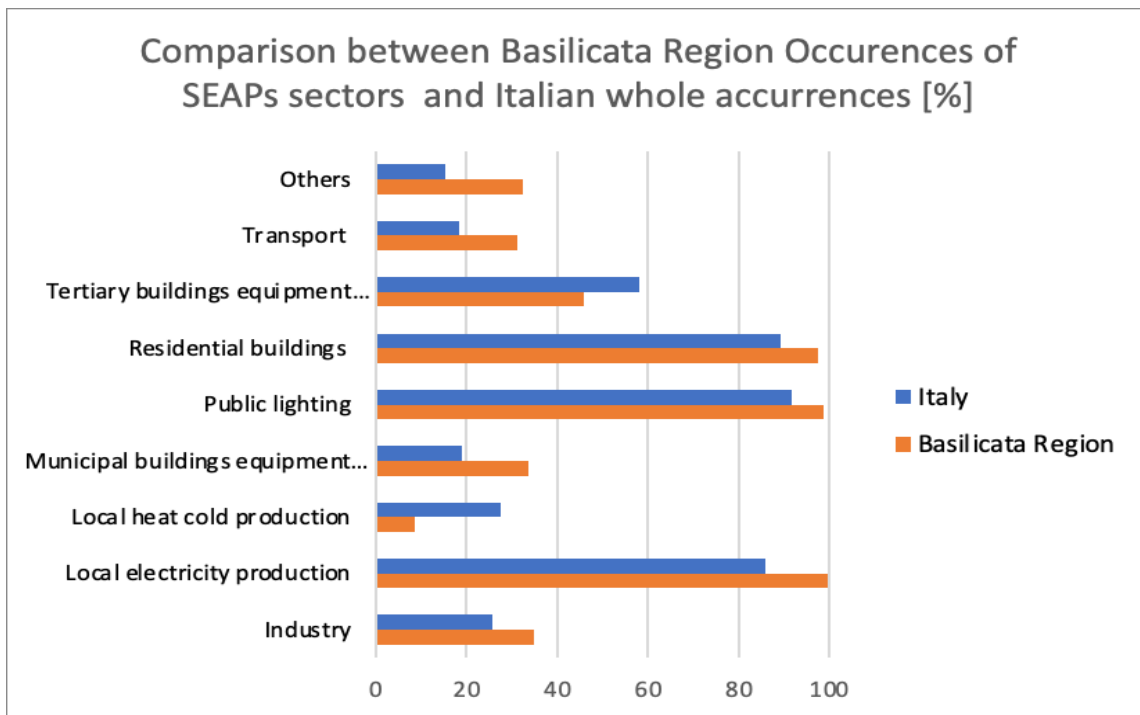


Figure 21 Comparison between occurrence of SEAPs submitted at national and regional scale

In Figure 11, a spatialization of the data on the Basilicata Municipalities SEAP sectors occurrences is proposed so as to provide a territorial assessment of the CoM experience in the Basilicata Region.

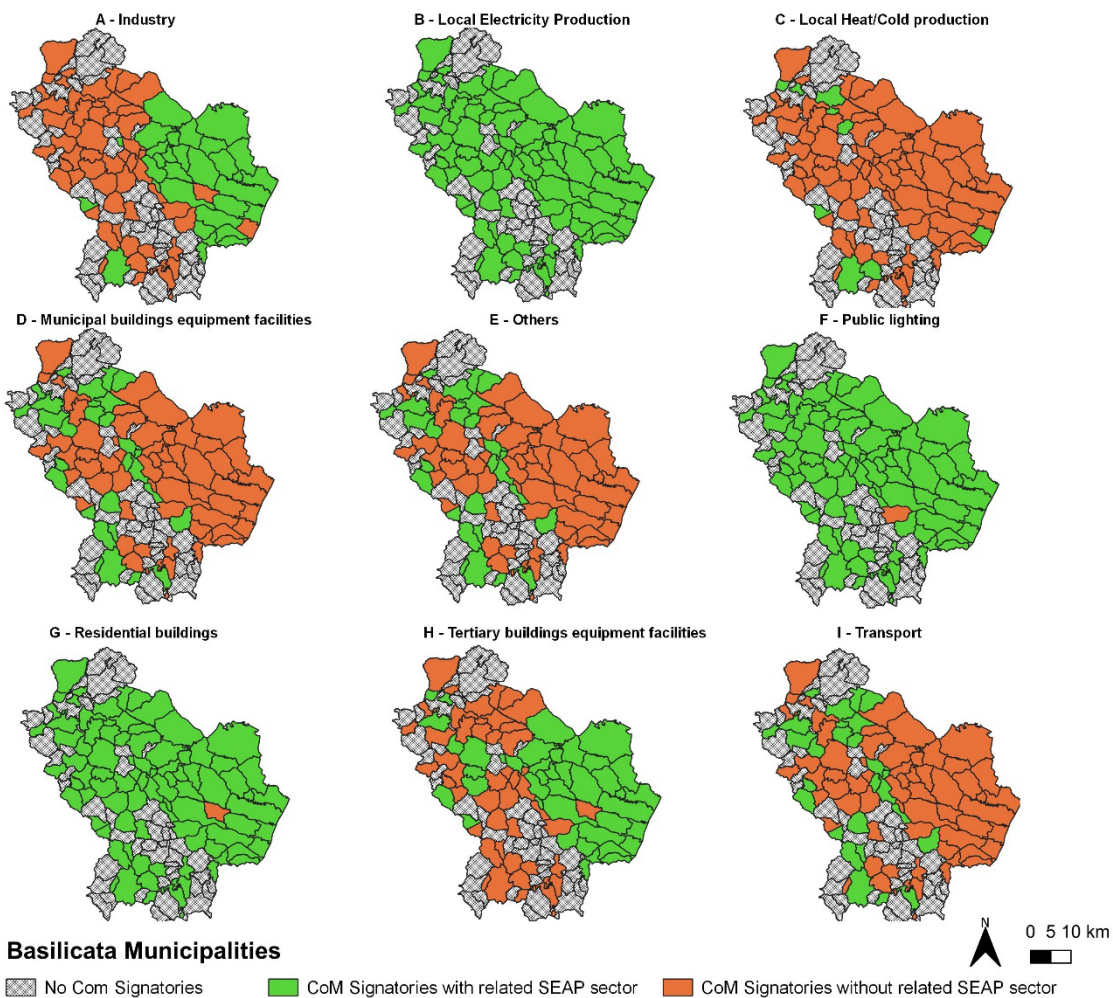


Figure 22 Basilicata CoM Municipalities with related SEAP sectors

Considering only the SEAP sectors in the Basilicata Region (see fig.21), their geographical distribution among the CoM Municipalities into the two Provinces of Potenza and Matera, highlights some interesting results:

among all the Basilicata Municipalities, the sectors widely involved in the SEAPs, are “residential buildings” (98%), “public lighting” (99%) and “local electricity production” (100%), highlighting a place-based approach of the investments suggested, combining public and private interests/actors that join the common goal of CO₂ reduction;

the Municipalities of the Matera Province have provided appreciable occurrences for “industry” (93%) and “tertiary (not municipal) buildings, equipment/facilities” (76%) sectors among the Basilicata SEAPs submitted. This explains, on one hand, the aim to improve the energy efficiency in the manufacturing processes, and on the other, the unbalanced planning of interventions of these sectors for the Municipalities of the Potenza Province;

Despite two Municipalities with over 5000 inhabitants, the “Municipal buildings, equipment/facilities” sector is included by the small Municipalities with a resident population under 5000 inhabitants. These Municipalities are almost all (96%) from the Potenza Province and from a geographical point view are located in the inland areas of the Basilicata Region

Discussion

Working on data available on the CoM website, allows easily allows - to experts and common citizens - to assess how the European Communities (represented through the municipalities) have warned of the topics about themes of the investments in renewable energies and also the climate change mitigation and adaptation policies. The data are is available as read-only format and no open data or data distribution services are available. This may represent a barrier to against encouraging data sharing and re-usage in sectoral studies and statistics.

Concerning the Italian data, the number of Italian signatories to in the CoM that developed a SEAP corresponds to 41% of the total Italian municipalities, a low number considering the relevance of the sector in the national strategic development policies. The themes of sustainable energy production and consumption and consequent investments in clean energy are hot topics not only into in European policies and strategies but also in the UN programs [173,187].

The percentage of Italian signatories who submitted a MR decreases to 32% of the total SEAP signatories. This is a proxy to understand the commitment level of the municipalities.

It is interesting to look at the resident population of the SEAPs signatories: most of them (2488) are small municipalities (or a union of small municipalities) with a population under 10000 inhabitants. It is relevant to underline that, among the municipalities with a population over 500000 inhabitants, Rome is not in the official list of CoM Signatories. However, but the city it adopted the SEAP in 2013.[188]. The large participation of small municipalities in terms of inhabitants is bound to the choice of SEAPs as instruments be able used to plan and provide funding for ordinary interventions on the urban areas instead place of institutional instruments (i.e. urban planning regulation, operational plans and programs established by National policies).

The figures of the CoM experience in Italy, as indicated in the showed in them official CoM DB, are not fully coherent with the effective status of the implementation process: in facts as a matter of fact,

many a lot of the missing data uploaded had been was identified especially concerning with regards the MRs. That's why it is very difficult to achieve a comprehensive framework. This critical point comes out results from the Basilicata study case, an example that representing a virtuous region in terms of signatories with a 64% of the total municipalities that signed up to for the CoM submitting a SEAP, but only 4% of the total municipalities have developed a MRs without even official feedback from the CoM website.

The reasons for these critical issues, are maybe probably related to the lack of support offered to the municipalities, always encouraged by energy service companies (such as SEL for the Basilicata Region) from the moment of the CoM submission to the development of the Action Plan and then left alone without guidelines to continue further with the MRs.

The SEAP process worked until a qualified technical structure provided the necessary assistance in defining the action plans. After this phase, in the absence of adequate funding, the municipalities demonstrated a technical weakness in the management of the subsequent phases or, worse, a low level of commitment with respect to the aims of the whole process.

The SEAPs are voluntary plans that in the last years have deeply influenced the urban development sometimes out of the normative and spatial framework defined through urban plans. The results of the local investigation conducted in the Basilicata Region allowed us to point out that SEAPs may could be an alternative planning tool in place instead of the lack of urban plans according to the National/regional urban laws. This is a critical mismatch discrepancy between the CoM objectives and the local implementation purposes mainly oriented towards facilitating projects implementation based on sectorial public or EU funding opportunities rather more than to governing a territorial process of transition towards a more sustainable energy scenario. [16].

The SEAPs are based on a bottom-up approach involving a complex whole of public and private actors. However, but in comparing the occurrences of the SEAP sectors, it appears that the "public" sectors (i.e. public lighting or municipal buildings, equipment/ facilities) are the main interventions areas. This may be representative of a prevailing top- down approach, missing that omits the opportunity to build local private-public-people partnership relations [163,189] In this way, most of the investments are supported by municipal authorities and less by private investors or stakeholders, showing a not so good poor relationship between the actions provided in the to SEAPs and the urban or territorial transformations that occurred ensued.

Conclusions

This paper aimed at evaluating the state of the Italian CoM implementation, assessing the results achieved in terms of the Municipalities involved (CoM signatories), the SEAPs developed and the MRs submitted. Based on the analysis of the MRs data, we discussed some critical appraisals concerning the performance level of the CoM, highlighting, as with the conclusions discussed by the report 316/2020 of ISPRA (The Italian Institute for Environmental Protection and Research, ISPRA - *Istituto Superiore per la Protezione e la Ricerca Ambientale*) [99], how the technical support for small municipalities and the effective commitment of local decision makers may affect the effectiveness of the entire process of CoM implementation at a local level. The figures referred to the Basilicata Region case study is are a measure of the mismatching discrepancy between the information available from the CoM official data and the effective implementation status at a local level.

This study delivered an assessment of the SEAP experience in Italy, that in 2020 achieved its first deadline passing the baton to the “new” CoM experience based on the Sustainable Energy and Climate Action Plan (SECAP) including the ambitious goal of climate adaptation coupled with sustainable energy management.

The data from the CoM official website investigated took into consideration the CoM signatories, the resident population under SEAP Municipalities, the MRs submitted and the occurrences of sectors among the Italian signatories. The main highlights are:

- A total of 3901 out of 7903 Italian Municipalities (corresponding to 49% of all the Municipalities) have signed up to the CoM, but only 15% of the Italian Signatories (in terms of Signatories these are 470 on out of 3217) have been strengthened reinforced their commitments to decreasing CO₂ emissions from 20% by 2020 to 40% by 2030 with the development and implementation of local adaptation strategies;
- From a geographical point of view the distribution of SEAPs is widespread in the North-East and South of Italy, including the islands of Sicilia and Sardinia islands where the percentage of SEAPs submitted on total by the municipalities, is 62%;
- Considering the same NUTS regions and comparing the percentage of the population involved by the SEAP and municipalities, there are geographical regions such as the “*Nord-Ovest*” (North-West) where the percentage of the total SEAPs submitted on the total CoM signatories, is less than the population involved by the SEAPs. This is mainly due to the adhesion of a few municipalities with a M or L population size (according to the CoM classification) that how could you think of more municipalities rather than a large number of municipalities;
- The theme of the MRs is the critical point of the CoM process. Only 32% of the MRs of the total SEAPs submitted are available on the CoM website; this does not mean that the Municipalities do not develop their MRs but means that there is a lack of support to the Municipalities uploading data on the CoM website. In this way, it is not possible to know how many MRs there are and how much progress has been achieved;
- In comparing the sectors involved by the Italian Municipalities, among the SEAPs and MRs, in terms of occurrence, the largest number is related to those sectors supported by a local administration as opposed to private stakeholders. This is highlighted more in the MRs, where sectors such as “Transport” have increased their occurrence fivefold, but in any case, the planned interventions support targeted interventions rather than urban policies.

In the Basilicata case study, the SEAP decisions, according to the principle of subsidiarity, have been taken at the lowest administrative level and closest to the place where each plan produces its effects. Nonetheless, the multi-level governance model included the entire institutional chain: the Basilicata Region, the Provinces and the Municipalities. On the other hand, the full involvement of all the stakeholders (locals, private investors, Small and Medium Enterprises (SMEs), citizen organizations, relevant groups, etc.) of the SEAP process had not come about. Recent studies have also analyzed the “social acceptance” of Renewable Energy developments at an urban level, identifying the trust building process as a way to reduce opposition effects in local communities [190,191]. As a matter of fact, a bottom-up approach including participation in SEAP development was not fully adopted and, in the perspective of the authors this is the major weaknesses to be overcome in the next GCoM season.

In addition, the Basilicata Region shows how SEAPs, intended as a complementary tool to in the institutional urban planning framework, and not as an alternative one, effectively support those municipalities with a low number of inhabitants or settled settlements in inland areas to achieve better results in terms of sustainable territorial management based on low-carbon targets: CO₂ emissions reduction and improvement of energy efficiency of buildings and industrial processes.

