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The role of sustainable energy and climate action plans (SECAPs) in urban energy transition

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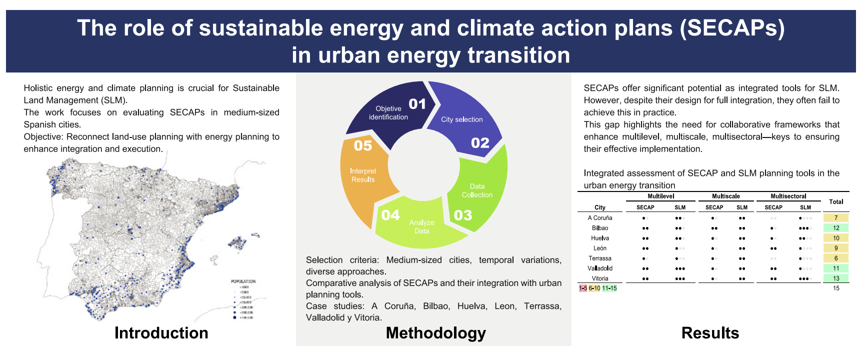
HIGHLIGHTS

- SECAPs foster synergies between energy and land use planning.
- Spatial integration and diverse funding enhance SECAP effectiveness.
- Spain is the EU country with the most SECAPs in medium-sized cities.
- An integrated SLM approach connects multilevel, multiscale and multisectoral dimensions of SECAPs.
- Convergence with SLM tools boost SECAP impact.

GRAPHICAL ABSTRACT



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ABSTRACT

Holistic energy and climate planning are prominent issues for Sustainable Land Management (SLM). This paper critically evaluates existing data of Sustainable Energy and Climate Action Plans (SECAPs), focusing on medium-sized Spanish cities within the framework of the 1ISECAP project under the H2020 program, as Spain stands out as the EU country with the most energy plans implemented in this range of cities. The study assesses the potential for creating synergies through SECAPs, highlighting challenges and potential contributions to local energy governance. SECAPs were selected based on previous studies, targeting cities with exemplary plans due to their specific implementation, integration with other urban and territorial plans, or success as examples of good practices. The goal is to reconnect land use planning with energy planning, fostering synergies that enhance sustainable energy planning and execution while engaging civil society in the energy transition. Results reveal the interplay between SECAPs and other urban planning tools, emphasizing their role in building synergies across spatial, sectoral, and governance dimensions through a comparative approach. Key success factors include spatial integration, diversification of funding sources, and collaborative frameworks. Overall, SECAPs are essential

Abbreviations: 1ISECAP, Institutionalized Integrated Sustainable Energy and Climate Action Plan; BEI, Baseline Emission Inventory; CCC, Climate City Contract; GHG, greenhouse gas emissions; PGOU, General Urban Plan (in its Spanish acronym); PIMUS, Sustainable Urban Mobility Plan (in its Spanish acronym); PPP, public-private partnerships; RVA, Risk and Vulnerability Assessments; SEAP, Sustainable Energy Action Plan; SECAP, Sustainable Energy and Climate Action Plan; SLM, Sustainable Land Management.

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instruments for local energy governance, with their effectiveness closely tied to the degree of synergy achieved between public and private actors, convergence with other urban plans, and active citizen participation. However, in some cases, SECAPs are used to access external funding without achieving the desired level of coordinated management, limiting their impact.

1. Introduction

The challenge of integrating energy planning with urban development has been a persistent issue in efforts to combat climate change (Akpan Umoh et al., 2024; Mi et al., 2019). Since the launch of the Covenant of Mayors in 2008, European local action plans, such as Sustainable Energy Action Plans (SEAPs) and Sustainable Energy and Climate Action Plans (SECAPs), have continuously evolved to align with EU frameworks aimed at reducing greenhouse gas (GHG) emissions (Guo et al., 2020; Melica et al., 2018; Rosenow et al., 2016).

Despite their alignment with European policies, SECAP implementation remains limited, with insufficient integration into other urban plans (Manzanera-Benito and Capellán-Pérez, 2021; Toopshekan et al., 2022). This is largely due to the inertia of traditional sectoral approaches and fragmented governance of urban infrastructure (Lafortune et al., 2019; Reckien et al., 2018; Wittmayer et al., 2020). Although studies highlight the potential of SECAPs to foster sustainable urban development (Fastenrath and Braun, 2018; Geekiyanage et al., 2021; Grubler et al., 2016), their quality and effectiveness depend on the level of detail and the commitment of local authorities to their implementation (De las Rivas-Sanz, 2019).

This complexity is closely linked to Sustainable Land Management (SLM), which requires a multilevel, multiscale, and multisectoral governance approach to effectively address spatial planning and land-use coordination (Cuervo and Délano, 2019; Dabrowski, 2022; Lee and Koski, 2015; Lozano et al., 2018; Rando Burgos, 2022; Zacharopoulou et al., 2021):

- Multilevel interactions coordinate governance across local, regional, national, and supranational levels, ensuring public-private partnerships and citizen involvement to enhance decision-making and resource mobilization.
- Multiscale interactions integrate spatial and temporal dimensions, adapting policies to scale-specific needs and securing tailored financing sources.
- Multisectoral interactions promote collaboration across sectors such as energy, transportation, and urban planning, minimizing ecological footprints and aligning with other planning instruments to develop integrated sustainability strategies.

Table 1 provides a quick overview of the articles cited in this document that address SLM and/or SECAPs over the past five years (since 2020), using the snowballing methodology (Wohlin, 2014). These articles are categorized based on their coverage of the SLM integrated approach, with a dot indicating the dimensions they encompass. The objective of this visual synthesis is to assess whether multilevel, multiscale, and multisectoral coordination is considered, given that SECAPs were originally designed as cross-sectoral instruments integrating multiple levels of governance, implementation scales, and sectors.

The sample of articles included in Table 1 shows diverse approaches in the literature while also identifying persistent gaps in achieving effective integration across these three dimensions, underscoring the need for further research. In reviewing this conceptual framework, significant potential within the SECAP structure was identified, as it inherently incorporates multilevel, multiscale, and multisectoral dimensions. However, while designed to be synergistic, SECAPs frequently fall short in bridging these dimensions effectively.

The 1ISECAP (Institutional and Integrated SECAP) H2020 project aims to enhance the capacity of public authorities to manage sustainable development and engage civil society in the energy transition (1ISECAP, 2024). Through this lens, it explores systemic barriers to effective integration of energy and land use planning, highlighting the importance of collaborative frameworks for achieving sustainable urban development (Ameen and Mourshed, 2019; Baskent, 2021).

Fig. 1 illustrates the distribution of SECAPs (in blue) and similar plans (in yellow) among the member countries of the 1ISECAP project (Denmark, Estonia, Greece, Italy, Netherlands, Slovenia, Spain, Switzerland), as well as the number of municipalities adhering to the Covenant of Mayors (European Commission, 2024).

In terms of SEAP/SECAP implementation, Italy leads with a total of 3770 plans. However, in medium-sized cities, Italy has implemented only 152 plans compared to Spain's 470 within this city size range (1ISECAP, 2024; European Commission, 2024).

The Spanish context, particularly in medium-sized cities (Fig. 2), exemplifies these difficulties in achieving effective SLM integration and provides insights applicable to similarly sized areas across Europe and the Americas that meet this definition (Hendrickson et al., 2016; Rabelo et al., 2017; Ramos-Mejía et al., 2018). This reality is shaped by several key factors:

- The financial crisis of 2008–2012 underscored vulnerabilities in Spain's real estate sector, marked by unprecedented construction rates (INE, 2014). Legislative responses such as the 2013 Law on Urban Regeneration aimed to address these issues, promoting urban renewal over new construction (Government of Spain, 2013). This legislative framework has influenced urban planning approaches, emphasizing regeneration and sustainability over growth, which is often shaped by developments in large cities that collaborate through

Table 1
Visual synthesis of the sample of cited papers from an integrated approach.

