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Financing climate change mitigation actions in cities: insights from the Covenant of Mayors initiative

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ABSTRACT

Financial capacity is critical to implementing local climate actions, including renewable energy deployment, energy efficiency improvements, and transport decarbonisation. This study examines how 203 European cities from 21 EU countries and covering 46 million inhabitants have financed their climate change mitigation efforts in the context of the Covenant of Mayors for climate and energy (CoM) initiative. It uses data submitted by participating cities in their Sustainable Energy and Climate Action Plans (SECAPs), and it analyses three key dimensions: (i) total budget allocation, (ii) funding sources, and (iii) financial instruments. The selected SECAPs, include more than 8500 mitigation actions and an estimated total investment exceeding €100 billion.

The results reveal a strong dependence on public funding, primarily on municipal budgets and grants, while innovative instruments such as green bonds, public–private partnerships (PPPs), third-party financing, and pay-for-performance schemes remain underutilised. Statistical analysis shows that population size and energy demand (measured through heating and cooling degree days) are the strongest predictors of planned investment, while GDP per capita is negatively correlated with investment levels. Climate targets' ambition does not significantly influence budget allocation.

These findings underscore persistent barriers to financial diversification, especially among small and medium-sized municipalities. By combining quantitative analyses with qualitative insights, this study provides policy-relevant evidence on local climate finance practices and supports efforts to enhance financial capacity for climate neutrality across the EU.

1. Introduction

Limiting global warming to 1.5 °C above pre-industrial levels requires rapid and deep reductions in greenhouse gas (GHG) emissions across all sectors and levels of governance (IPCC, 2023). Cities are central to this challenge. Urban areas are associated with approximately 70 % of global GHG emissions, mainly due to energy consumption in buildings and transport (Zhang & Khor, 2023), emphasising the urgency of targeted mitigation efforts at the local level.

By 2050, an additional 2.5 billion people are projected to move from rural to urban areas, mostly in Asia, Africa, and Latin America (EIB, 2023). Cities differ widely in their emission profiles, shaped by factors such as population size, income, infrastructure access, climate, and governance autonomy (Creutzig et al., 2019; Dijkstra et al., 2020; Palermo et al., 2020). In Europe, Australia, and the US, per capita emissions are significantly higher than in many developing countries, reflecting more energy-intensive lifestyles and infrastructure (IEA, 2023). This disparity reinforces the critical role of local governments in advancing climate change mitigation and resilience. The New Urban Agenda also highlights urban economy and finance as key pillars of sustainable development (United Nations, 2017).

Finance plays a pivotal role in this transition, as it directly influences the ability of cities and regions to design and implement climate change mitigation measures, such as renewable energy, building retrofits, and sustainable mobility systems. Understanding how cities mobilise and allocate financial resources is therefore critical to bridging the gap between climate ambition and effective implementation (Clapp & Samargandi, 2023).

City governments shape climate outcomes both through direct investment and by enabling action across sectors. Effective climate

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governance depends increasingly on multi-level and multi-actor collaboration, requiring horizontal and vertical coordination (Betsill & Bulkeley, 2017; IPCC 2018, 2018; Kern & Alber, 2009). Urban governance is increasingly polycentric, spanning multiple institutions and spatial scales (Jordan et al., 2015; Palermo et al., 2020). Local climate strategies therefore rely on coordination with regional and national governments, international organisations, the private sector, and civil society (Melica et al., 2018; Negreiros et al., 2021). To facilitate this integration, several transnational initiatives, such as the Global Covenant of Mayors for climate and energy (GCoM), ICLEI, C40, and the EU Mission for 100 Climate-Neutral and Smart Cities, have emerged to align local climate actions with global targets. The GCoM alone includes over 13,000 signatories, representing more than 1.2 billion inhabitants (Global Covenant of Mayors for Climate & Energy, 2023). These initiatives provide cities with tools to develop strategies, implement measures, and mobilise actors, while offering opportunities for peer learning, thus constituting key mechanisms of transnational climate governance (Castán Broto, 2017). Participating cities disclose data such as GHG inventories and action plans (Rivas, Urraca, Palermo et al., 2022), which are essential for assessing mitigation potential and tracking progress (Bertoldi et al., 2018; Palermo et al., 2020).

Previous studies have examined the determinants of urban carbon intensity, linking emissions to energy systems, urban form, and local socio-economic characteristics (Athanassiadis et al., 2017; Busch et al., 2018; Croci et al., 2017; Fujii et al., 2017; Pablo-Romero et al., 2018). These findings point to significant regional differences, reinforcing the need for context-sensitive strategies. This study extends that perspective to the financial dimension, analysing how municipalities within the EU Covenant of Mayors (CoM) initiative has financed their climate change mitigation actions. It investigates the financial sources and mechanisms reported by a selection of cities and municipalities, and how these vary according to geographical, demographic, and socio-economic factors.