The SEAPs experience has given introduced in Italy, for the first time, a renewed approach towards voluntary planning, this is particularly relevant for a Country that is closely linked to a top-down approach for the development of urban planning.

The forthcoming season of GCoM, characterized by the challenge of Climate-Change invites Signatories to improve their commitments, with a 40% reduction of CO₂ by the 2030 and the development of adaptation strategies at an urban scale. This is complementary with the further EU Cohesion Policy (2021/2027) that supports (with relevant funding opportunities) locally-led development strategies and empowers local authorities in the management of investments. As a matter of fact, particular care will be given to the urban dimension of the Cohesion Policy strengthening the sustainable urban development with a minimum reserve of 6% of the ERDF and by a new networking and capacity-building programme for urban authorities: the European Urban Initiative.

Additionally, the European Green Deal may represent a horizontal platform to support investments included in the SECAPs and a way to reinforce actions towards sustainable EU citizenship[5].

The future development of this research will include examining the considerations highlighted, for any critical points of the SEAPs and MRs, so as to extend them to other European adaptation initiatives such as the URBACT and LIFE programs or Integrated Territorial Investments [192] for CoM and non- CoM municipalities , to develop a decision support system oriented towards the recommendation of strategic adaptation actions[193–195], and taking into account the approaches and the local conditions of the municipalities and the elaboration of performance indicators of the strategies developed. [130,196]

The contributions of this work could represent a starting point for a more in-depth evaluation of both the first CoM experience (2008–2015) and the results achieved by the actions included in the SEAP and MRs for every Italian Region, as suggested by the Basilicata Region case study. The knowledge should not stop at the evaluation of the occurrence of the SEAP sectors but should also evaluate the details of the fund expenditures; however, with this paper, we highlight a lack of data in the official CoM sources

Urban climate adaptation represents a growing trend that includes multiple sectors of investments and generally requires a rethinking of tools and solutions in planning practice: “climate change at an urban scale is creating new ways of understanding and intervening in cities”. [197,198]

4. Impacts and effectiveness of SE(C)AP procedures on Small EU Municipalities⁵

Abstract: *Since its launch in 2008, the Covenant of Mayors Europe (CoM) has given voice to local authorities in their commitment and contribution to the climate challenge, by supporting local climate mitigation and adaptation actions. The CoM has been providing a methodological framework to support more than 10000 local authorities of all sizes and characteristics (including XS municipalities with a population below 10000 inhabitants). By signing the CoM, local authorities voluntarily commit to take action to decarbonise and increase the resilience of their territories, as well as ensure a sustainable affordable energy access to their citizens. Signatories submit their Sustainable Energy and Climate Action Plan (SECAP), a politically approved document describing the long-term strategies and the actions through which achieve the emission reduction target and adaptation goals. Through its bottom-up approach, the CoM has contributed to bridge local authorities' technical and financial barriers. Through this study, the role of SE(C)AP as a "bridge" complementing traditional planning tools in XS municipalities is explored. Potential additional indirect benefits of SE(C)APs are assessed through three separate perspectives: Socio-Economic, Energy and Environment, and Urban and Territorial Management and the use of a set of indicators. An application of the indicators to a sample of CoM XS municipalities is presented and discussed, supporting the SE(C)APs role to direct urban planning practice and providing insights into the rationale of the three perspectives.*

Keywords: Small municipalities, SEAP/SECAP, Covenant of Mayors, climate action, cobenefits

Introduction

Small municipalities and their development were analysed, among the first times, in a guidebook to rural development practitioners and decision makers in order to achieve a comprehensive understanding of rural development fundamentals by [199] providing also a first classification of small municipalities as “Small Town” with a population between 5,000 and 25,000 and “Rural” with a population below 5,000. Further definitions have been based on the population [200,201] or on the analysis of degree of urbanisation [202]. From these definitions, a class of local authorities that are not densely populated and may have limited access to financial and technological resources emerges. Small municipalities share the lack or inefficiency as providers of goods and service, remarking the central place theory as put forth in the rank-size law [203]. A relevant additional element characterising small municipalities is the cooperation with other (surrounding) areas to create critical mass for i.e. efficient industrial symbiosis [204]. Small municipalities are also vulnerable to economic changes [205], strongly depend from the regional or national economy. As shown in figure 23, municipalities with a limited number of inhabitants are frequent in Europe, particularly in Italy, where 70% of municipalities has a population below 5000 inhabitants [206] and in Spain, where 61% is below 1000 inhabitants [207].

⁵ Santopietro L., Palermo V., Bertoldi P., Scorza F. (2024). Impacts and effectiveness of SE(C)AP procedures on Small EU Municipalities. Paper to be submitted to *Sustainable Cities and Societies*

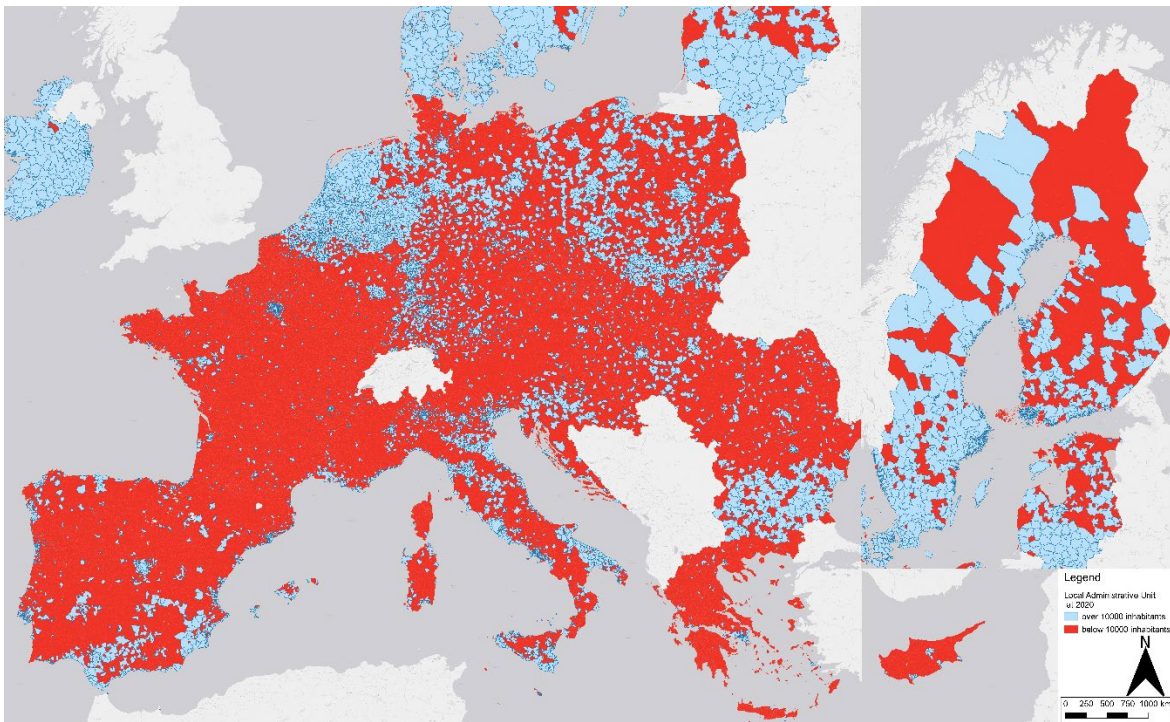


Figure 23 EU-27 municipalities below 10000 inhabitants in 2020

Small municipalities contribute to the sustainable transition being able to scale down global policies towards the achievement of the Sustainable Development Goals (SDGs). In particular, small municipalities adopt programs that advance to sustainability at their scale and context [208] thereby potentially becoming local excellences within regional, national, and global economies when focusing on their specific characteristics and seizing their opportunities [209]. Moreover, the contribution of small municipality is also evident in tackling climate change, its causes and impacts at local level, as urban areas are key players in this challenge [128].

The need to take climate mitigation and adaptation action at multiple levels of governance has been early recognised by the EU, who is playing a leading role in the global scene for more than 20 years, by setting ambitious targets and developing key policies. The climate and energy “20-20-20 package” [210] acknowledging the need decarbonisation and setting targets, followed by the energy and climate package, which represented a turning moment in coupling energy and climate targets. Ambitions have been stepped up with the European Green Deal [5] which has also integrated the economic and social component of the green transition, aiming to making Europe the first climate neutral continent by 2050 [211]. In this framework, the Covenant of Mayors Europe (CoM) has given voice to local authorities in their commitment and contribution to the climate challenge, by supporting local climate mitigation and adaptation actions. The CoM is open to local authorities of all sizes and characteristics, and since its launch in 2008, has provided a methodological framework to support more than 10000 local authorities [212]. By signing the CoM, local authorities voluntarily commit to take action to decarbonise and increase the resilience of their territories, as well as ensure a sustainable affordable energy access to their citizens. Signatories submit their Sustainable Energy and Climate Action Plan (SECAP), a politically approved document describing the long-term strategies and the actions through which achieve the emission reduction target and adaptation goals [213]. Through its bottom-up approach, the CoM has contributed to bridge technical, financial and logistic barriers of local authorities across Europe. This is particularly evident for municipalities with less than 10000 inhabitants - referred as XS municipalities and representing the 62% of the CoM signatories - who were able to approach and advance in local climate policies finding support in the CoM

methodological framework complementing lacking resources. In addition, CoM provides local authorities the opportunity to cooperate and exchange knowledge and best practices and it advocates for multi-level governance on climate and energy issues. Finally, the CoM methodological framework allows for progress tracking and corrective actions, through monitoring reports [213].

Against this background, this study aims to assess potential additional indirect benefits of SE(C)APs on XS municipalities. Three separate perspectives have been selected to analyse the potential indirect effects of SE(C)APs: Socio-Economic, Energy and Environment, and Urban and Territorial Management. These perspectives are explored through a set of indicators that supports the evaluation of potential co-benefits XS municipalities have from the implementation of the SECAPs, intended also as an opportunity to improve the territorial competitiveness and the environmental/social protection. Moreover, is investigated the role of SE(C)AP as a "bridge" complementing traditional planning tools in term of flexibility of planning processes and supporting of energy and climate efficiency projects.

The next sections expand on the SE(C)APs role to direct urban planning practice and provide insights into the rationale of the three perspectives and into the related indicators. The outcomes of the application of the indicators to the sample of CoM XS municipalities are presented and discussed. Finally, conclusions and future perspectives are drawn.

Driving urban planning practice through Sustainable Energy (and Climate) Action Plans

The Covenant of Mayors has been evolving through time. A first phase of the initiative, framed signatories' mitigation commitment of 20% Greenhouse Gas (GHG) emissions reduction target by 2020. In 2015, the adaptation and energy access pillars were integrated, and the mitigation commitment stepped up to 40% GHG emissions reduction by 2030. In 2021, in line with the EU Climate law, the target for 2030 was further raised to 55% GHG emissions reduction. The evolution has been reflected in the key document of the initiative, the Sustainable Energy Action Plan (SEAP) developed for 2020 objectives became Sustainable Energy and Climate Action Plan (SECAP) to take into account the climate change adaptation component and the increased commitments for 2030 targets. The CoM has made clear the link between urban planning and energy and climate progresses, through the SE(C)AP, which is a distinguishing element of the initiative, and represents a concrete opportunity for local authorities to plan actions and monitor progresses. CoM data of 2022 shows that more than 6000 local authorities have submitted their Climate Action Plan.

While fitting the existing urban regulatory frameworks, the SE(C)AP is not an institutionalised traditional planning instrument. Planning frameworks in Europe are often linked to a vertical/hierarchical supervision of decisions concerning territorial transformations [162]. In France there are inter-municipal associations that manage the Schéma de la Cohérence Territoriale (SCOT), that in turn monitors the municipal Plan Local d'Urbanisme (PLU) (see[214,215]). Germany has implanted its regulations concerning regional planning in 1975 with "General Regional Planning Program for the Federal Territory" (see [216–218]); Italian planning regulations is based on a hierarchical planning procedure at different spatial/administrative levels with the urban masterplan, based on the National Planning Law 1150/1942; similar experiences of institutional planning framework can be also found in the Netherlands, Belgium, Denmark, and Sweden [219,220].

Intended as a "planning tool", the SE(C)AP may complement existing spatial and sectorial planning regulated by legal frameworks [221], and influence local and environmental strategies, thereby, playing the role of a "playmaker" as it enables implementing and scaling up EU and SDGs commitments and policies related to climate and energy within traditional institutional normative planning framework.

Three main characteristics enable the SE(C)AP in contributing to urban sustainability:

- Its flexibility: the structure of the plan is flexible in designing targets, actions, and engaging stakeholders with a long-term political commitment. Moreover, the SE(C)AP is not a fixed instrument, as it may be subject to revision through the monitoring phase;
- Being action-oriented: the SE(C)AP guides local authorities in developing the strategies to achieve the targets and translate these into actions in the short /medium terms;
- Arising strong implementation opportunities through specific technical support: the SE(C)AP has the capability to support the design and implementation of energy and climate efficiency projects, going beyond the limitations of traditional planning tools.

Therefore, the SE(C)AP represents an effective operative tool to design and implement local urban development strategies and interventions with an energy connotation, while advancing the ordinary planning system to support effectively the territorial governance needs in downscaling the EU and global energy policies at local level [28,166,222]. Voluntary planning approaches can complement and fill the gaps due to the formality of institutional spatial planning and the bureaucratic constraints. The SECAPs allow to directly assess the impacts of EU policies on lower levels of governance being in parallel an opportunity for sustainable local development

In this scenario, SE(C)AP is a key opportunity for the XS municipalities in designing territorial transformations towards increasing environmental awareness [42] and transition to climate neutrality. In addition, through the SE(C)AP, local authorities can fill the gaps in and compensate the development of climate action and its monitoring, addressing limited technical and financial resources of these municipalities [223].

These may be indirect positive outcomes of the mitigation and adaptation actions planned within the plans, or may come from virtuous cycle forged through the SE(C)AP process (i.e. dedicated municipal departments, engagement with stakeholders, collaborations with public institutions). In this study the potential co-benefits deriving from the development and implementation of the SE(C)APs on small communities have been assessed through three perspectives:

- Socio-Economic perspective – to explore potential outcomes on the lives of people on counteracting the trends of depopulation;
- Energy and Environment perspective – complementing the CoM targets and exploring the effects of SE(C)APs on air quality, soil sealing and local energy mix;
- Urban and Territorial Management perspective – to evaluate any potential effects on the development of urban planning tools integrating a sustainable component.

-

Materials and research methodology

To assess the potential additional benefits of SECAPs on XS municipalities, an indicator-based approach has been developed, crossing the three above mentioned perspectives.