Scientific references	SLM integrated approach		
	Multilevel	Multiscale	Multisectoral
(Guo et al., 2020)		•	•
(Lucertini & Musco, 2020)		•	•
(Montoya et al., 2020)			•
(Palermo et al., 2020)	•	•	
(Wittmayer et al., 2020)	•		
(Baskent, 2021)		•	•
(Geekiyanage et al., 2021)		•	
(Kissinger & Stossel, 2021)		•	
(Rivas et al., 2021)			•
(Zacharopoulou et al., 2021)		•	
(Assumma et al., 2022)	•		•
(Dabrowski, 2022)	•	•	•
(Gonçalves et al., 2022)	•		•
(Masuda et al., 2022)	•	•	
(Orejon-Sanchez et al., 2022)	•		•
(Rando Burgos, 2022)	•	•	•
(Richiedei & Pezzagno, 2022)	•	•	
(Rivas et al., 2022)	•	•	
(Cunha & Ferrão, 2023)	•		•
(Sanchez-Rivero et al., 2023)	•	•	
(Zhang et al., 2023)			•
(Akpan Umoh et al., 2024)	•		
(Soares de Moura et al., 2024)			•

1 topic 2 topics 3 topics

networks and have access to far greater public economic and human resources. (European Commission, 2007, 2010).

- Medium-sized cities, typically defined as having populations between 50,000 and <500,000 inhabitants (Broto et al., 2012; Lucertini and Musco, 2020), play a crucial role in the urban network, acting as hubs for regional development and innovation. However, they face distinct challenges and opportunities compared to larger metropolitan areas (Assumma et al., 2022; Servillo et al., 2017). A major issue in this category of cities is the global trend of population decline, which undermines their economic sustainability, limits public service funding, and weakens their capacity to retain talent and resources (Statistical Commission, 2020). In many cases, medium-sized cities tend to "follow" the larger cities, both in terms of development and urban planning priorities, rather than establishing their own independent paths (Manzanera-Benito and Capellán-Pérez, 2021).

Visually, Figs. 1 and 2 underscore Spain's unique position in the EU, with the highest number of SECAPs in medium-sized cities, making it an ideal case study. This dynamic raises a key question: "Under what conditions can medium-sized cities retain their populations and sustain growth?" This article seeks to answer that question by exploring how the SECAP framework, as a synergistic tool, can contribute to promoting SLM networks for municipalities with fewer resources and limited analytical capacity (Sanchez-Rivero et al., 2023).

Therefore, the objective of this work is to present a comprehensive analysis of the practical challenges and successes in implementing SECAPs in medium-sized cities, providing a replicable model for other contexts. Assessing whether SECAPs are genuinely synergistic can serve as an indicator of progress toward decarbonization, a critical component of advancing SLM (Kissinger and Stossel, 2021; Wang et al., 2023).

These findings are especially relevant for urban planners, policymakers, and scholars focused on sustainable urban development and energy governance. Lessons learned from medium-sized cities in Spain can inform strategies in other countries, contributing to a broader understanding of how to effectively integrate energy and urban planning in response to the challenges posed by climate change (Bhattacharya and Painho, 2018; Gonçalves et al., 2022; Ramos-Mejía et al., 2018).

2. Material and methods

The methodology is designed to ensure reproducibility and robustness, enabling independent researchers to replicate the study. It combines qualitative methods with a critical analysis of SECAP documents and supplementary planning instruments, including General Urban Plans (PGOUs, in its Spanish acronym), Sustainable Urban Mobility Plans (PIMUS, in its Spanish acronym), and Urban Agendas (Rivas et al., 2022).

The SECAPs framework (Table 2) follows the structure established by the European Commission and outlines the key components and

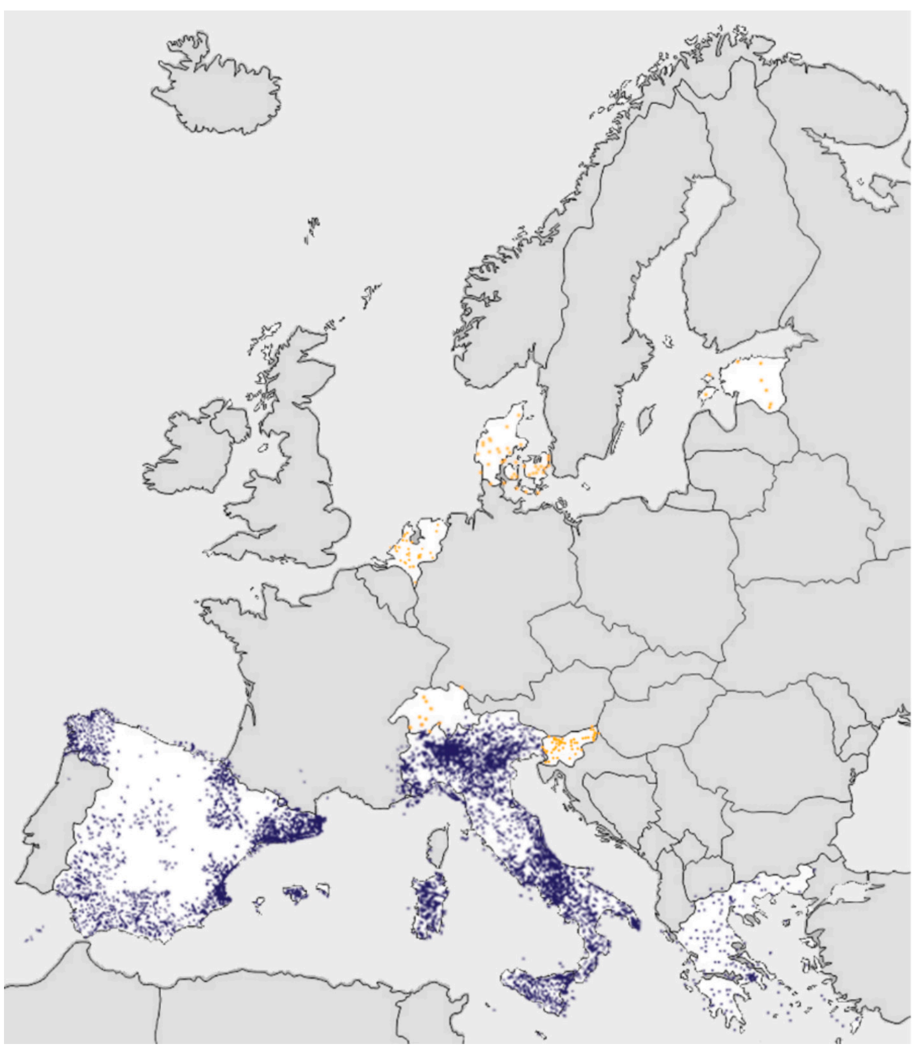

Fig. 1. SECAPs (in blue) and others similar plans (in yellow) among the member countries of the 1ISECAP project (created by the authors).

integration points of SECAP implementation, emphasizing their role in embedding SLM principles (Cunha and Ferrão, 2023; Hassan and Lee, 2015; Melica et al., 2018; Mi et al., 2019).

The SECAP implementation process begins with defining the implementation approach (whether sectoral, multisectoral, or multilevel) involving various administrative bodies. Key steps include setting ambitions, implementing actions, and establishing evaluation and monitoring mechanisms (Soares de Moura et al., 2024; Directive-2018/844-EN-EUR-Lex, 2018). While this flexibility allows municipalities to tailor their assessments to local conditions, it can also lead to variability in the comprehensiveness and accuracy of the plans (Conke and Ferreira, 2015). Nonetheless, the structure ensures that municipalities align their local contexts with standardized guidelines (Rivas et al., 2018).