The need to finance climate action in urban areas is increasingly recognised, yet actual investment remains far below requirements. Global investments in urban climate finance have more than doubled between 2017 and 2022 and were estimated at USD 831 billion (approx. € 712 billion). Yet investments in mitigation (USD 814 billion in 2021–2022) are far from the total USD 4 328 billion (€ 3711.69 billion) required by 2030 to meet climate targets. In particular, according to the State of Press-Williams et al. (2024), USD 4.3 trillion annually (€ 3.69 trillion approximately) would be required until 2030 for climate mitigation alone.

Beyond Europe, comparable local-level initiatives offer useful insights into how cities mobilise climate finance globally. Evidence from the CDP-ICLEI Track platform indicates regional contrasts in funding composition: in Europe, local and subnational public sources dominate; in Latin America, subnational governments contribute roughly half of all flows; in Asia, public-private partnerships are increasingly relevant; while in Africa, funds are more evenly distributed among public, international, and private actors. Similar patterns are reflected in Mokhles and Acuto (2024), which analysed mitigation actions across nearly 800 local governments worldwide. Together, these findings position the European experience within a broader global framework of urban climate finance.

Globally, over 90 % of climate investments between 2017 and 2020 targeted mitigation, primarily in renewable energy, energy efficiency, and transport (Negreiros et al., 2021; OECD et al., 2018; UNFCCC Standing Committee on Finance, 2018). In Europe, climate investments in key sectors such as energy, buildings, transport, and clean technologies reached approximately €498 billion in 2023, well below the estimated average requirement of €842 billion per year for 2025–2030 to meet the EU's climate and industrial targets, implying a financing gap of around €344 billion annually (Calipel et al., 2025). Although European cities benefit from frameworks such as the Covenant of Mayors, ELENA, and the EIB-backed City Climate Finance Gap Fund (which targets developing and emerging countries, mainly in the Western Balkans and Eastern Partnership), EIB loans, and in some cases the EU Cohesion Fund, many face challenges related to fiscal autonomy, limited technical capacity, and restricted access to financial instruments (Economidou et al., 2023; Lombardi et al., 2016).

Structural challenges persist in aligning sustainable finance policies with the needs of subnational actors. Recent studies have highlighted the fragmented landscape of financial support, disparities in investment readiness, and the limited uptake of green finance tools at the local level (Olumekor & Oke, 2024). Other studies have emphasised the need to innovate urban financial instruments to better match the characteristics of local projects, particularly in the context of smart cities and smaller municipalities that lack access to conventional climate finance tools (Dorostkar & Ziari, 2025). These barriers are especially evident among small and medium-sized municipalities, which often face structural difficulties in accessing and managing funds.

Although the technological potential for urban climate change mitigation is well established as emissions could be reduced by up to 90 % using current solutions (Coalition for Urban Transitions, 2019), the implementation of climate projects remains limited. According to the International Finance Corporation, up to USD 2.5 trillion (approx. €2.1 trillion) per year could be unlocked across sectors such as energy, waste, mobility, and buildings in emerging markets (Negreiros et al., 2021). More recent estimates from the Climate Policy Initiative indicate that total climate finance flows reached a record USD 1.9 trillion (€1.74 trillion) in 2023 and are projected to have surpassed USD 2 trillion (€1.83 trillion) in 2024, with annual investment needs for a 1.5 °C pathway averaging at least USD 6.3 trillion (€5.76 trillion) between 2024 and 2030 (Naran et al., 2025).

Among the most common constraints are the lack of stable and predictable funding, high upfront and transaction costs, and limited capacity to develop bankable projects (Boer, 2015; Gouldson et al., 2015; Negreiros et al., 2021; Boukerche et al., 2021). A recent survey of 362 European cities identified several critical issues: 66 % reported insufficient access to financing schemes, 36 % cited high investment costs, and 32 % pointed to fragmented or inefficient financial processes (Ulpiani et al., 2023). This is further confirmed by a comprehensive risk analysis within the EU Climate-Neutral and Smart Cities Mission, which highlighted financial management as a key vulnerability in climate neutrality strategies (Ulpiani & Vetters, 2023). Cities reported challenges in securing long-term resources, limited capacity to access external funding, and a general lack of stable, dedicated financial instruments at the local level. These issues are compounded by weak collaboration between public and private actors and by misalignment between national and local policy frameworks, and, in the EU, by tight budget rules that further limit cities' investment possibilities.