The selected indicators are multi-dimensional in assessing and benchmarking conditions and trends across space and time, monitoring progress toward goals and targets, informing planning and decision-making [224,225], although there is not a comprehensive set of indicators able to reflect the urban complexity [226]. Indicators are required at all levels of results-oriented development goals [227], providing the necessary information for measuring environmental, economic and social progress [228] and achieving sustainability targets by providing information to policymakers and the

citizens. Moreover, the indicators allow to identify weaknesses and strengths, and help prioritize areas for action towards sustainability[229].

On this track, their design represents not only a way to validate a framework but also to provide valuable insights into the phenomena being monitored [230], and help in measuring, analysing and implementing sustainable practices, in policy making and public communication [231,232]. In this study, the outcomes of the indicators reflect two moments: prior to the implementation of the SE(C)APs and post implementation, in order to assess any potential change that can be correlated to the plan itself.

The methodology is structured in 4 steps and has been developed in GIS, which allows for the spatialization of the indicators in the municipalities and future additional spatial analysis:

1. Design of the sample: including XS CoM municipalities with commitments in climate change mitigation and/or adaptation and its characterisation through basic statistics.
2. Literature review and state of the art on existing indicators on key fields at local level;
3. Definition of suitable indicators taking into account the availability of data over time;
4. Analysis of the sample through the dashboard of selected indicators, in two moments “pre” and “post” SE(C)AP implementation

XS Sample

The sample of this study consists in a selection of XS municipalities having submitted a SE(C)AP which has been successfully evaluated by the Joint Research Centre⁶ (JRC), hence suitable to achieve the targets selected by the cities. by focusing only on positively evaluated plans, it allows to assess potential additional benefits of the SECAPs, beyond its designed scope.

The source of the sample is the dataset [233] extracted from MyCovenant reporting platform and cleaned by the JRC, as scientific body of EC. The dataset includes data from the Baseline Emission Inventories (BEIs), Risk and Vulnerability Assessments (RVAs), targets and actions reported by signatories cities through MyCovenant platform. Out of 7068 SE(C)APs submitted, the sample includes 488 SE(C)APs from individual XS municipalities in EU 27. In addition, out of these, 43 plans also include a complete Monitoring Report. Figure 24 shows the geographical distribution of the selected CoM municipalities with high shares in Belgium, Croatia, Hungary, Italy, Portugal, Spain and Sweden.

This sample is the basis of the present study as detailed in the next sections.

⁶ As scientific body of the European Commission (EC), the Joint Research Centre is in charge of evaluating the SE(C)APs of signatories from Europe and other regions of the world. The outcomes of these evaluations are included into a Feedback Report shared with municipalities.

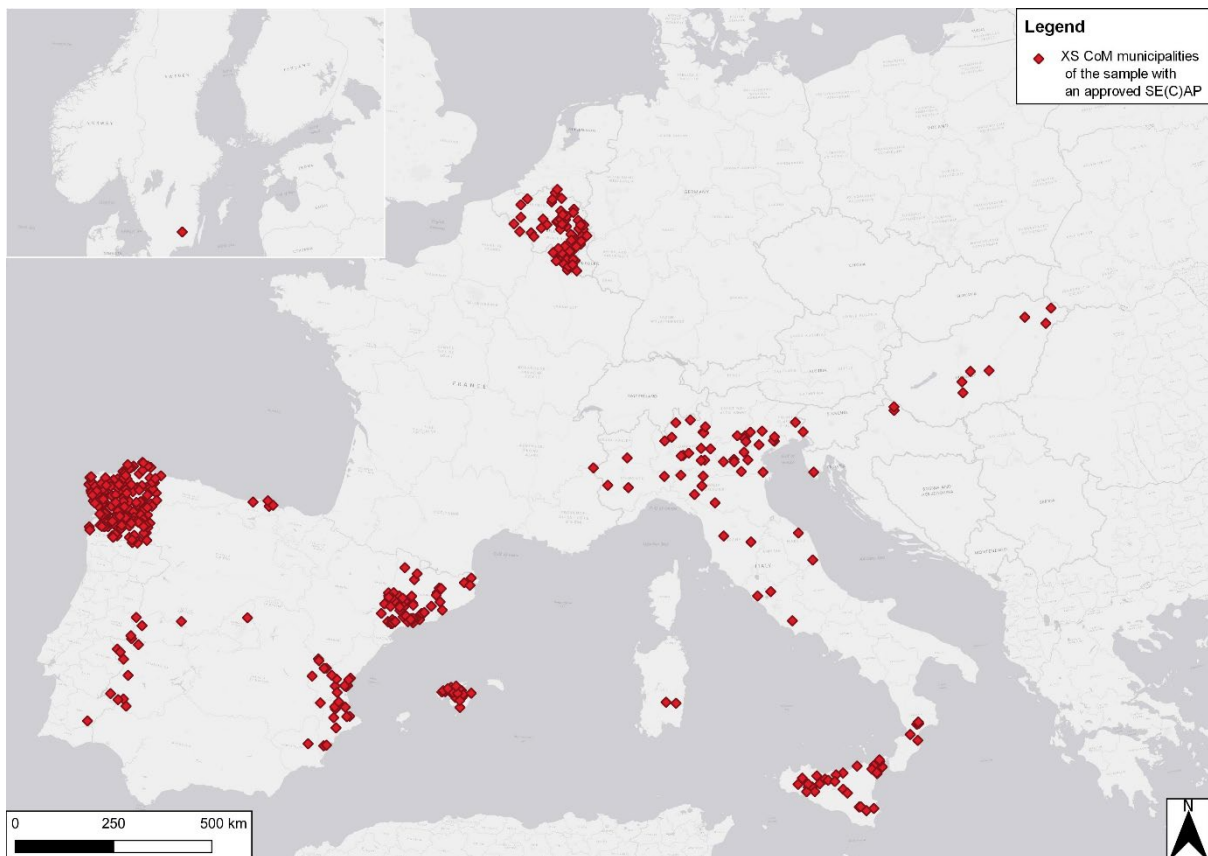


Figure 24 Distribution of municipalities selected in the sample

Indicators' dashboard design

The literature review conducted to the selection of 8 potential suitable indicators that we organized in a dashboard according to the following criteria:

- Avoiding Similarity and indicators' overlapping – in cases where the indicators aimed at assessing comparable variables only one indicator has been kept. This happened mainly for the Socio-Economic and Energy and Environment perspectives, where the large availability of data produced a set of similar indicators;
- Avoiding unavailability of data at local level – the cases where the indicators were based on data at higher levels were excluded. The availability of data only at higher levels blocked the implementation of indicators and assessments at lower levels, reducing the ability in describing the local contexts more fully;
- Enhancing the linkages with SE(C)AP actions – potentially suitable indicators were excluded if not related to any action included in the SE(C)APs of the sample. The three-perspectives selected can be described with a high number of potential indicators, however the authors have selected only ones related to the SE(C)APs actions, according to a refining process such as pointed out above.

Through the combination of the 8 indicators an overall representation of the condition of the local authorities is gained. Therefore, while each indicator is valid alone, for a comprehensive assessment of the urban and territorial impacts of SECAP (co)benefits on the municipalities, it is crucial to consider all eight indicators collectively.

Each indicator assesses the “ex ante” and “ex post” SE(C)AP conditions. The years selected to express the ex-ante and ex-post time frame vary based on the availability of data. To compare the effects of the SECAP implementation, the year 2011, that corresponds to the median of the SECAPs approval year distribution, has been selected as cut off year. Therefore, the period before 2011 is considered as pre-SE(C)AP, while 2020 has been considered as the end year, to be aligned with the 1st target period provides a timeframe of almost ten years. For each indicator, the source, the rationale with a short description, its temporal coverage and the link to SDGs are provided. Table 10 summarises the dashboard of indicators developed by combining and aggregating existing indicators from the literature [227,234–236] and structured across the three above key perspectives adopted in this study; the indicators are fully described in the next paragraphs.

Table 10 Dashboard of indicators

Perspective	Indicator
Socio-Economic (SE)	SE1 Population growth rate
	SE2 Population Density
	SE3 Built Up
Energy and Environment (EE)	EE1 Land Cover Artificial Surfaces
	EE2 Land Cover Green Areas
	EE3 Energy consumption and GHG Emission population ratio
	EE4 Air Quality
Urban and Territorial Management (UT)	UT1 Urban & Territorial Planning implementation

Socio Economic (SE) Indicators

Table 11 Overview of the SE indicators

	Indicator	Rationale	Time coverage	Data source	SDG targeted
Social	SE 1 Population growth rate (PGR)	Ratio of population growth rate	2011-2020	[237], EUROSTAT Geographic Information System of the Commission	11
	SE 2 Population Density	Population density (PD) evaluated "Ex ante" and "Ex post" CoM adhesion, rated to LAU 2	2011-2020	[238]	3,10,11
	SE 3 Built Up	Built-up surface per LAU 2	2005-2010 -2020	[238]	11,15

SE1 Population growth rate (PGR)

The Population growth rate⁷ (PGR) is described in equation 1.

The PGR assesses the population growth with a linear approach suiting developed countries and small municipalities. The resulting indicator is a growth rate between two measurement periods. This assumption was due to the low increase of the population growth rate related to the municipalities' size.

In order to assess the trend of PGR for the period 2011-2020, the XS CoM municipalities sample was compared with a control group designed by municipalities below 10'000 inhabitants coming from the EU27 countries of the sample.

$$PGR = \frac{Pop_{t+n} - Pop_t}{y} \quad (1)$$

Where:

- Pop_t is the Local Administrative Unit (LAU2)⁸ population in t (initial year) retrieved from EUROSTAT;
- Pop_{t+n} is LAU2 population in $t+n$ (final year) retrieved from EUROSTAT;
- y is the number of years between the two measurement periods.

The selected timeline covers the period occurring between 2011 and 2020 due to the availability of data for the analysed municipalities.

SE 2 Population Density (PD)

Population density (PD) is described in equation 2.

PD refers to the measure of the number of people residing in a specific area. PD is expressed as ratio between the annual population within the LAU2 level (retrieved from GISCO and expressed in km^2).

PD is used as a measure of the level of demand for resources, services, and infrastructure.

$$PD : \frac{LAU2 \text{ Population}}{LAU2 \text{ Surface}[Km^2]} \quad (2)$$

- LAU2 Population is the LAU2 population in y year, retrieved from EUROSTAT
- LAU2 Surfaces is the LAU2 surface expressed in Km^2 , retrieved from EUROSTAT -GISCO

The year 2010 is selected as cut-off for the pre-SE(C)AP period and 2020 as post SE(C)AP.

SE 3 Built up

Built-up indicator SE 3 is described in equation 3.

⁷ The PGR is also chosen by indicator SDG 11.3.1 to monitor population growth over time with an exponential approach, which is appropriate for developing countries as it considers population growth exponential.

⁸ LAU2 are the lower LAU level (LAU level 2) consisted of municipalities or equivalent units in the 27 EU Member States set up by Eurostat (<https://ec.europa.eu/eurostat/web/nuts/local-administrative-units>)

The Built-up indicator estimates the amount of built-up surface expressed in km², assessed from Earth observation records. A “built-up” surface is the gross surface bounded by the building wall perimeter with a spatial generalisation compliant with 1:10,000 topographic map specifications [238].

The source of data is the summary statistics of Global Human Settlement Layer– (GHSL) built-up surface statistics in Europe at LAU2 level, for the years 2010 and 2020 from the polygon layer provided by Eurostat-GISCO [238].

Each LAU2 polygon has linked the sum of built-up surfaces as the result of a GIS spatial join operation between two databases: GHSL-BUILT-LAU2STAT and LAU2 boundaries from EUROSTAT-GISCO.

$$SE3 : GHSL - BUILT - LAU2STAT \cap LAU2 \text{ boundaries } (3)$$

- GHSL-BUILT-LAU2STAT are the summary statistics of built-up surfaces at LAU2 level expressed in km², retrieved by the GHSL
- LAU2 boundaries are the polygon geometries of each LAU2, retrieved by EUROSTAT-GISCO

Data related to 2010 is used to express the ex-ante condition and data on 2020 as ex post condition.

Energy and Environmental (EE) indicators

Table 12 Overview of the EE indicators

	Indicator	Rationale	Time coverage	Data source	SDG targeted
Environmental	Land Cover Artificial Surfaces EE1	Total artificial land per Local Administrative Unit	2006 - 2012 - 2018	Copernicus Corine Land Cover Artificial Surfaces Urban Fabric (111 – 112 code)	11,13
	Land Cover Green Areas EE2	Total green areas per Local Administrative Unit	2006 - 2012 - 2018	Copernicus Corine Land Cover Forest and semi-natural areas (All class codes)	3,11,13
	Energy consumption (ECPR) and GHG Emission rate to population (GHGPR) EE3	Ratio of GHG emissions rate to population (GHGPR) and energy consumption rate to population (ECPR).	Referred to BEI and MEI years of each signatory	[233]	11,12,13
	Air Quality EE4	Air Quality Assessments (AQA) calculated for PM 2.5 and PM 10 at LAU2 level	2005-2019	Air Quality Health Risk Assessments (NUTS3 and countries) [239]	3,11,13

EE1 –EE2 Land Cover Artificial Surfaces and Green Areas

The source of the two indicators in this session is the Corine Land Cover (CLC), the inventory of European land cover split into 44 different land cover classes [240], developed in cooperation with European countries with a timespan of data available from 1990 to 2018.

The evaluation of Artificial Surfaces related to the urban fabric was developed following two approaches: 1- by evaluating the CLC Artificial Surfaces changes between 2012 and 2018; 2- by comparing the CLC Artificial Surfaces and built-up in both absolute and changes terms.

EE1 and EE2 indicators were computed according to the spatial join (equation 4) in a GIS software.

$$EE1 \text{ or } EE2 \text{ data set} : LAU2 \text{ boundaries} \cap CLC \text{ Surfaces} \text{ (4)}$$

\cap denotes the spatial join operation, and the resultant data set is a combination of spatial features from both input data sets:

- LAU2 boundaries are the geometry of administrative boundaries for each LAU2 municipality of the sample –retrieved from EUROSTAT - GISCO
- CLC surfaces are the Artificial Surfaces and Forest and semi-natural areas expressed in Ha retrieved from Copernicus Corine Land Cover

Data referring to 2012 was considered to express ex ante SECAP condition, while data related to 2018 as ex post condition.

However, it is necessary to highlight that the data related to the built-up includes the whole set of municipalities in the sample, while for CLC Artificial Surfaces, 103 municipalities of the sample were partially evaluated or excluded. This is due to a limited spatial resolution of CLC that has a Minimum Mapping Unit (MMU) of 25 hectares for areal phenomena and a minimum width of 100 m for linear phenomena.

In terms of land cover classes, the selection included Artificial Surfaces and Forest and semi-natural areas. In detail, from Artificial Surfaces class were selected two class codes (111 and 112) regarding continuous and discontinuous urban fabric, while from Forest and semi-natural areas all class codes were considered to take into account all green areas.