Fig. 3 summarizes the methodological approach followed to obtain the results (Hély and Antoni, 2019; Orejon-Sanchez et al., 2022):

1. Size, temporal and regional trends in SECAP adoption: examines the geographical and temporal dimensions of SECAPs to identify relevant patterns.
2. Disconnect in SECAP content and implementation: assesses inconsistencies between SECAP objectives and their practical execution within their established framework. This includes evaluating the extent to which each SECAP achieves its intended integration across these dimensions, identifying gaps where the plan's objectives of cohesion and cross-functional collaboration are unmet.
3. Integration of SECAPS with planning tools: enables a systematic classification of SECAPS according to the integrated SLM approach, highlighting cross-sectoral synergies. This involves analyzing the synergies between each SECAP and other urban planning instruments in the respective cities, categorizing these synergies under the relevant multilevel, multiscale, or multisectoral approach.
4. SLM connection analysis: applies the same methodology to other SLM tools, establishing connections and addressing the energy land-use planning disconnect. By comparing the outcomes across cities, we aim to pinpoint areas where integration falls short and to identify specific aspects of synergy—or its absence—that hinder effectiveness.

Table 2
Key components of SECAPs and their integration points (created by the authors).

SLM integrated approach	Component	Description	Integration Points
Multilevel	Methodological Structure	Framework for defining implementation approach, personnel, and budget	Cross-departmental coordination, stakeholder engagement
Multiscale	Baseline Emission Inventory (BEI)	Calculation of GHG emissions by energy consumption and sector breakdown	Alignment with PGOUs, sector-specific policies (e.g., building regulations)
Multisectoral	Risk and Vulnerability Assessment (RVA)	Evaluation of climate risks, vulnerabilities, and adaptation capacity	Coordination with disaster risk management plans, public health strategies
	Action Plans and Implementation	Detailed mitigation and adaptation actions, timelines, and monitoring	Integration with PIMUS, social welfare programs (e.g., energy poverty actions)

The SECAP methodology has not been a major focus in sufficiency reviews. In the current investigation, we aim to identify where synergies exist and where they do not, providing a useful framework for municipalities that lack substantial economic and human public resources. The study builds on previous research analyzing energy transition in Spain, conducted through the Intensss-PA project (Cantero Celada and Fernandez Maroto, 2018). To achieve a comparative perspective on the profiles of SECAPs in Spanish cities, seven case studies have been selected based on specific criteria and justification (A Coruña, Bilbao,

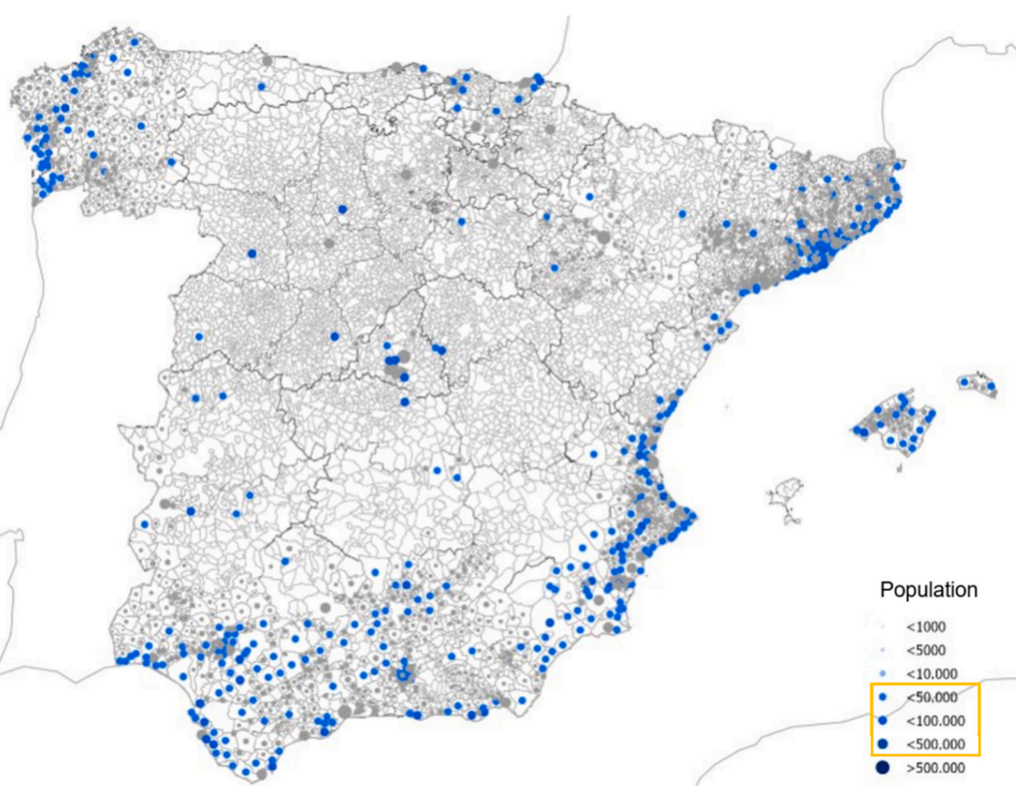

Fig. 2. Medium-size municipalities with SECAPs in Spain (created by the authors based on data from the Covenant of Mayors, 2024).

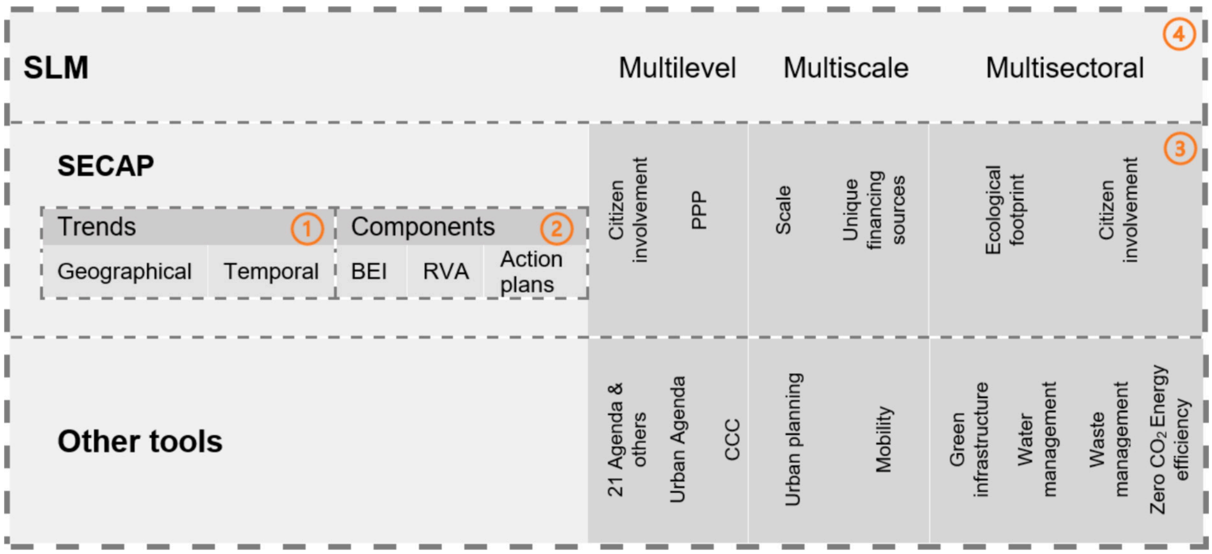

Fig. 3. Methodological framework for SECAPs analysis (created by the authors).