Additional barriers include limited creditworthiness, low fiscal autonomy, and regulatory fragmentation. The High-Level Expert Group on Sustainable Finance (EU High-Level Expert Group on Sustainable Finance, 2018) has also highlighted a mismatch in technical expertise across Member States, slowing the implementation of sustainable infrastructure projects (Agora Energiewende & Sandbag, 2017). While many cities have been testing new instruments, such as green bonds, energy performance contracts, and blended finance (Pablo-Romero et al., 2018; Economidou et al., 2023) their use remains inconsistent, and tracking efforts are fragmented.

Although a variety of financial tools are available, ranging from own-source revenues and intergovernmental transfers to development funds and concessional loans, limited evidence exists on how these tools are applied in practice at the local level. Most existing studies on urban climate finance remain conceptual or based on small samples. Large-scale empirical assessments based on city-reported data are still rare, despite earlier calls to strengthen the evidence base on the economics of urban climate action (Lombardi et al., 2016; Ulpiani et al., 2023).

Fig. 1 presents a broad categorisation of the barriers that hinder climate investment in cities. These challenges span macroeconomic, regulatory, institutional, and operational dimensions, ranging from

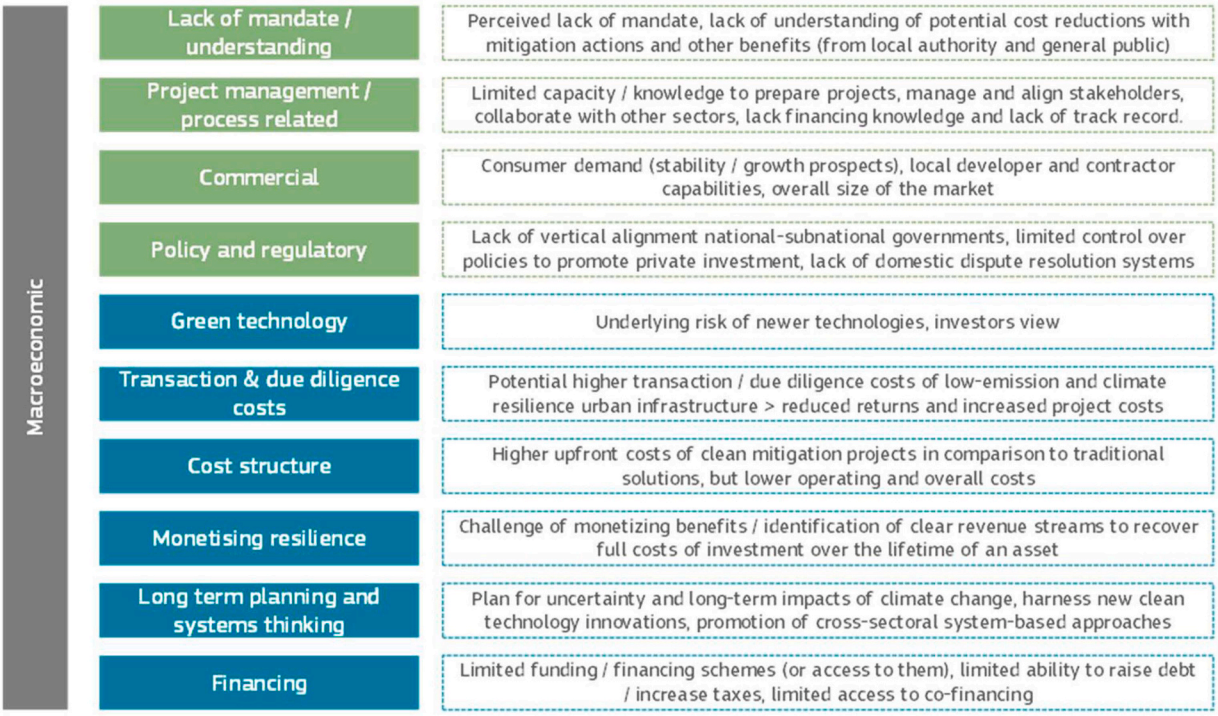


Fig. 1. Main categories of barriers to urban climate investment.
Source: Own elaboration based on: Boer, 2015; Gouldson et al., 2015; Negreiros et al., 2021; Boukerche et al., 2021; Ulpiani et al., 2023.

structural limitations (e.g., lack of mandate, fragmented governance) to financial and commercial issues (e.g., high transaction costs, limited bankability, or low market maturity). The classification builds on recent literature and reporting data from European cities, and aligns with the analytical framework developed in the 2025 edition of the Covenant of Mayors Guidebook on climate finance (Todeschi et al., 2025). As shown in the figure, barriers are not limited to access to finance alone. They also include gaps in technical capacity, long-term planning, regulatory alignment, and the monetisation of resilience benefits. Addressing these barriers requires systemic approaches that combine suitable financial instruments with institutional strengthening and cross-sectoral coordination.