The changes from green areas to artificial surfaces (and vice-versa) for each LAU2 were evaluated through GIS, according to the equation 5:

$$CLC \text{ LAU2 Changes} : CLC \text{ LAU2 2018 Surfaces} - CLC \text{ LAU2 2012 Surfaces} \text{ (5)}$$

- CLC LAU2 2012 (or 2018) Surfaces are the Artificial Surfaces (or Forest and semi-natural areas) expressed in hectares evaluated at years 2012 and 2018 for each LAU2 of the sample

The description of the processes of land consumption⁹ within the timeframe was conducted on the basis of the transitions' triangle (see fig.25).

The proposal of Saganeiti [241] shows the re-interpretation of the triangles proposed by the EEA [242] and further developed by the Italian National Observatory on Land Consumption 2009 (ONCS) [243]. It has as main object the processes of land transformation, indicated in the triangle with a continuous arrow, with main reference to land take and land consumption.

⁹ EEA defines "land take" as referring only to totally sealed surfaces, while "land consumption" also refers to changes in coverage due to intensive land use

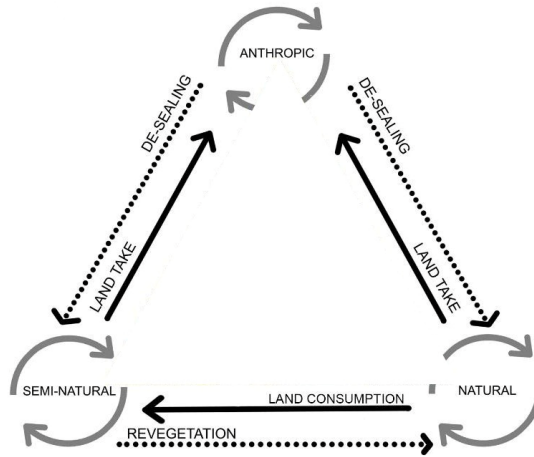


Figure 25 Transitions triangle: the proposal of (Saganeiti, 2020) modified by the authors

EE3 -Energy consumption population ratio (ECPR) and GHG Emission population ratio (GHGPR)

The indicators: “Energy consumption population ratio” (ECPR) and “GHG Emission population ratio (GHGPR)” have been designed to assess the variation of energy consumption and GHG emissions per capita before and after SECAP implementation. Although these indicators are strictly related to the SECAP main goals, their analysis provides insightful information on the trends of energy consumption, particularly if coupled with the actions.

These two energy-related indicators developed by the authors are based on the data reported by each signatory in their Baseline Emission Inventory (BEI) and, for a sub-sample of 43 signatories with a complete Monitoring Report (MR), on the data reported in their Monitoring Emission Inventory (MEI). MRs have a share of 8%, when comparing the 22% share of EU-27 signatories with a MEI is remarked the need of support by XS signatories. overall

ECPR is described in equation 6 and measures the consumption of energy per capita expressed as MWh/year.

GHGPR described in equation 7 measures the GHG emissions per capita, according to the energy consumption and the corresponding emission factors [213,244,245].

$$ECPR : \frac{BEI \text{ (or MEI) Energy measure } \left[\frac{\text{MWh}}{\text{year}} \right]}{BEI \text{ (or MEI) Inhabitants [No]} } \quad (6)$$

- BEI (or MEI) Energy measure is the total amount of consumed energy of whole sectors and carriers provided in the SE(C)AP BEI (or MEI);
- BEI (or MEI) Inhabitants are the inhabitants of the municipality in the SE(C)AP BEI (or MEI) year.

$$GHGPR : \frac{BEI \text{ (or MEI) Emission measure } [TCO_2]}{BEI \text{ (or MEI) Inhabitants [No]} } \quad (7)$$

- BEI (or MEI) Emission measure is the total amount of consumed energy of whole sectors and carriers in the SE(C)AP BEI (or MEI);

- BEI (or MEI) Inhabitants are the inhabitants of the municipality in SECAP BEI (or MEI) year.

$$\Delta_{ECPR} : ECPR_{BEI} - ECPR_{MEI} \quad \Delta_{GHGPR} : GHGPR_{BEI} - GHGPR_{MEI} \quad (8)$$

In ECPR and GHGPR delta assessment, BEI is used to express the ex-ante condition and MEI ex post condition.

EE4 - Air Quality

The indicator is described in equation 9.

The aim of EE4 is to assess the contribution of actions included in the SECAPs to improve air quality.

The design of the indicator is structured in two steps:

1. computation of per capita pollutant exposure according equation 9

$$PM_{2.5 \text{ or } 10} \text{ per capita exposure} : \frac{PM_{2.5 \text{ or } 10} \text{ NUTS3 population weighted } [\frac{\mu g}{m^3}]}{\text{NUTS3 population}} \quad (9)$$

- NUTS3 population-weighted is the population-weighted concentration average (a measure of exposure) for particulate matter (both PM_{2.5} and PM₁₀), aggregated at NUTS3 level from the ETC/ATNI interpolated maps[246]
 - NUTS3 population is the NUTS3 population at year y retrieved by EUROSTAT [247]
2. Computation of LAU2 population exposure

The PM_{2.5} and PM₁₀ population-exposure at LAU2 level is computed according equation 10.

$$PM_{2.5 \text{ or } 10} \text{ LAU2 population exposure} : PM_{2.5 \text{ or } 10} \text{ per capita exposure} * \text{LAU2 population} \quad (10)$$

- PM 2.5 or 10 per capita exposure is the variable above explained;
- LAU2 population is the LAU2 population retrieved by EUROSTAT.[247]

Data referring to years 2011 and 2019 has been selected to represent the turning moment pre and post SE(C)APs.

Urban and territorial management (UT) Indicator

Table 13 Overview of UT indicators

	Indicator	Rationale	Time coverage	Data source	SDG targeted
Planning	Urban & Territorial Planning implementation UT1	Implementation of urban planning regulation or local measures related to the urban/territorial planning through SECAP	Referred to BEI and MEI years of each Signatory	[233]	11,13

UT1 indicator is described in equation 11.

The purpose of UT1 is to assess whether the adoption of the SE(C)AP leads to changes in planning processes and whether it potentially supports the development of planning actions oriented towards sustainable development.

Following criteria have been applied in selecting the SE(C)APs:

- For mitigation actions, the actions whose “policy instrument” was flagged in the dataset as “land use planning”, “land use regulation” or “mobility planning regulation” were selected.
- For adaptation, actions classified under “land use planning” category to the “adaptation sector were selected”

SE(C)APs containing planning actions selected as mentioned above (mitigation and/or adaptation) were tagged with the Urban and Territorial index (UT1) as explained in equation 11.

$$UT1 = \begin{cases} 1, & \text{if } SECAP \text{ includes planning actions} \\ 0, & \text{if } SECAP \text{ does not include planning actions} \end{cases} \quad (11)$$

The actions encompassing urban and territorial planning with mitigation or adaptation impacts detected from the selected plans, could be further clustered to assess the approaches and key areas of intervention of urban planning actions oriented towards climate neutrality.

Results and discussions

In this section, the results from the application of the indicators are reported and discussed. While presented according to each perspective, the indicators are to be read through an integrated perspective to fully gain the urban and environmental processes and dynamics occurring in these municipalities.

Socio-Economic (SE) Indicators

The PGR (SE1) has been assessed for the municipalities in the sample as well as for all XS European municipalities in the countries represented in the sample, in order to create a “control group” (not including CoM signatories), allowing to potentially highlight specific trends and patterns.

Figure 26a shows the PGR distribution for all XS municipalities in the countries represented by the municipalities in the sample, and Figure 26b gives a focus on the XS municipalities of the dataset.

Key differences in the PGR assessments emerge for the classes showing a negative PGR. The class (-38,46; -23,07) represents the 7% in the “control group” and the 18% in the XS CoM sample. The class (-23,07; -7,69) instead, represents the 16% in the XS CoM sample and the 23% in “the control group”. Moreover, looking at the left and the right sides (marked in red for negative values and green for positive ones) of the two PGR distributions in figure 4, a depopulation phenomenon is evident in both cases, with different trends. XS municipalities in “control group” have a higher trend of depopulation (89%), compared to what recorded for CoM XS municipalities (72%), as per figure 4. Furthermore, analysing the municipalities by country, differences in the PGR are recorded, i.e. a positive average of PGR is shown in Belgium, Portugal and Sweden, while Italy and Spain register a negative PGR trend. More specifically, Belgian municipalities have the highest average PGR (31 inhabitants/year), while Italy has the lowest (-8 inhabitants/year). However, these average per country may not fully represent the specific trends and circumstances happening at local levels.

Figure 26a Population Growth Rate of small municipalities from the sample Countries between 2011 and 2020 (top) and 4b a focus on the subset including only the XS CoM sample (down)

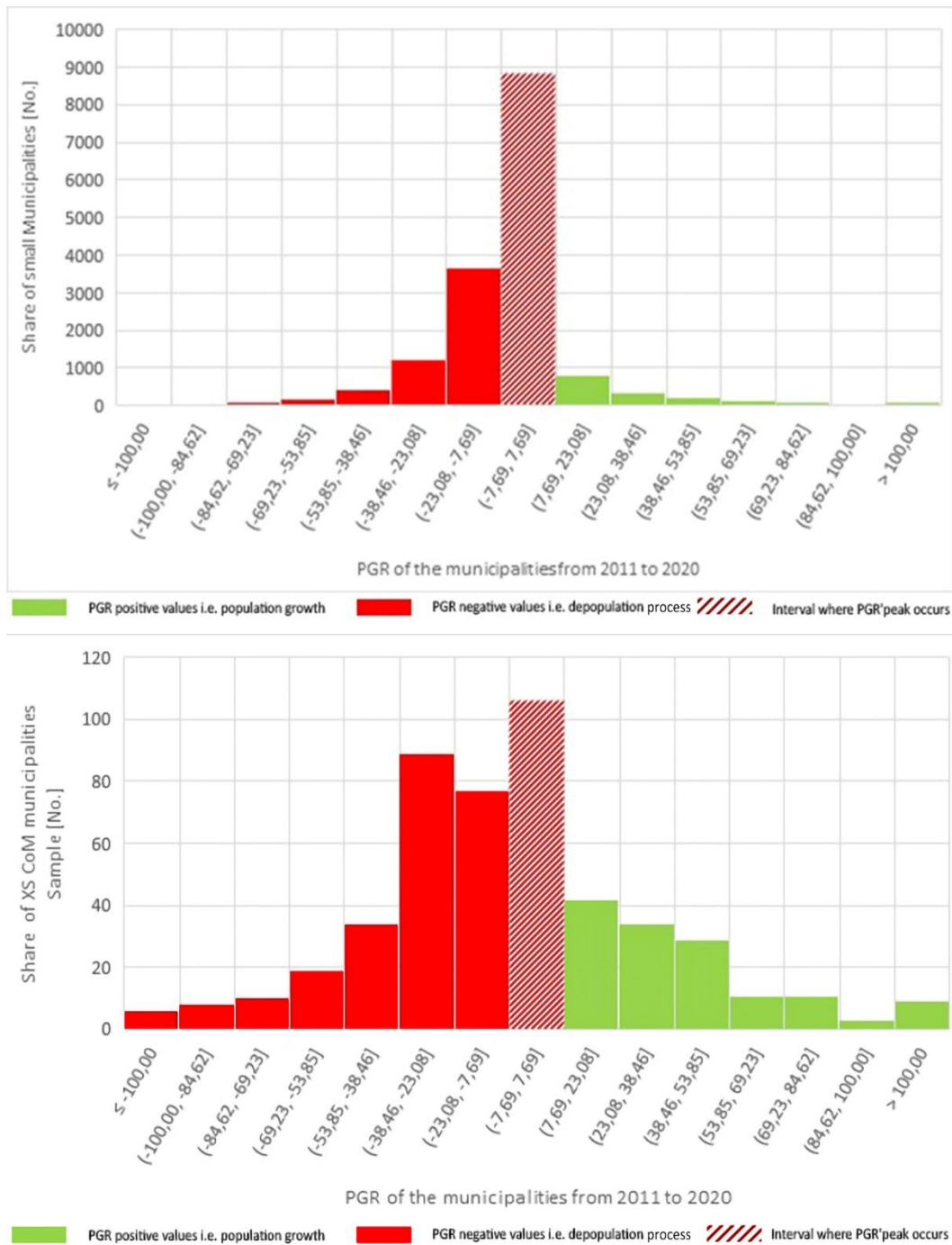


Figure 27 represents SE2, by zooming on the variation of the population density, hence, showing the attitude of XS CoM municipalities to depopulation processes after 2011, (apparently avoiding land consumption). However, in this scenario, the 36% of municipalities increased the population density, with particularly high increases in some cases (e.g. Rocafort 10%, Bonrepòs i Mirambell 12%).