Huelva, León, Terrassa, Valladolid and Vitoria, in alphabetical order).

2.1. Selection criteria for case studies

These cases are selected based on three criteria: they are medium-sized cities, they vary temporally to assess cities that joined at different times, and they have different approaches to SECAPs, including whether they are developed in conjunction with other local instruments (Palermo et al., 2020; Rivas et al., 2021; Sanyasi Naidu, 2018).

- Medium-sized cities: medium-sized cities are defined as those with populations between 50,000 and 500,000 inhabitants (Servillo et al., 2017). Studying medium-sized cities allows for a broader range of cases, capturing the diversity of urban types. This selection includes Bilbao (346,096), the largest among the selected cities, which is in transition and on the threshold of becoming a large metropolitan area, and Leon (121,281), the smallest, representing a more compact urban environment.
- Temporal criterion: cities are selected to represent different time-frames of SECAP adoption to evaluate the changes and improvements over time. The selection ranges from early adopters, such as A Coruña (2013), to more recent implementers, such as Terrassa (2022) or Huelva (2023). This criterion helps understand the impact of EU climate policies and funding mechanisms introduced at different periods.
- Diverse approaches: the selected cities' SECAPs exhibit diverse approaches, including sectoral integration, implementation strategies, coordination with local planning instruments, and the development of Climate City Contracts (CCCs). This diversity provides a comprehensive basis for analyzing how different methodologies influence the effectiveness and coherence of climate action plans. While CCCs have been more prevalent in larger urban centers, Valladolid and Vitoria stand out as intermediate cities that have successfully established CCCs. In these cases, SECAPs have served as a foundation for developing CCCs, reinforcing their alignment with broader climate and sustainability policies.

The data collection process involves a detailed review of the SECAP documents, supplementary planning instruments (e.g., PIMUS, urban regeneration plans), and interviews with key stakeholders involved in the development and implementation of these plans. The information gathered is summarized in the table included in the annex.

2.2. Justification of the case selection

The methodological selection of cities is justified through a combination of scientific literature and practical relevance to ensure a robust and representative analysis. Table 3 and Fig. 4 provide a summary of the selected cities, the rationale for their inclusion, and relevant references.

3. Results and discussions

This section examines the adoption, integration, and effectiveness of SECAPs in Spanish municipalities, focusing on size-related patterns, regional and temporal trends, integration with urban planning tools, and emission inventory analyses.

3.1. Size, temporal and regional trends in SECAP adoption

Focusing on their role in advancing urban energy transitions, our examination reveals that approximately 25 % of Spanish municipalities have adopted SECAPs, with adoption rates varying significantly by municipal size. Table 4 presents the distribution of municipalities by population, showing a clear correlation between municipal size and the number of SECAPs—adoption rates increase as population size rises.

Complementing Table 4, Fig. 5 illustrates the correlation between municipal size and SECAP adoption, highlighting that only six cities (Barcelona, Madrid, Malaga, Sevilla, Valencia, and Zaragoza) exceed 500,000 inhabitants, just 0.1 % of the total. Additionally, the map reveals a notable absence of SECAPs in the central region of Spain, particularly in Extremadura, Castilla y León, and Castilla-La Mancha. This geographic gap suggests a disparity in the adoption of climate and energy planning tools, underscoring the need for stronger multilevel governance and policy incentives to promote SECAP implementation in these areas.

In addition to size-related patterns, Fig. 6 (with its breakdown in the annex, Fig. B) demonstrates the temporal and regional distribution of SECAP adoption, revealing clusters of municipalities that joined the Covenant of Mayors in different phases. This temporal progression reflects a gradual increase in SECAP adoption across specific regions, starting with Catalonia and Andalusia. Interestingly, although the development phase of the SECAP is estimated to be two years, the final approval of the plans has been more uniform, with 834 plans approved

Table 3
Selection of case study cities and justification (created by the authors based on INE, 2024).

City	Population 2023 year	Covenant adoption	SECAP	Approach	Justification
A Coruña	247,376	2010	2013	Sectoral integration	Early adopter with a strong focus on energy efficiency in buildings (Lozano et al., 2018).
Bilbao	346,096	2015	2019	Multisectoral coordination	Mid-term adopter integrating mobility and renewable energy projects (López-Goyburu and García-Montero, 2018).
Huelva	142,532	2011	2023	SECAP with PPP	Early adopter leveraging Public-Private Partnerships (PPPs) for renewable energy projects (Masuda et al., 2022).
Leon	121,281	2016	2022	SECAP with urban regeneration projects	Mid-term adopter focusing on urban regeneration and energy poverty (van Vuuren et al., 2015; Zhang et al., 2023).
Terrassa	225,277	2020	2022	SECAP with PIMUS	Recent adopter integrating sustainable mobility with energy planning (Batty et al., 2012).
Valladolid	297,459	2012	2022	Standalone SECAP	Focus on adaptation strategies with limited integration with other plans (Montoya et al., 2020).
Vitoria	255,886	2018	2021	Multilevel governance	Recent adopter with emphasis on multilevel governance and community engagement (Richiedei and Pezzagno, 2022).

Fig. 4. Location of the case studies (created by the authors).

Table 4
SECAPs distribution by population size (created by the authors based on INE, 2024).

Population	Municipalities (n°)	Distribution in Spain (%)	SECAPs (n°)	SECAPs distribution (%)	SECAPs (%) for municipalities
<1000	4997	61.5	581	28.0	12
<5000	1821	22.3	715	34.4	39
<10,000	553	6.8	304	14.6	55
<50,000	611	7.5	377	18.2	62
<100,000	86	1.1	50	2.4	58
<500,000	57	0.7	43	2.1	75
>500,000	6	0.1	6	0.3	100
Total	8131	100	2076	100	25.5