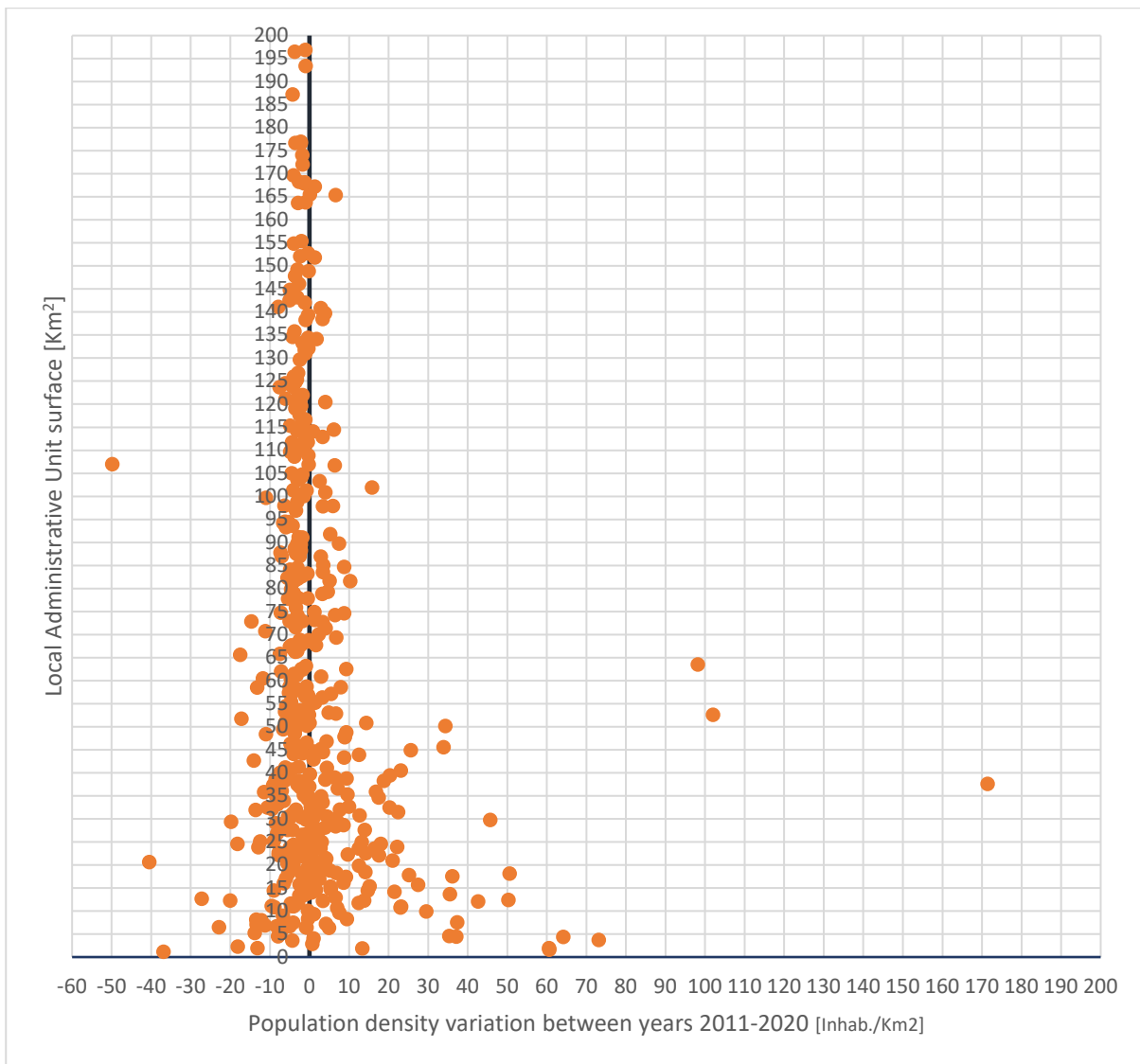


Figure 27 Zoom on Population density variation of municipalities' sample compared to their LAU2 surface in the years 2011- 2020 -SE2

The outcomes explained in SE2 could be coupled to the outcomes of SE3, expressed as comparison between variation of population and built-up surfaces for years 2010 and 2020 compared to the LAU2 surfaces. This allows a measure of the built-up variation, adopting a Jenks classification clustering approach [248]. Figure 28 shows that municipalities across countries follow a common trend in increasing built-up areas, with the highest occurrences recorded in the class with a built-up area increase below 0.17 km².

The distribution is aligned with the trend of municipalities over 10000 inhabitants, that experienced an average variation of built-up area of 0.008 square Kilometres per capita of LAU2 surface for the years 2010-2020.

However, despite limited, the increase of built-up areas compared to the outcomes of indicator SE1, may show the pace of the current settlement processes. Built-up has increased although the lack of an effective demand for new constructions and an overall population decreases.

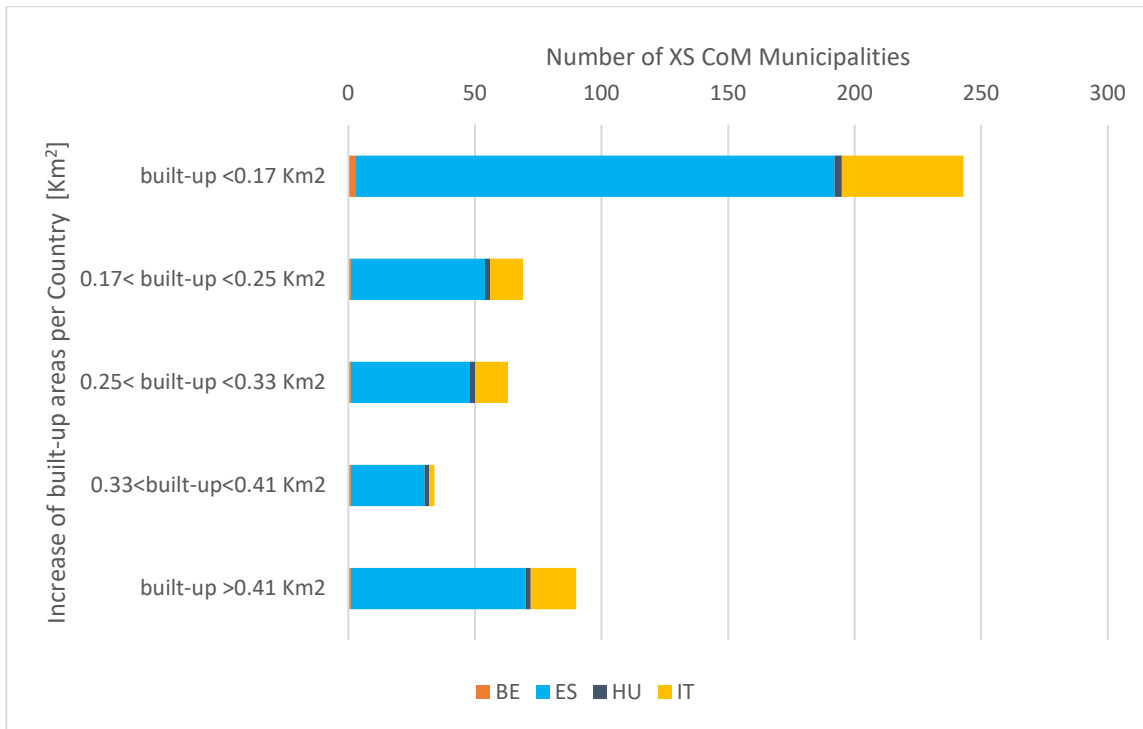


Figure 28 SE3 Increase of Built-up areas between 2010-2020 among the Countries of the sample

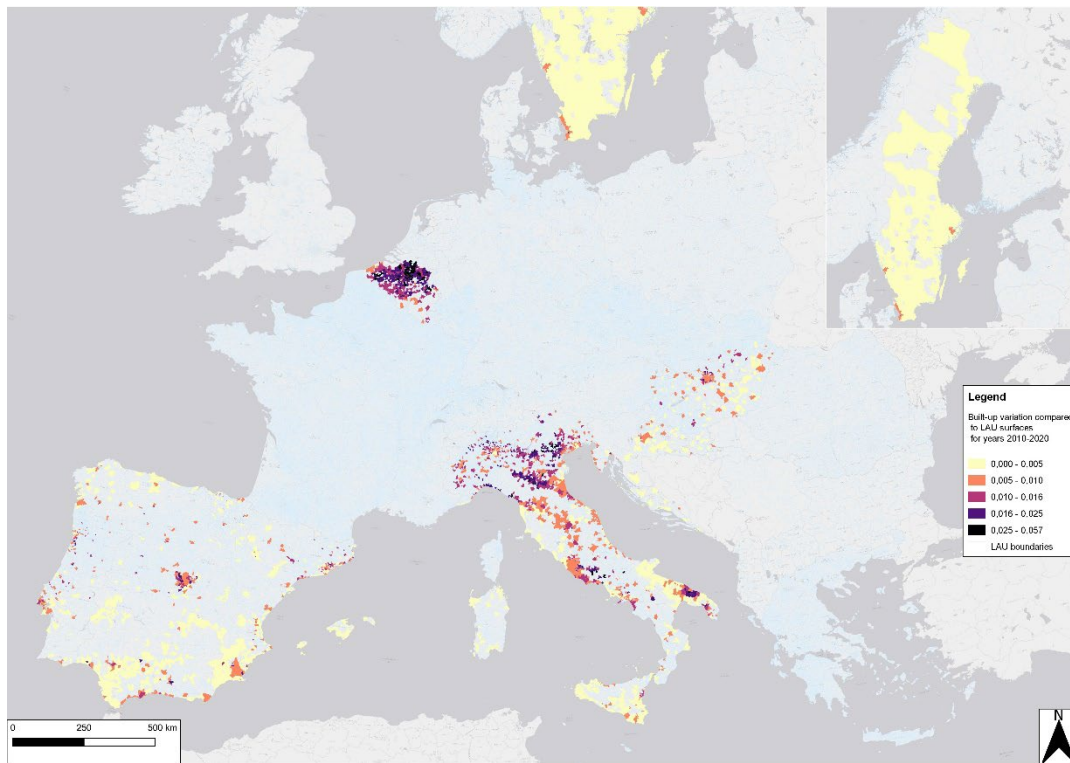


Figure 29 Built-up compared to the LAU surfaces of municipalities over 10000 inhabitants in the EU countries of the sample for the years 2010-2020

The increasing trend of built-up areas despite the recorded depopulation process (as shown in figure 30) is confirmed by the fact that, a share of 66% municipalities recorded a decrease of population opposite to an increase of built up in ten years, with peaks reaching 200 or 300%.

These results outsourcing from a sample of XS municipalities, on the depopulation processes identified by the PGR, coupled with the increase in built-up areas, are in line with the business-as-

usual projection (a built-up area growth twofold or more that of the ‘containment’ scenario for the majority of EU27 countries) of the rural and intermediate regions for the period 2015-2030 studied by [249].

Moreover, as shown in the next paragraph, looking at the whole EE indicators, the increase of built-up areas is not necessarily linked to a change in green areas.

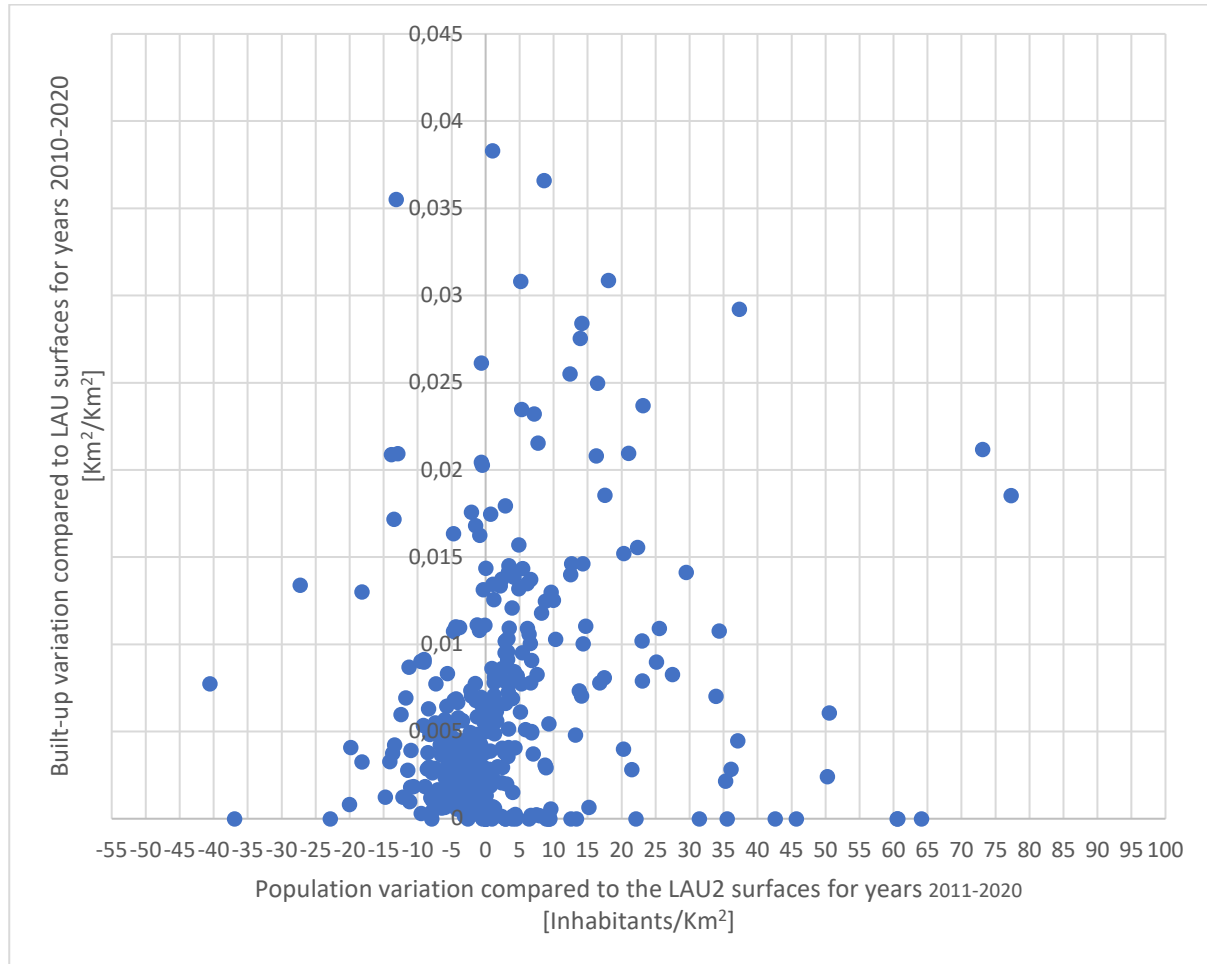


Figure 30 Variation of built-up areas and population compared to LAU2 surfaces for years 2010 and 2020

Energy and Environment (EE) Indicators

Land Cover Artificial surfaces (EE1) of the municipalities have been assessed and compared for the years 2012 and 2018 as shown in figure 31.

The variation of CLC artificial surface was about 37 square kilometres, with an effective change (i.e. with an increase of CLC artificial surfaces over 5%) addressed only to the 24% of sample.

This suggests that increase of built-up surfaces did not affect the land consumption, on the contrary there might have been a densification of the built-up areas. In order to understand it, a comparison between the variation of CLC surfaces and built-up surfaces for the period 2010-2020 was performed. Results confirmed that variation for built-up surfaces (111 Km²) have been higher than CLC surfaces (37Km²). Moreover, the comparison between built-up areas and CLC artificial surfaces in figure 32 shows that the increase in built-up areas was not related to the variation of artificial surfaces, with

19% of the sample having increased their built-up areas by more than 50 hectares in 10 years within the same artificial surfaces.

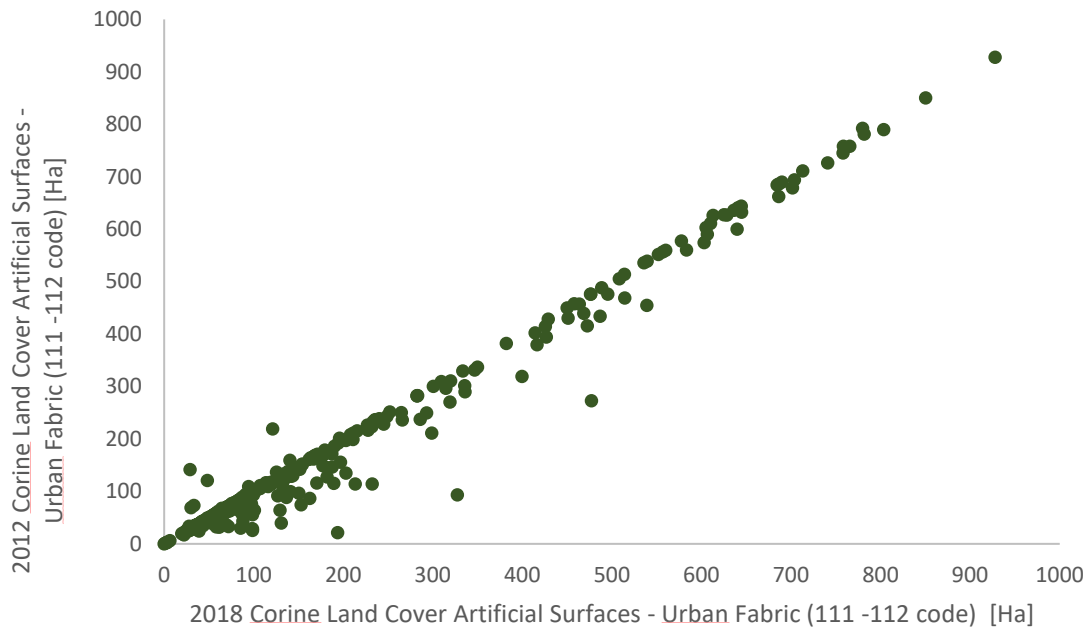


Figure 31 Comparison of land Cover Artificial Surfaces – Urban Fabric (code 111-112) of the sample between 2012 and 2018

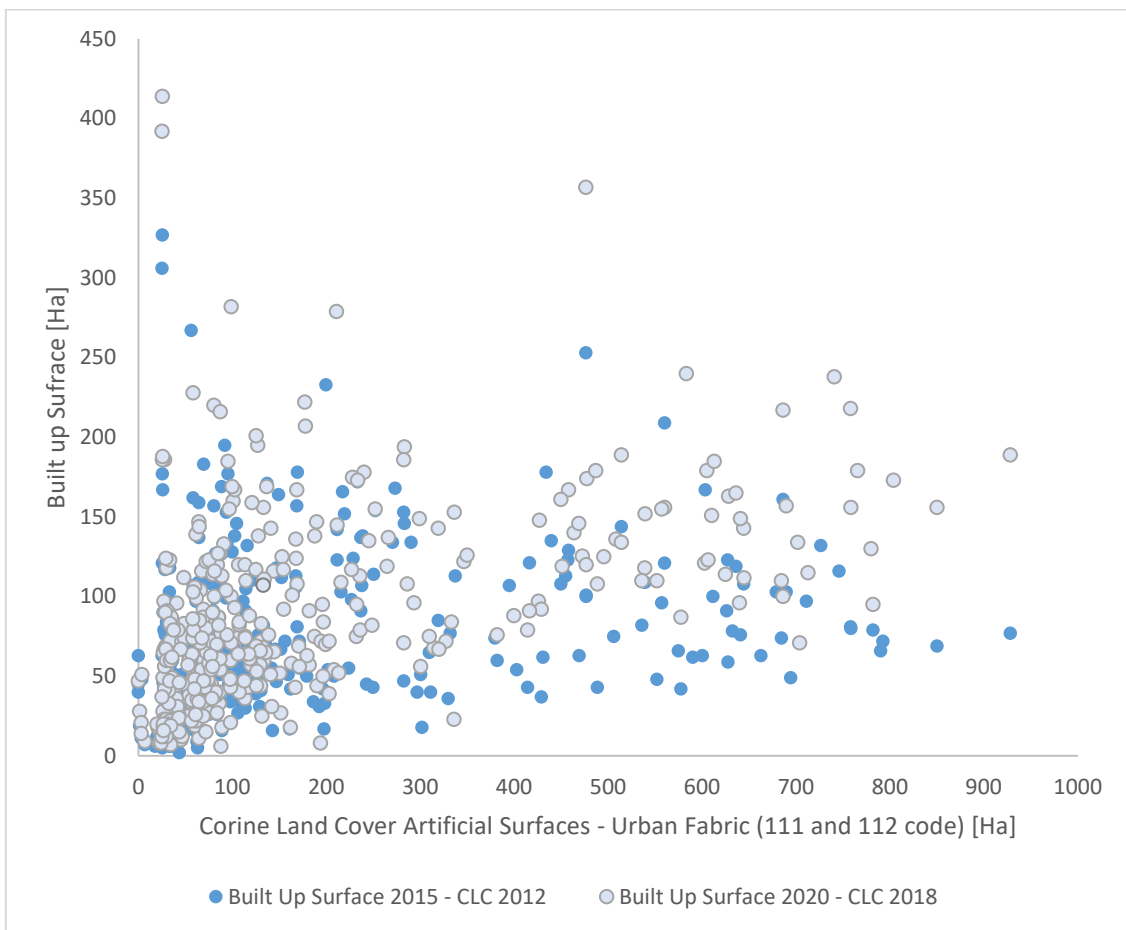


Figure 32 Comparison between Built-up and CLC Artificial surfaces

Moreover, for the period 2010-2020, the 80% of the sample has doubled its built-up surfaces. Notably, 28 municipalities of the sample have experienced an increase in their built-up surface of over 100% and are out of the trend linked to the context.

Figure 33 shows the outcome of the indicator EE2 on Land cover Forest and semi-natural areas. Overall, XS CoM municipalities did not register any changes in the land cover under these categories in the period 2012-2018, with the exception of a few municipalities (only three setting a variation of Land cover Forest and semi-natural areas over 5%) municipalities. This result reinforces the outcome from SE2, with a built-up increase not impacting on natural and green areas.

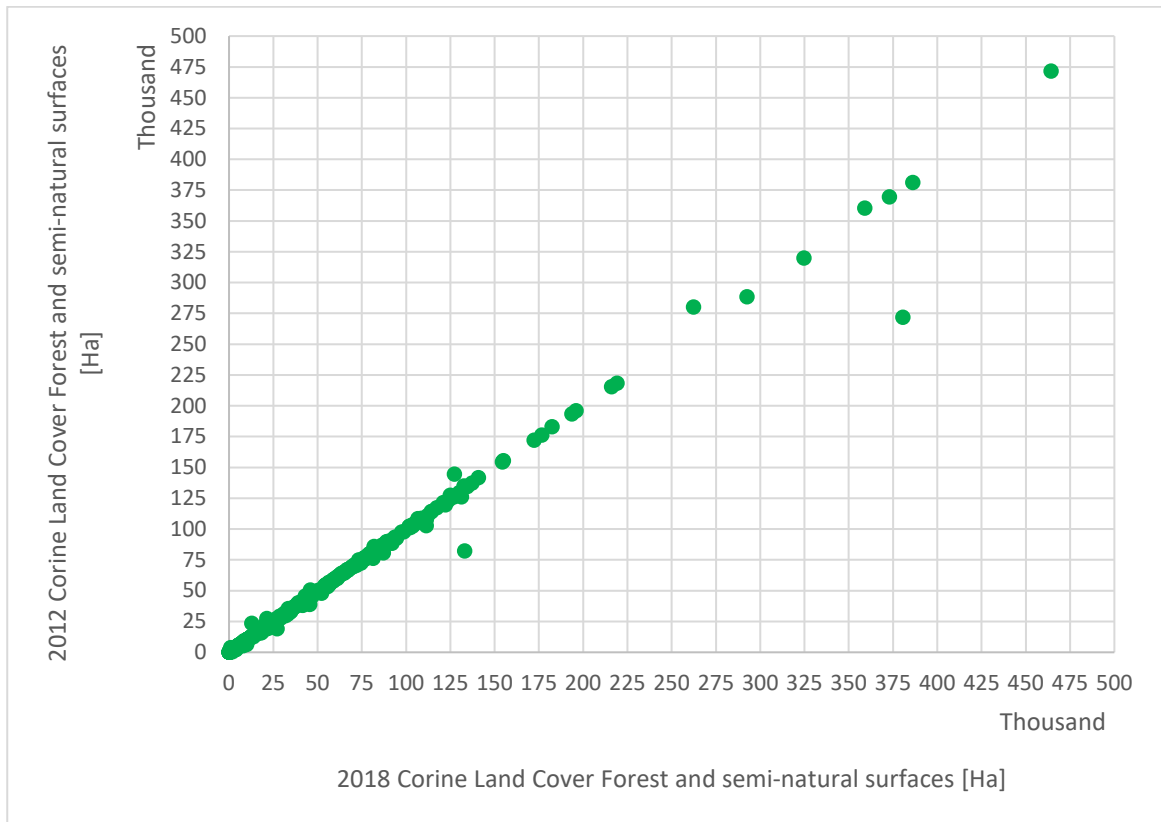


Figure 33 Corine Land Cover Forest and semi-natural surfaces of the sample between 2012 and 2018

Overall, the land Cover between 2012 and 2018, a total of 2807 polygons changed class (corresponding to a surface of 44 Km²), with 1442 inter-class changes within the same class (Artificial Surfaces, Agricultural Areas and Forest and Seminatural-Areas) and 1365 changes occurred from a class to another class (see Figure 34). In detail, there were 20 changes from Artificial Surfaces to other classes, 72 changes from Agricultural Surfaces to other classes and 1273 changes from Forest and semi-natural areas to other classes. These changes mainly consist of de-sealing and revegetation, reverse soil sealing and land take processes. Within the sample, de-sealing, consisting of the removal of surface impermeable layers, aims to increase the permeability of soils to improve their ecological performance and capacity to provide ecosystem services. occurred for 486 Km² of surfaces (equal to 11% of CLC changes). Revegetation, intended as changes from semi-natural surfaces to natural ones (see [250]), occurred for 664 Km² (equal to 15% of CLC changes). Land consumption, indicating changes in coverage due to intensive land use, is the first in terms of changed surfaces, 21 Km² corresponding to the 47% Land Cover surfaces changes. These results provide an insight on the economic structure of some municipalities as happened in Spain, where used agricultural areas registered a slight increase of 6.4% for years 2009-2020, with significant growth of some components as woody crops that increased for the 14% ones (see [251]).

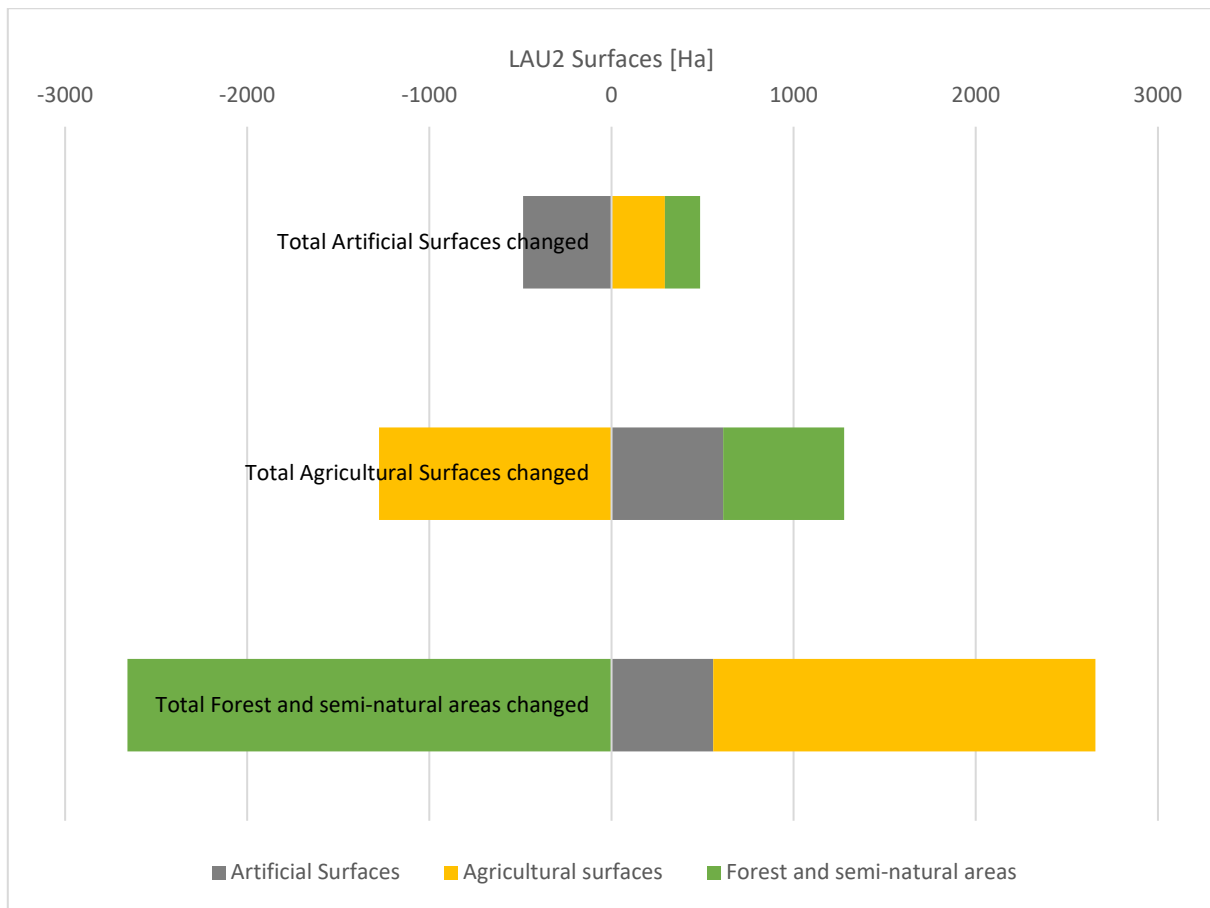


Figure 34 Land Cover Changes in hectares of the XS CoM Sample between years 2012-2018

Figure 35 shows the outcomes of indicator EE3. Municipalities achieved on average a 26% reduction in GHG emissions and a 20% reduction in energy consumption. These results represent the positive impact of SE(C)AP actions, highlighting the role of the monitoring report in benchmarking successful experiences. However, in a positive scenario of decreasing GHG and energy consumption, some municipalities reported a slight increase in energy consumption (with an average share of 3%) without affecting GHG emissions. Only one municipality reduced its energy consumption but slightly increased its GHG emissions.