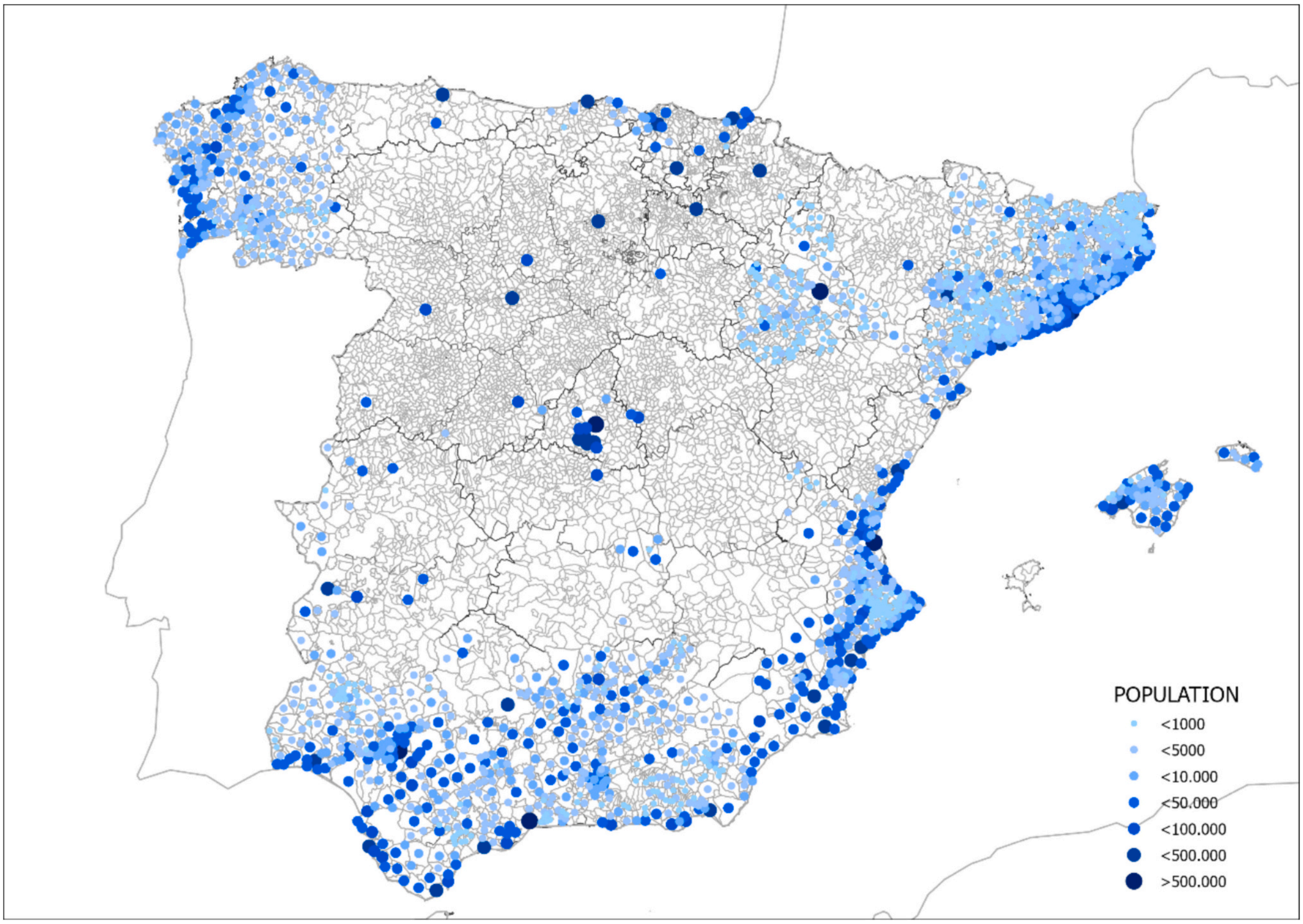

Fig. 5. Distribution, by size, of municipalities with SECAPs in Spain (created by the authors based on data from the Covenant of Mayors, 2024).

between 2009 and 2012, 711 plans in the second period, 2013–2018, and 706 plans between 2019 and 2023.[1]

3.2. Disconnect in SECAP content and implementation

Table 5 summarizes the sources consulted to identify the various synergies found, outlining key components such as strategy, GHG inventory, studied consumption sectors, risk evaluation, mitigation and adaptation actions, and energy poverty actions. This comparison reveals that while all cities have a defined strategy, significant discrepancies exist in areas such as risk evaluation and energy poverty actions. Moreover, some missing elements in certain SECAPs should be mandatory according to the methodology outlined in Table 2.

The variability in the scope and detail of SECAP actions further highlights the complexity of urban energy transitions. Differences in the number and specificity of proposed actions, as well as the integration with broader climate and energy policies, underscore the diverse approaches municipalities take in their efforts to enhance energy sustainability. There is a divergence among the different SECAPs, not only in their format but also in the amount of information provided. Regarding the initial conception, the case of Vitoria stands out. Starting in 2021, Vitoria drafted two parallel plans to merge them into a single document, giving equal importance to both climate and energy.

Concerning the assessment of environmental risks, neither A Coruña nor Valladolid addresses this aspect. In the case of A Coruña, it is an older SEAP, so the climate factor is not developed in the plan. In Valladolid, despite being a recent plan, specific climate risks and vulnerabilities of the municipality are not analyzed. The case of Terrassa is noteworthy, with a section on adaptation capacity that leads to a reorganization of the municipal government, identifying existing plans that impact adaptation and highlighting available municipal resources.

The implementation of a SECAP implies an integrated approach, as its methodology requires a framework defining budget, personnel, implementation strategies, risk assessments, and actions. However, it is surprising to note that some items appear as "No", despite being mandatory in SECAPs. This is a critical finding that has not been highlighted.

Finally, regarding the actions proposed in each case, there are significant differences in the number of actions proposed (ranging from 35 in Terrassa to 1202 in Huelva) and in the description of each action. In some cases, there is only a brief description (Valladolid or Huelva), while in others, there is a detailed description, including timelines, stakeholders involved, identified barriers, and relationships with the Urban Agenda objectives (Vitoria). Therefore, there is evident disparity in the content of the analyzed plans, where despite the framework imposed by the Covenant of Mayors, their scope and development depend on the expertise of each city.

3.3. Integration of SECAPs with planning tools

Complementing trends and component aspects, we investigate the integration of SECAPs with other urban planning tools, such as spatial planning, sustainable mobility, and green infrastructure. Table 6 presents the interaction metrics within each SECAP, while a more detailed version of this table is included in Appendix A.

[1] Data obtained from https://eu-mayors.ec.europa.eu/en/action_plan_list.

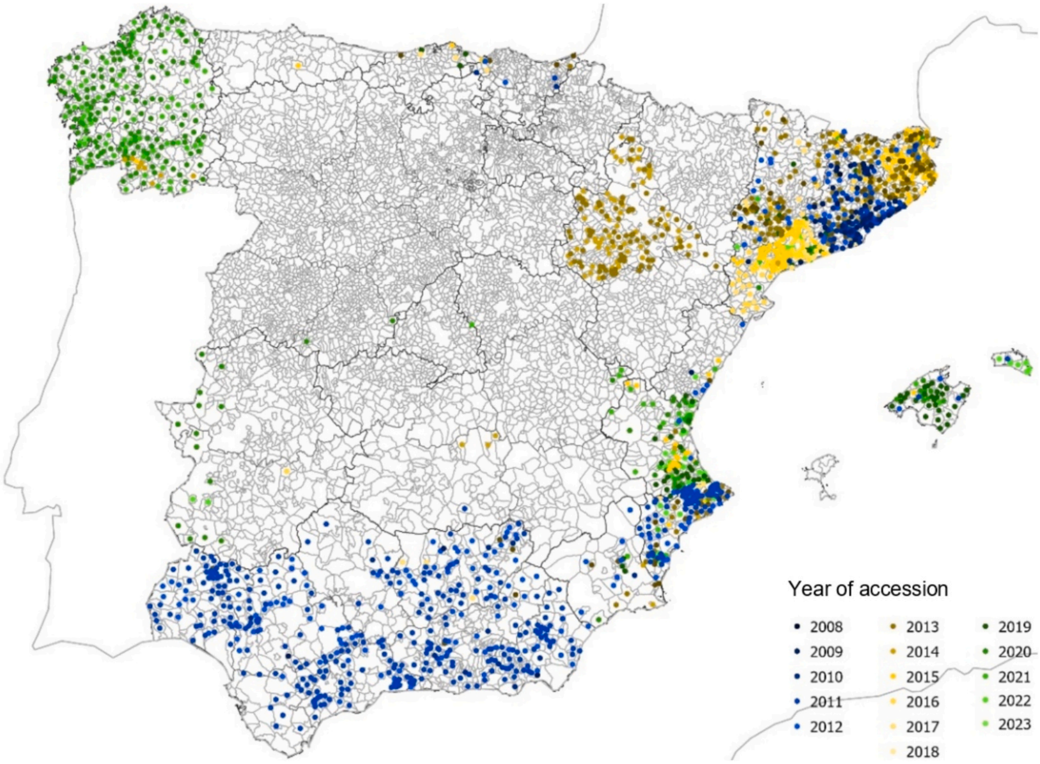

Fig. 6. Distribution by stages of municipalities adhering to the Covenant of Mayors in Spain (created by the authors based on data from the Covenant of Mayors, 2024).

Table 5
Assessment of SECAPs content in the analyzed cities (created by the authors).