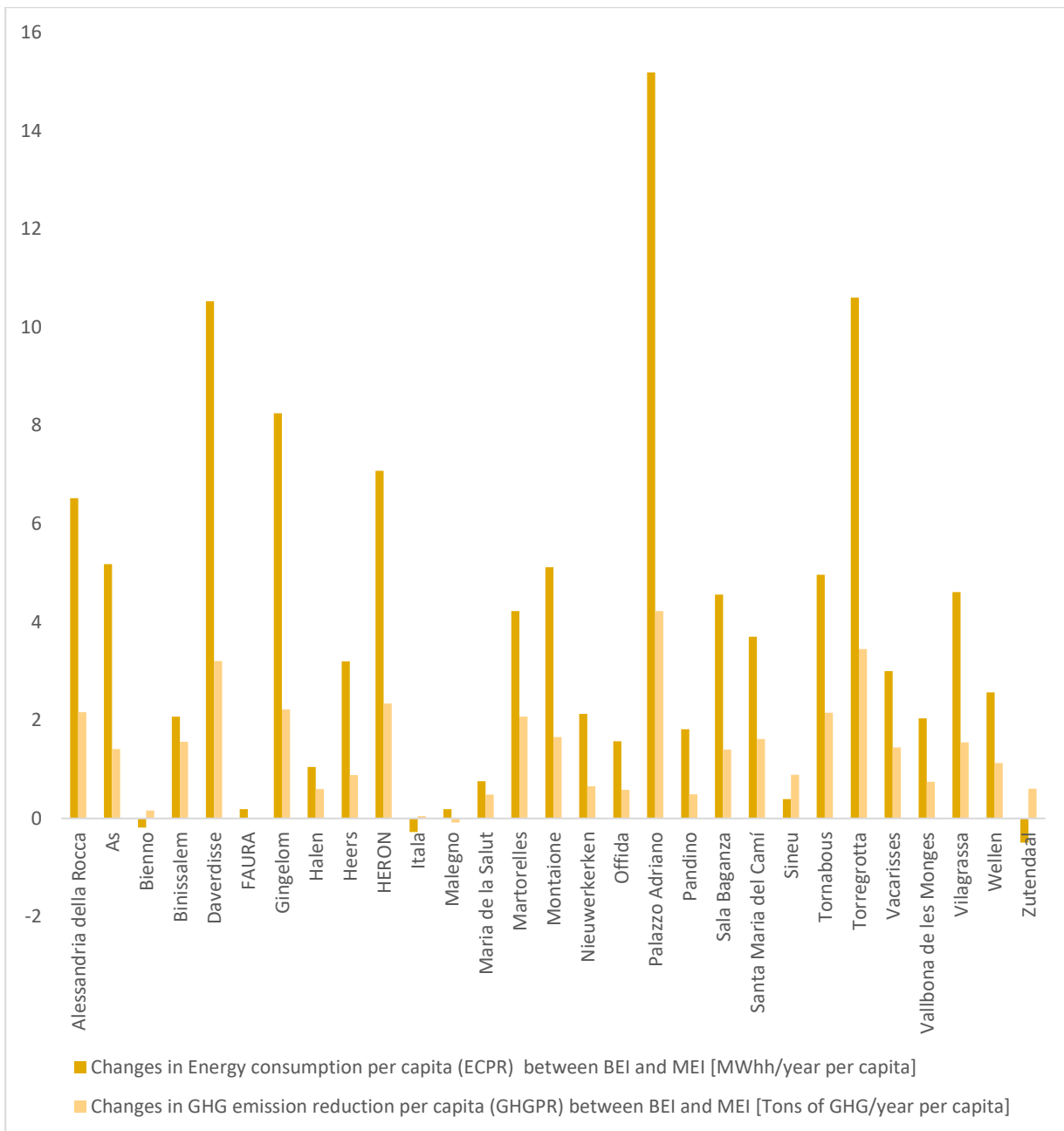


Figure 35 Changes in terms of ECPR and GHGPR (EE3) per capita for the XS CoM Sample municipalities between BEI and MEI

Finally, figure 36 plots the exposure (PM_{2.5} and PM₁₀) per municipality for the years 2009 and 2019, selected as reference years ex ante and ex post. The reduction achieved was on average 28% for PM_{2.5} and 20% for PM₁₀ over the period considered. Despite this overall positive reduction trend, 17 signatories increased the PM_{2.5} for a share of 5% and 30 signatories increased PM₁₀ for a share of 9%. This may be due to population growth over the period considered. These results can be linked to the contribution of mitigation actions planned in the SECAP having impacts also on air quality (i.e. buildings, renewable energy installations, introduction of eco-vehicle). municipalities could further reduce PM_{2.5} and PM₁₀ emissions with specific air quality improvement measures [252].

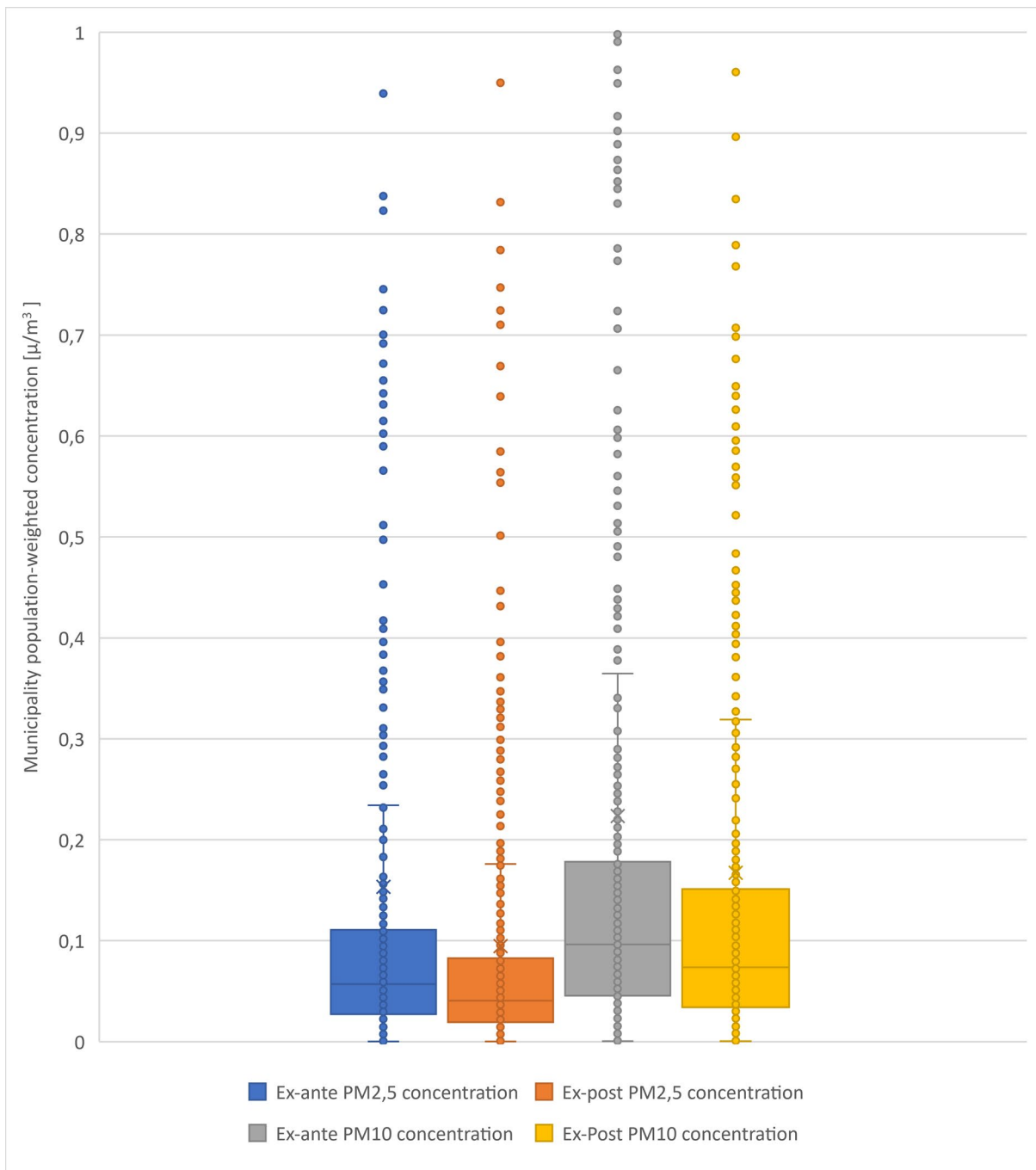


Figure 36 Population-weighted concentration (a measure of exposure), for PM_{2,5} and PM₁₀ particulate matter ex-ante and ex-post CoM adhesion, EE4

Urban and territorial management (UT) Indicator

Results from UT1 indicator recorded 262 SECAPs including 587 mitigation actions and 636 adaptation actions from the complete collection of action plans and monitoring reports from MyCovenant reporting platform. Figure 37 shows the share of Climate Action Plans containing at least one action that can be related to Urban and territorial management and related actions planned by XS municipalities in the EU countries. On average, each SE(C)AP contains two planning actions, within the mitigation and /or the adaptation pillar. The distribution of mitigation actions reflects the

general trend of SE(C)AP submissions per country, with Belgium, Italy and Spain with the highest number of submitted SECAPs. showing relevant ratio when comparing actions with submitted SECAPs.

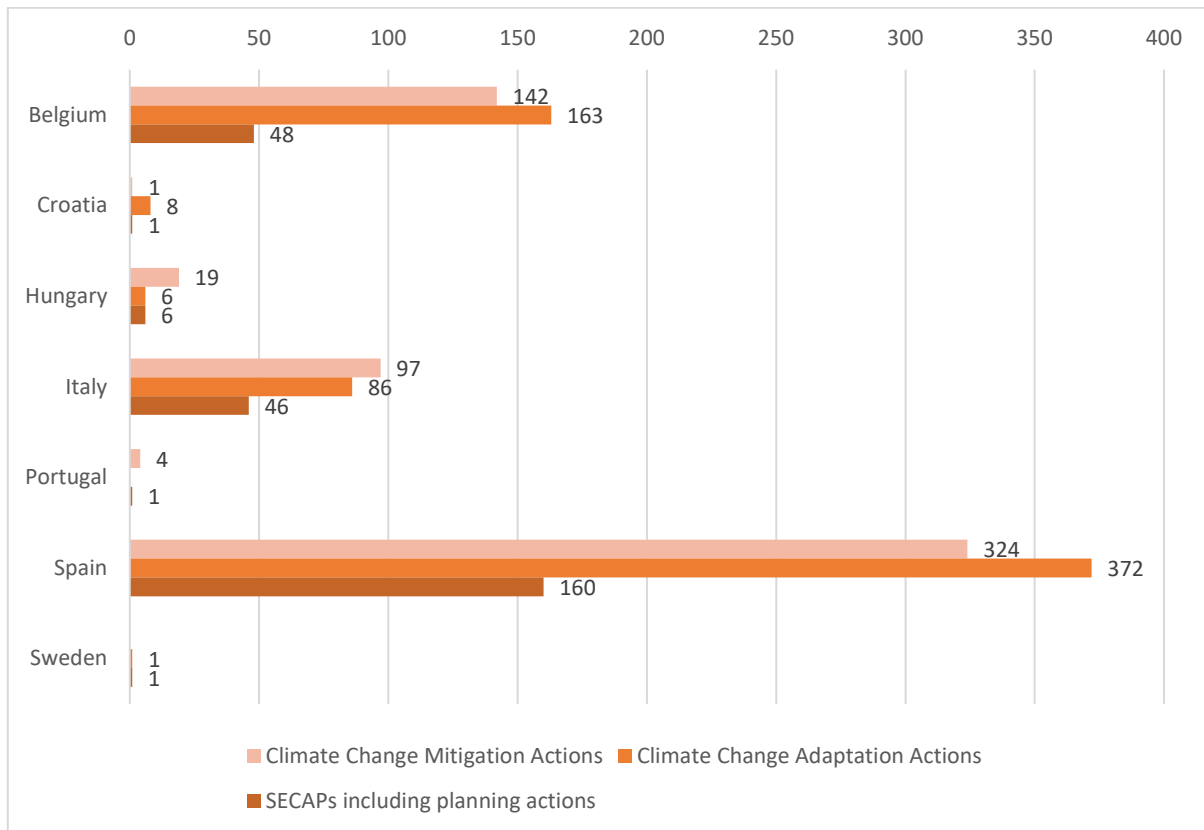


Figure 37 Planning Actions classified per EU Countries of the XS municipalities analysed

The actions were further classified to highlight potential patterns and trends in the areas where urban planning focuses its efforts. Three groups were defined: renewables, transport and planning tools:

1. **Renewables:** actions included in this group are mainly related to the detection of best areas where to plan a local energy generation plant. These actions may be implemented by the signatories in order to reduce the dependence from the non-renewable energy sources and subsequently decrease the community's carbon footprint. By adopting renewable energy systems, signatories provide for the reduction in consumption costs for the community, enhanced energy independence, and a consequent reduction in carbon emissions. Moreover, installation of such systems fosters a sustainable approach to energy production, promoting renewable energy utilization at the local level;
2. **Transport:** actions are basically aimed at reducing CO₂ emissions associated with the mobility sector of the transportation system. In this group, measures implementing structural changes such as actions promoting pedestrian and bicycle mobility, as well as encouraging the use of public transport, were included.
3. **Planning tools:** in this group are included actions referred to the development of planning tools that may complement institutional traditional planning. These can refer to planning, regulation or market-based policies, urban design, specific tools to support and improve the green transition.

The first two groups contain actions on renewables and transport, which are specific sectors of reporting as per the CoM guidelines. Therefore, developing actions in these fields can be considered as a direct outcome of correctly embedding the CoM processes in the Urban planning field. Acting on urban planning tools, required an additional effort from the municipalities, and therefore, the aim of the UT1 index, is to understand how the SE(C)AP supported the development of planning tools oriented towards climate neutrality and sustainability. With a focus on the third group, planning actions retrieved in this first assessment, were labelled according to three macro-groups: Nature Based Solutions (NBS), energy regulations and urban regeneration processes.

Actions referring to Nature-Based Solutions (NBS), include Sustainable Urban Drainage Systems (SUDS), and focus on improving stormwater runoff management, implementing water collection strategies to cope with droughts, and reducing the risk of flooding or excessive runoff in urban areas. In Italy and Spain there was the development of specific plans and measures related to droughts and forest fires, with a particular focus on fire prevention.

Other examples include actions oriented to develop energy annexes with ad hoc energy efficiency measures for existing and new constructions.

Conclusions

This research focused on assessing the potential additional benefits of SE(C)APs in XS municipalities. The CoM has seen the high engagement of small municipalities that despite multiple barriers, show their commitment and contribution to reduce greenhouse gases emissions and increase urban resilience. To explore the additional potential contributes of the SE(C)APs in an indicator-based approach with eight indicators was developed and applied on a sample of XS CoM signatories. Three perspectives have been analysed before and after the adoption of the SECAP by each municipality: 1. Socio-Economic, 2. Energy and Environment and 3. Urban and Territorial Management.

Results from SE1 and SE2 indicators show a negative trend for the population growth rate, with an apparently attitude to evolve toward a compact form of the settlement avoiding land consumption, and remarking at same time, the decreasing trend explicated through the PGR. SE3 indicator highlighted that the built-up has been increasing although the lack of an effective demand for new constructions compared to a population decreases. Therefore, from the three SE indicators it emerges that the SE(C)AP had no effect on depopulation and built-up processes. Even if SE(C)AP had no direct impacts on population growth, it may represent a tool providing effective constraints to the increase of built-up areas. In this perspective, it could provide additional benefits, in promoting recovery measures for uninhabited built-up as social housing recognised as an important dimension of social welfare policy and affordable housing provision [253].