City	Strategy	GHG inventory	Studying consumption sectors*	Risk evaluation (ERV)**	Mitigation actions (n°)	Adaptation actions (n°)	Energy poverty actions (n°)
A Coruña	Yes	Yes	1, 2.1, 2.2, 3 and 4	No	Yes (53)	No	No
Bilbao	Yes	No	–	Yes	No	Yes (55)	No
Huelva	Yes	No	–	Not specified	No	Yes (1202)	No
León	Yes	Yes	Not Specified	Yes	Yes (24)	Yes (21)	No
Terrassa	Yes	Yes	1 and 4	Yes	Yes (24)	Yes (9)	No
Valladolid	Yes	Yes	1, 2, 3 and 4	No	Yes (17)	Yes (31)	Yes (2)
Vitoria	Yes	Yes	1, 2.1, 2.2, 3, 4.1 and 4.2	Yes	Yes (40)	Yes (61)	Yes (5)

* Sectors: 1. Municipal equipment and facilities, 2. Buildings and equipment/facilities in the tertiary sector (non-municipal), 2.1 Service sector, 2.2 Industry, 3. Residential buildings, 4. Transportation, 4.1 Public, 4.2 Private.

** No reference to vulnerable groups, despite their recommendation in the JRC guide.

Table 6
SECAP qualitative analysis: interaction metrics (created by the authors).

SECAP	Multilevel		Multiscale		Multisectoral		
City	Citizen Involvement	Public-Private Partnership	Scale	Unique Financing Sources	Ecological Footprint	Relationship with Other Plans	Total
A Coruña	•			•			2
Bilbao	•	•	•	•		•	5
Huelva	•	•	•		•		4
León	•	•		•	•	•	5
Terrassa		•		•			2
Valladolid	•	•		•	•	•	5
Vitoria	•	•		•	•	•	5
1-2 3-4 5-6							6

In the multilevel approach, the analysis focuses on citizen involvement and PPPs, assessing the extent to which these elements contribute to SECAP implementation, ranging from active participation strategies to collaborations with private entities on specific projects.

In the multiscale approach, the interaction metrics examine scale and unique financing sources, evaluating whether interactions occur at local or regional levels. The results highlight that the highest level of cross-departmental coordination occurs in financing sources, which include European projects, grants from the European Commission, and funds from state, regional, municipal, national, and private entities. These funding mechanisms can be combined to adapt to the specific needs of each context.

In the multisectoral approach, the analysis focuses on ecological footprint and the relationship with other plans. This includes examining actions related to emissions monitoring, awareness campaigns, and the execution (or omission) of specific climate actions. This analysis also considers the relationship between SECAPs and other existing plans, identifying whether they exhibit continuity, combination, integration, or accumulation.

The combination of these variables results in the unique character of each SECAP, as each plan adapts to the specific realities and needs of its local environment.

For a SECAP to be considered integrated and synergistic (with a maximum of six points in the metrics), at least one point must correspond to different integration approaches (multilevel, multiscale, and multisectoral). For instance, A Coruña and Terrassa, despite being flagship SECAPs, lack integration with other plans and scales, significantly limiting their effectiveness. This highlights that the multiscale approach is the area most in need of improvement, as the absence of multiscale integration restricts the articulation of SECAPs with broader planning instruments.

In this scenario, the convergence or lack thereof of other plans with the SECAP in each case will be relevant because it provides a qualitative approximation of urban governance conditions in each instance. This also serves as an external indicator of the quality based on the confidence demonstrated in the planning within the analyzed cities. From this, we can characterize each city based on the detected singularities.

Table 7, expanded in Annex Table A.2, organizes the information from Table 5 into different supplementary planning instruments associated with the SECAP framework. The "SECAP" column consolidates the results from Table 6, while the subsequent columns indicate whether the cities possess various types of Sustainable Land Management (SLM) tools, grouped into the final column as the total number of plans. This structure allows for a comparative analysis of how SECAPs align—or fail to align—with other planning instruments within the multilevel, multiscale, and multisectoral frameworks.

The results show a significant disconnect between SECAPs and other urban planning instruments. For instance, cities like Valladolid, which operates under an integrated approach, do not utilize the SECAP as a multisectoral tool, limiting its potential impact. Conversely, cities like A Coruña, which have multiple planning instruments across the three integrated approaches, fail to align their SECAP with these tools, undermining its role as a unifying framework. Bilbao and Vitoria stand out as cities that exhibit the highest degree of integration, yet gaps persist even in these cases.

3.4. SLM connection analysis

To better understand the relationship between SECAPs and other SLM planning tools within the urban energy transition, Table 8 synthesizes the information from Tables 6 and 7, providing a comprehensive assessment of integration across the multilevel, multiscale, and multisectoral dimensions. The total integration score reflects how well a city's SECAP connects with broader planning instruments. Cities like Vitoria, Valladolid and Bilbao exhibit the highest levels of integration, suggesting a strong alignment between SECAP strategies and SLM planning tools. In contrast, other cities, such as Terrassa and A Coruña, show lower integration scores, indicating limited synergy with other urban policies.

The disparity between SECAPs and SLM tools in the multiscale dimension suggests that while SECAPs require improvement in cross-level coordination, SLM tools already incorporate multiscale perspectives. This finding reinforces the importance of better aligning SECAPs with existing urban planning frameworks, leveraging complementary tools to enhance coordination and drive the urban energy transition forward.

Moreover, the multisectoral dimension stands out as the weakest across all cities, emphasizing the need for stronger inter-sectoral integration. To address this, policymakers and urban planners should prioritize the development of cross-sectoral strategies that not only connect SECAPs with broader sustainability plans but also enhance collaboration between different policy areas.

This disconnect highlights a critical gap that administrations must address to unify their ongoing actions. Despite the variety and sophistication of existing planning instruments, the lack of coordination limits the effectiveness of SECAPs as a central tool for integrated urban energy and climate planning.

We propose addressing this gap through the SECAP paradigm. As illustrated in Fig. 7, SECAPs express key data, such as CO_2 emissions, in actionable terms, making them not only a practical tool for monitoring but also a critical indicator for advancing decarbonization. By aligning SECAPs with other planning tools, cities can foster synergies that

Table 7
Supplementary planning instruments analysis (created by the authors).

City	SECAP	Multilevel			Multiscale		Multisectoral				Total
		21 Agenda & others	Urban Agenda	CCC	Urban planning	Mobility	Green infrastructure	Water management	Waste management	Zero CO_2 / Energy efficiency	
A Coruña	2	•	•		•	•	•				5
Bilbao	5	•	•		•	•	•	•	•		7
Huelva	4	•	•		•	•	•	•			6
León	5	•			•	•	•				4
Terrassa	2		•		•	•	•				4
Valladolid	5	•	•	•	•	•	•				6
Vitoria	5	•	•	•	•	•	•	•		•	8
	6										9

SECAP 1-2 3-4 5-6

SLM 1-2-3-4-5-6 7-8-9

Table 8
Integrated assessment of SECAP and SLM planning tools in the urban energy transition (created by the authors).