EE1 indicator seems to confirm the effective contribution of SECAPs in avoiding land consumption with 98% of the XS CoM municipalities of the sample recording a variation of land Cover artificial surfaces below the 5%. EE2 indicator shows that no changes were recorded in green land cover in the period 2012-2018 (post SE(C)AP), with the exception of sporadic cases. The comparison between SE3 and EE 1 and EE2 reinforces the assumption that the built-up increase did not have any impact on natural and green areas. Furthermore, analyzing the land cover changes, the majority was related to de-sealing and revegetation processes after the adoption of the SE(C)AP, revealing a potential positive impact of the plans and the CoM adhesion. Thus, specific measures related to land

consumption processes are eligible to be tackled as well as mitigation and adaptations ones in a future SE(C)AP update process.

Moreover, the SE(C)AP could represent a tool in implementing local policies according to the current EU framework on the land take/consumption facing climate change, as provided by the legislation on land use in the EU 2030 climate and energy framework [254].

Results from EE3, EE4 remark the key elements of success of SECAP: the development of actions related to the energy efficiency and GHG emissions reduction. Looking at XS municipalities that provided a monitoring report, a 20% reduction of energy consumption and GHG emissions was recorded, which represent the positive impact of the SE(C)AP actions, meanwhile highlighting the important role of the monitoring report in benchmarking and sharing of successful experiences. Finally, results from EE4 can be linked to the contribution of mitigation actions planned in the SE(C)AP having impacts also on air quality (i.e. buildings, renewable energy installations, introduction of eco-vehicle).

The UT1 indicator highlighted the SE(C)AP role as a playmaker in designing planning actions arisen from the impetus of a green transition but with positive impacts on the territory. However, only 262 plans (54% of the sample) have planned urban planning actions, thereby highlighting that the opportunity to build upon the SE(C)AP to renovate and update urban planning policies and practices is not deemed necessary or determinant for the future shape of the territory by all municipalities.

Overall local authorities have been working within CoM and had been in “contact” with the SE(C)AP for more than 10 years, and with different grades and levels it is taking the shape of a tool capable of bridging technical barriers towards the implementation and design of climate change measures and plans at the local level. The design of specific planning tools, the increased consideration for climate change risks and the implementation of NBS solutions represent a fruitful integration into the institutional planning framework of XS municipalities. Therefore, in this perspective, the SE(C)AP can be considered a “bridge” complementing traditional planning tools in term of flexibility of planning processes and supporting of energy and climate efficiency projects representing an opportunity and not a weakness that needs to be more investigated for the EU small municipalities with ambitious targets towards climate neutrality.

However, in this study the changes and trends highlighted from the assessment have been directly related to the implementation of the SE(C)APs, neglecting potential transformation due to contextual aspects, i.e. national regulations, macro-economic adjustments, social innovations that may have contributed and impacted the territories. Moreover, the results are affected by the limited sample (488 on 4242 XS municipalities), that does not give the chance to fully explore the variety of plans, actions, and assess the benefits.

Nevertheless, this research provides an assessment on the potential co-benefits that can be brought by SE(C)APs in XS municipalities, often showing the higher incidence in need of technical support over all planning process stages. In this context, the SE(C)AP represents an effective tool in providing support and additional benefits: “unlocking” the potential contribution of XS municipalities in facing climate change challenges. Moreover, the CoM demonstrated to be a way to affirm the principles of local strategic planning in a result-oriented perspective.

5 Conclusions

According to the recent IPCC AR6 [255] the remaining carbon budget from 2020 onwards for limiting warming to 1.5 °C with a probability of 50 % has been estimated to be 500 Gt CO₂, this means that at current emission levels it will be depleted in 10 to 15 years. This gives an idea of the urgency and size of the climate challenge and the need to adopt urgently new and effective policies and measures at the global level to achieve more sustainable energy systems, reducing the global energy demand, and meeting the remaining demand with zero carbon energies [256].

The CoM initiative promoting the development of energy and climate plans (the SE(C)APs) by signatory cities, has offered a harmonised methodology based on a partnership and collaborative learning. The benefits of a common action on climate change are clear, and the issue of estimating the real impact of this bottom-up initiative represents a challenge both for scientists and decision makers [223]. The criticism that voluntary bottom-up initiative is unable to mitigate GHG mitigation, is counterbalanced by the CoM planning, monitoring and reporting framework. However, this is valid only if a large majority of participants monitor and report regularly, which for the CoM 2020 was not the case [223].

Whitin climate responsive planning processes, the voluntary planning (VP) approach is an expression of the awareness and commitment gained by the municipalities. It is recognized in this research as a tool capable of directing and governing the transformations of the territory at the appropriate scales. This approach can promote bottom-up processes that allow the local community and local players to express their views and needs for the local sustainable development in line with the SDGs.

The framework of the VP also introduces a new urban planning paradigm: energy efficiency and climate challenges require a new generation of planning tools, and SECAP (suggested by the CoM) is such a candidate for producing relevant changes in the complex system of EU Municipalities, integrating specific urban issues and broader sustainable territorial objectives. In this perspective, the SECAP, intended as a tool to facilitate decision-making processes in energy and climate local actions, is very flexible compared to other institutional planning processes and could fill the gap of traditional urban planning tools concerning the objectives of GHG reduction and climate adaptation/mitigation. SECAPs thus define a planning platform of European cities, making the European cities approach in managing climate adaptation and energy sustainable transition comparable across the EU, as it is based on a common approach, a common planning scheme and common evaluation metrics. Moreover, the methodological proposal discussed in this PhD research steers the SECAP approach towards the systemic view of urban planning. On this track, the key elements are the “territorial targets” and their elicitation allows to “spatialize” the actions we classified as adaptation, mitigation or other. Among the typologies of actions, those defined as nature-based solutions [168–170] represent a valuable benchmark towards building an effective adaptation/mitigation strategy facing the climate-change challenges for the future sustainable cities, within the green transition processes.

The holistic approach pursuit by this PhD research aims to design and compare similar experiences among the municipalities, towards building an effective adaptation/mitigation strategy facing the climate-change challenges for future sustainable cities, included in the low-carbon transition process. As suggested by the CoM, ICLEI, C40 or 100 Resilient Cities, the holistic approach, together with the bottom-up approach, could represent a suitable mix for VP in:

- Better orienting the decisions and initiatives taken on by the Municipalities;

- Better evaluating the experiences done, improving the interventions in accordance with the local needs towards a sustainable development;
- Better defining the contribution to the climate and energy challenge from the “small” to the “major” municipalities.

The CoM Italian experience at the end of the first commitment period in 2020, counted a total of 3901 signatories out of 7903 Italian Municipalities (corresponding to 49% of all the Municipalities). Only 82.5% (3217) of these signatories approved a SEAP and only 15% of them (470) have been strengthened reinforced their commitments to decreasing CO₂ emissions from 20% by 2020 to 40% by 2030 with the development and implementation of local adaptation strategies (SECAP).

The preparation and submission of monitoring reports (MRs) is the critical phase of the CoM process: only 32% of the SEAPs have a related MR. Indeed, a key element for climate action success is to ensure the inclusion of the monitoring process in the planning phase as exposed in previous studies [128,257]. The lack of the requirement of a final monitoring report at year 2020, the low number of intermediate monitoring reports submitted (32.5% of accepted signatories), and the heterogeneity of both baseline and monitoring years, are the critical step for the overall analysis of the monitoring phase of local climate plans. In comparing the sectors selected by the Italian Municipalities in developing SE(C)APs in terms of occurrence, the largest number is related to those sectors supported by a local administration as opposed to private stakeholders. This is highlighted more in the MRs, where sectors such as “Transport” have increased their occurrence fivefold, but in any case, the planned interventions support targeted interventions rather than urban policies. Despite the MR phase, the SEAPs experience has introduced in Italy, for the first time, a renewed approach towards voluntary planning, which is particularly relevant for a Country that is closely linked to a top-down approach for the development of urban planning (although this is not true for climate planning).

In the Basilicata case study, the SEAP decisions, according to the principle of subsidiarity, were taken at the lowest administrative level and closest to the place where each plan produces its effects. Nonetheless, the multi-level governance model included the entire institutional chain: the Basilicata Region, the Provinces and the Municipalities. On the other hand, the full involvement of all the stakeholders (locals, private investors, Small and Medium Enterprises (SMEs), citizen organizations, relevant groups, etc.) of the SEAP process had not come about. Recent studies have also analyzed the “social acceptance” of Renewable Energy developments at an urban level, identifying the trust building process as a way to reduce opposition effects in local communities [190,191]. As a matter of fact, a bottom-up approach including participation in SEAP development was not fully adopted and, in the perspective of the authors this is the major weaknesses to be overcome in the next GCoM season. In addition, the Basilicata Region shows how SEAPs, intended as a complementary tool to in the institutional urban planning framework, and not as an alternative one, effectively support those municipalities with a low number of inhabitants or settled settlements in inland areas to achieve better results in terms of sustainable territorial management based on low-carbon targets: CO₂ emissions reduction and improvement of energy efficiency of buildings and industrial processes.

As happened in the Basilicata Region case study, municipalities developed their SEAPs individually or with the support of a Covenant Territorial Coordinator (CTC), supra-municipal entities like provinces or regions that offer technical or financial support. However, it would be critical for small cities to receive technical support to enable them to report and to improve the support they receive by CTCs. This support needs to complement a correct elaboration of the plan with a tailor-made support in the implementation and monitoring phase of the plan [258].

The CoM registered the highest engagement of small municipalities that despite multiple barriers, show their commitment and contribution to reduce greenhouse gases emissions and increase urban resilience. To explore the additional potential contributes of the SE(C)APs in an indicator-based approach we developed and applied an eight-indicator dashboard on a sample of XS CoM signatories. In this context, three perspectives were analysed before and after the adoption of the SECAP by each municipality: 1. Socio-Economic, 2. Energy and Environment and 3. Urban and Territorial Management. From these three socio-economic indicators it emerged that the SE(C)AP had no effect on depopulation and built-up processes. Even if SE(C)AP had no direct impacts on population growth, it may represent a tool providing effective constraints to the increase of built-up areas. In this perspective, it could provide additional benefits, in promoting recovery measures for uninhabited built-up as social housing recognised as an important dimension of social welfare policy and affordable housing provision [253]. Energy and environment indicators seem to confirm the effective contribution of SECAPs in avoiding land consumption with 98% of the XS CoM municipalities of the sample recording a variation of land Cover artificial surfaces below the 5%. Furthermore, analyzing the land cover changes, most of them were related to de-sealing and revegetation processes after the adoption of the SE(C)AP, revealing a potential positive impact of the CoM adhesion and the resulting plans. Thus, specific measures related to land consumption processes are eligible to be tackled as well as mitigation and adaptations ones in a future SE(C)AP update process. Moreover, the SE(C)AP could represent a tool in implementing local policies according to the current EU framework on the land take/consumption facing climate change, as provided by the legislation on land use in the EU 2030 climate and energy framework [254]. Results from GHG Emission rate to population (GHGPR) and Air quality indicators remark the key elements of success of SECAP: the development of actions related to the energy efficiency and GHG emissions reduction. Looking at XS municipalities that provided a monitoring report, a 20% reduction of energy consumption and GHG emissions was recorded, which represent the positive impact of the SE(C)AP actions, meanwhile highlighting the important role of the monitoring report in benchmarking and sharing of successful experiences. Finally, results from Air quality indicator can be linked to the contribution of mitigation actions planned in the SE(C)AP having impacts also on air quality (i.e. buildings, renewable energy installations, introduction of eco-vehicle). The urban and territorial management indicator highlighted the SE(C)AP role as a playmaker in designing planning actions arisen from the impetus of a green transition but with positive impacts on the territory. However, only 262 plans (54% of the sample) provided for urban planning actions, thereby highlighting that building upon the SE(C)AP to renovate and update urban planning policies and practices is not deemed necessary or determinant for the future shape of the territory by all municipalities.

Overall, local authorities have been working within CoM and had been developing SE(C)APs for more than 10 years. This means that, albeit with different grades and levels, SECAP is taking the shape of a tool capable of bridging technical barriers towards the implementation and design of climate change measures and plans at the local level. The design of specific planning tools, the increased consideration for climate change risks and the implementation of nature-based solutions represents a fruitful integration into the institutional planning framework of XS municipalities. Therefore, in this perspective, the SE(C)AP can be considered as a "bridge" that complements traditional planning tools in term of flexibility of planning processes and support for energy and climate efficiency projects, representing an opportunity that needs to be more investigated for the EU small municipalities working on the ambitious targets towards climate neutrality.

The limitations of this PhD research are related to the changes and trends highlighted by the assessment of the implementation of the SE(C)APs, neglecting potential transformation due to

contextual aspects, i.e. national regulations, macro-economic adjustments, social innovations that may have contributed and impacted the territories. Moreover, the results are affected by a fairly limited sample (488 out of 4242 XS municipalities), that does not give the chance to fully explore the variety of plans, actions, and assess the benefits. The limited size of the sample is due to the choice to focus only on more advanced signatories, i.e. those committed to the 2030 targets, thus requiring further analysis once the dataset will be more complete. Another limitation is linked to the lack of information submitted by signatories, i.e. often only mandatory information is reported, leaving a gap in the detailed description of the action.

Nevertheless, this research provides a useful assessment of the potential co-benefits that can be brought by SE(C)APs in XS municipalities, often showing the highest incidence of need for technical support over all planning process stages. In this context, the SE(C)AP represents an effective tool in providing support and additional benefits and to “unlock” the potential contribution of XS municipalities in facing climate change challenges. Moreover, the CoM demonstrated to be a way to affirm the principles of local strategic planning in a result-oriented perspective.

The key highlight emerged in this PhD research is: while the CoM provides a framework steering small municipalities towards local climate policies, further efforts are needed to make the municipal choices more systematic.

A relevant component, to be reinforced in a further development of this research, is the involvement of citizens [116] and the engagement of stakeholders in the SECAP design process. This is a grey area that requires effective participation methods [117–120] (such as public consultation, working groups, forums, workshops) to improve the plans and make the entire planning process more effective. Currently, a promising perspective of this PhD thesis comes from the application of the methodological framework in a series of case studies. In particular, we are engaged to demonstrate the performance of applying such an approach in small municipalities, adapting the SECAP design process to the specific needs of a place. This aspect becomes more and more relevant when such a context requires a development strategy oriented to overcome, in all relevant planning sectors, the weaknesses of the socio-economical structure and must consider peculiar environmental protection principles, sometimes conflicting with the effectiveness of the plan.

This component will strengthen the forthcoming season of GCoM, focused on the climate neutrality by 2050, climate adaptation and the current challenge of the energy poverty (mandatory as of 2025). It is also complementary to the further EU Cohesion Policy (2021/2027), which supports (with relevant funding opportunities) locally-led development strategies and empowers local authorities in the management of investments.

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