City	Multilevel		Multiscale		Multisectoral		Total
	SECAP	SLM	SECAP	SLM	SECAP	SLM	
A Coruña	●○	●●○	●○	●●	○○	●○○○	7
Bilbao	●●	●●○	●●	●●	●○	●●●○	12
Huelva	●●	●●○	●○	●●	●○	●●○○	10
León	●●	●○○	●○	●●	●●	●○○○	9
Terrassa	●○	●○○	●○	●●	○○	●○○○	6
Valladolid	●●	●●●	●○	●●	●●	●○○○	11
Vitoria	●●	●●●	●○	●●	●●	●●●○	13
1-5 6-10 11-15							15

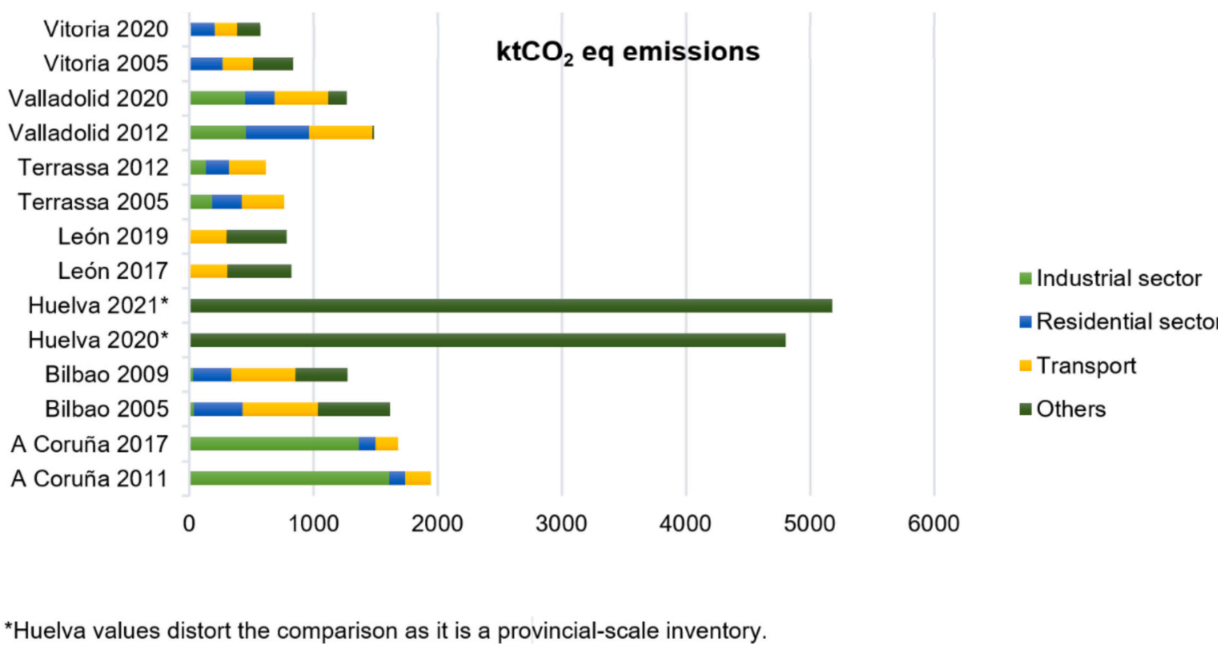

Fig. 7. Emission inventory evolution (created by the authors based on emission inventory data).

enhance the impact of their climate and energy strategies, ultimately promoting a cohesive, sustainable urban development framework.

Fig. 7 illustrates CO_2 equivalent emissions in the seven case studies, tracking their evolution from the base year of reference emissions to the year of SEAP development across three major sectors: industrial, residential, and transportation. Although drawing objective conclusions from these data is challenging due to the lack of standardization in criteria and the disparity of data included in each section, this analysis remains essential for understanding emission trends at the municipal level.

Notably, the reduction in emissions even before the formal development of SEAPs/SECAPs reinforces the idea that climate action is not an isolated effort but rather a continuous process that benefits from the integration of multiple SLM tools. This finding strengthens the core argument of the study, emphasizing SECAPs as key instruments for linking planning tools, tracking emission trends, and refining local climate policies.

However, current emissions data would be valuable for comparison, but changes in methodology now present emissions at the provincial level, making direct comparisons with previous municipal-scale inventories more complex. The high number of emissions in Huelva corresponds to a provincial inventory within an industrial setting and lacks municipal data. The same situation occurs in Bilbao, where recent data are detailed only at the provincial level. Notably, in A Coruña, the extremely high emission rate from the industry sector stands out in comparison to other sectors.

This methodological shift highlights the need for standardized CO_2 monitoring at the local level, reinforcing the role of SECAPs not only as a coordination tool but also as a framework for new carbon emission measurements aligned with urban sustainability strategies. In this context, considering that the primary goal of SECAP is the reduction of CO_2 emissions, only the analysis of emission inventories and the balance of their evolution will allow for the assessment of goal achievement.

Generally, there is a decline in the overall CO_2 emission values, although the trend suggests that the expected 40 % reduction by 2030 might not be achieved. In any case, the fundamental difficulty in quantitatively comparing different indicators among the SECAPs becomes more pronounced. This is due to the lack of consistency in considering the same sectors, and even when it seems possible, the measurements are not grouped the same way (Wolfram, 2016).

4. Conclusions

SECAPs hold considerable potential as integrated instruments to address the challenges of urban energy transitions and climate action. However, while they are designed to function as fully integrated tools, they frequently fall short of achieving this goal in practice. This disconnect underscores the need for collaborative frameworks that facilitate intersectoral and multilevel coordination—essential elements for meeting their objective of effective integration.

The misalignment between SECAPs and existing planning instruments is particularly evident in municipalities like Valladolid and A Coruña, where critical disconnections weaken their effectiveness. Despite these challenges, SECAPs offer a unique capacity for monitoring energy consumption and CO_2 emissions, positioning them as key tools for assessing progress toward decarbonization and climate neutrality. Strengthening this function would enable SECAPs to not only serve as analytical frameworks but also as practical, action-driven tools that guide cities toward sustainable transitions.

However, to fully realize this potential, certain structural weaknesses must be addressed:

- The omission of risk and vulnerability assessments in some municipalities, such as A Coruña and Valladolid, represents a critical gap that undermines the resilience of climate action plans.
- Disparities in the level of detail and planning depth among SECAPs reduce their effectiveness. While Vitoria provides comprehensive action plans linked to Urban Agenda, cities such as Valladolid and Huelva present only minimal descriptions, lacking implementation strategies.
- Smaller municipalities exhibit significantly lower SECAP adoption rates, indicating a need for targeted technical and financial support to ensure these territories can effectively engage in climate planning.

Furthermore, this study underscores that SECAPs can play a central role in energy and climate transition if key actions are taken:

- Aligning SECAPs with existing planning instruments is essential to maximize their impact as integrative frameworks. The multiscale perspective is well addressed in SLM tools but remains a key weakness in SECAPs, reinforcing the need for better alignment and coordination between planning instruments.
- Standardizing criteria for emissions reporting and analysis will facilitate more accurate comparisons and rigorous progress evaluation. While SECAPs provide a structured framework for CO_2 emission monitoring, methodological inconsistencies, such as the shift from municipal to provincial-level inventories, hinder comparability over time.
- The effective implementation of SECAPs requires adequate technical expertise, institutional capacity, and financial resources. The role of SECAPs as a coordinating tool should be reinforced, ensuring they serve as a common reference point for local, regional, and national climate action strategies.
- Creating networks among municipalities to share best practices, as exemplified by the innovative case of Vitoria, can inspire and guide the development of better SECAPs in other territories.

Only through integrated and synergistic planning, supported by robust collaborative frameworks, will it be possible to achieve decarbonization goals and progress toward a SLM. This requires not only technical sound plans but also effective implementation through stronger intersectoral and multilevel connection.

CRediT authorship contribution statement

Alejandra Duarte Montes: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mónica Victoria Sánchez-Rivero:** Writing – review & editing, Visualization, Methodology, Formal analysis, Data curation. **Miguel Fernández-Maroto:** Validation, Supervision, Investigation, Conceptualization. **Juan Luis De las Rivas Sanz:** Validation, Supervision, Resources, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Convergence of planning tools with SECAPs in the analyzed cities

Table A.1
SECAP qualitative analysis: interaction metrics (created by the authors).

SECAP	Multilevel		Multiscale		Multisectoral		Total
City	Citizen Involvement	Public-Private Partnership	Scale	Unique Financing Sources	Ecological Footprint	Relationship with Other Plans	
A Coruña	Action to be Executed	-	Local	European Projects, State Grants, Municipal Funds	-	Convergence / Continuity	2
Bilbao	During Planning	Financing	Regional	EU Grants, State Grants, Municipal Funds	Awareness	Overlap / Combination	5
Huelva	Strategic Objective	Action Development	Regional	Not Defined	Action to be Executed	Convergence / Continuity	4
León	During Planning	Financing	Local	EU Grants, State Grants, Municipal Funds	Monitoring	Overlap / Combination	5
Terrassa	Awareness	Financing	Local	European Projects, Regional Grants, Municipal Funds	-	Convergence / Continuity	2
Valladolid	Action to be Executed	Action Development	Local	Regional Grants, Municipal Funds	Monitoring	Accumulation	5
Vitoria	During Planning	Financing	Local	State Grants, Municipal Funds, Private Funds	Action to be Executed	Symbiosis / Integration	5
1-2 3-4 5-6							6

Table A.2
Supplementary planning instruments analysis (created by the authors).

		Multilevel			Multiscale		Multisectoral				
City	SECAP	21 Agenda & others	Urban Agenda	CCC	Urban planning	Mobility	Green infrastructure	Water management	Waste management	Zero CO_2 / Energy efficiency	Total
A Coruña	SEAP (2013)	Agenda 21 (2002) Coruña Verde y Azul: Coruña futura (2017)	Axenda Urbana A Coruña 2030 (2022)		PGOM (2013)	PMUS 2014-2020 (2013)	Estrategia infraestructura Verde Da Coruña (2019)				5
Bilbao	SEAP (2019)	Agenda 21 2005-2008	Agenda Urbana Bultzatu 2050 (2023)		PGOU (2022)	PMUS 2015-2030	Estrategia de Infraestructura Verde Urbana Bilbao (2018)	Plan Hidrológico Demarcación Hidrográfica del Cantábrico Oriental (2022-2027)	II Plan Integral de Gestión de Residuos Urbanos de Bizkaia 2005-2016 (2005)		7
Huelva	SECAP (2023)	Agenda Local 21 (2014)	Agenda Urbana (2022)		PGOU (1999)	PMUS (2022)	Estrategia Desarrollo Urbano Sostenible Huelva Pulmón Verde Social (2021)	Plan Estratégico Sostenible de Aguas de Huelva 2021			6
León	SECAP (2022)	Agenda 21 (2010)			PGOU (2004)	PMUS (2023) *	León Greenways: Infraestructuras verdes lineales (2018)				4
Terrassa	SECAP (2022)		Agenda Urbana Terrassa 2030 (2022)		PGOU (2003)	PMUS 2016-2021 (2017)	Anella Verda de Terrassa (2015)				4
Valladolid	SECAP (2022)	Local Agenda 21 (2016-2020)	AUVA 2030 (2023)	Valladolid Climate City Contract (2023)	PGOU (2020)	PIMUSSVA (2021)	Urban GreenUp (2017-2022)				6
Vitoria	5 SECAP (2021)	Agenda 21 (2019) PAACC 2030 (2021)	AU2030VG (2022)	Vitoria Gasteiz Climate City Contract (2023)	PGOU (2003) *	PMSEPVG (2022)	Plan Infraestructura Verde Urbana (2013)	Plan Integral de Ahorro de Agua 2004-2008		PATEI 2021-2030 (2021)	8
	6										9

SECAP 1-2 3-4 5-6   SLM 1-2-3 4-5-6 7-8-9   *In project new plan/project

Appendix B. Covenant of Mayors years of accession

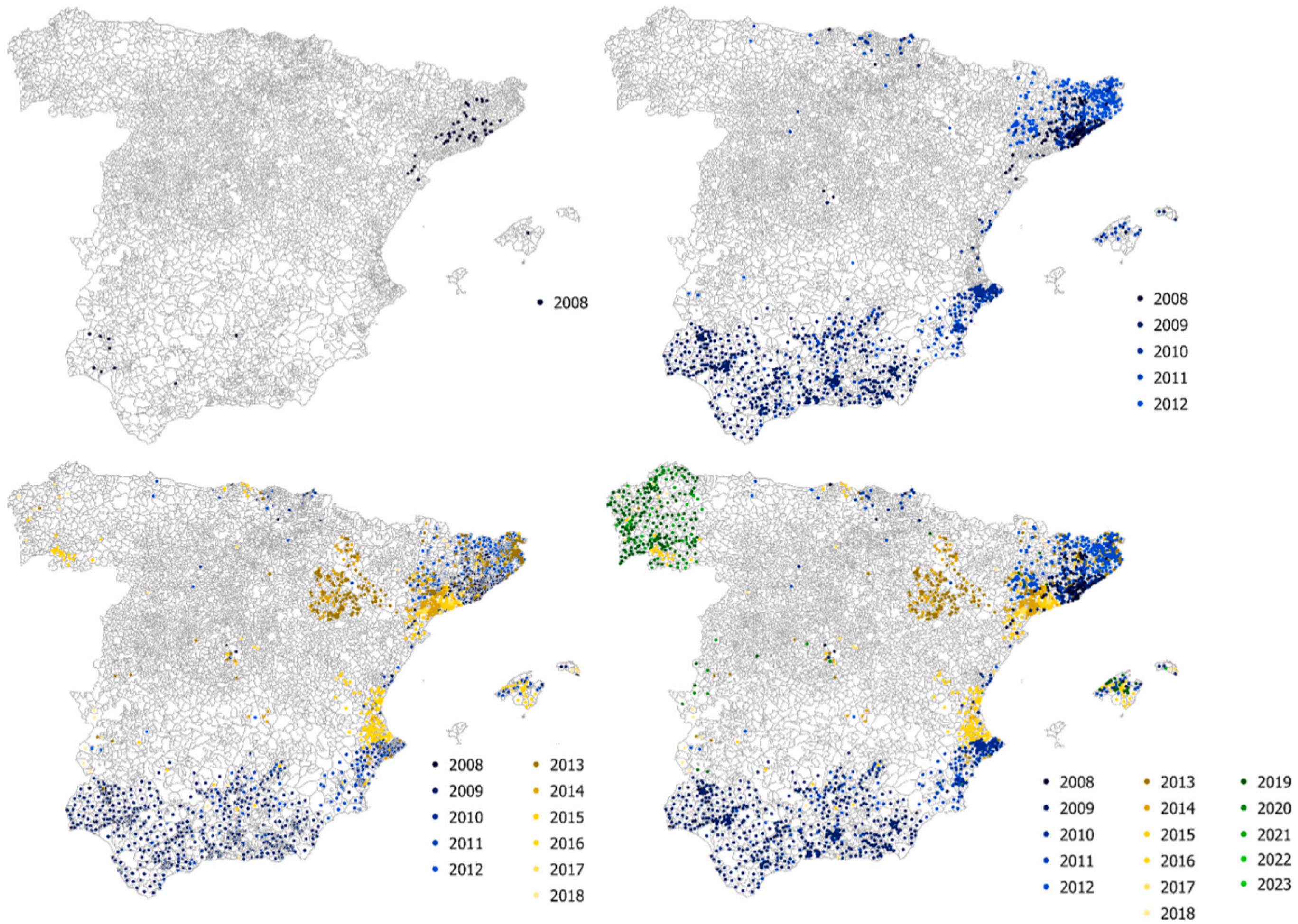

Fig. B. Evolution of the years of accession [created by the authors based on inventory data (European Commission, 2024)].

Data availability

The data used is public

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