This research contributes to the growing literature on urban climate finance through a large-scale empirical study on how European municipalities report the financing of their climate change mitigation efforts. It analyses Sustainable Energy and Climate Action Plans (SECAPs) with 2030 or longer-term emission reduction targets, submitted under the European CoM initiative. Unlike many previous studies, which are conceptual, case-based, or nationally focused, the analysis focuses on a consistent dataset of 203 cities with over 50,000 inhabitants across 21 EU Member States, covering a wide geographical and socio-economic spectrum across the EU.

This analysis focuses on climate change mitigation, which provides consistent financial data. Relying solely on data submitted via the MyCovenant reporting platform ensures consistency across cities and enables a harmonised assessment of planned budgets, funding sources, and financial mechanisms used by municipalities throughout the EU. The study addresses three main dimensions:

(i) how much funding is allocated to climate change mitigation in each plan, and what does this reveal about the financial ambition of cities;
(ii) what types of funding are used –e.g., municipal budgets, national or EU funds, private investments, or public-private partnerships;
(iii) which financial instruments are employed, ranging from traditional grants and loans to more innovative tools such as green bonds, energy performance contracts, emissions trading, or crowdfunding.

By examining these aspects, the study aims to identify patterns and relationships between financial choices and contextual variables, including population size, income level, urbanisation degree, and geographic location. The findings help uncover current practices, highlight common constraints, and identify trends in the use of financial instruments. In addition to the quantitative analysis, the results section also presents a qualitative overview of complementary financial instruments, such as green bonds, blended finance, and community-based approaches, illustrating practical examples that could serve as best practices for other cities.

By bridging local planning data and financial strategy, this study offers actionable insights for policymakers, city officials, and financial institutions aiming to strengthen local financial capacities. Ultimately, it contributes to enhancing the implementation potential of local climate plans in support of EU-wide climate neutrality goals.

The remainder of this work is structured as follows. Section 2 presents the methodology and dataset. Section 3 describes the results of the SECAP analysis, focusing on budget levels, funding sources, and financial mechanisms. Section 4 discusses common financing patterns and selected examples of complementary instruments. Section 5 concludes with policy implications and recommendations.

2. Methodology

This study focuses on the analysis of SECAPs submitted by EU municipalities under the CoM initiative. The selection was limited to SECAPs from cities with populations over 50,000 inhabitants and mitigation targets established for 2030 or beyond. These plans have been submitted either by individual municipalities or by groups of municipalities, which often include smaller or rural entities, collaborating under a joint SECAP. An overview of the methodological workflow is provided in Fig. 2.

SECAPs are structured around three pillars: mitigation, adaptation,

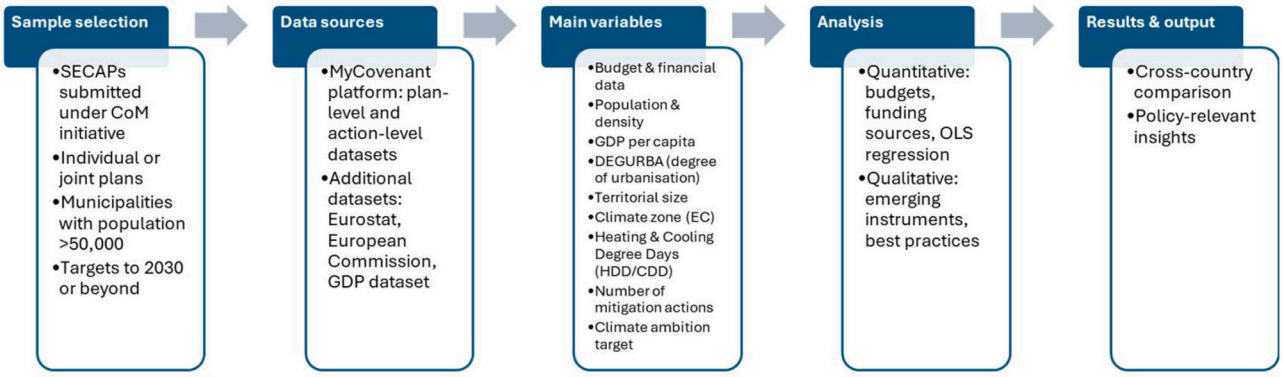


Fig. 2. Overview of the methodological approach.
Source: Own elaboration

and energy poverty. While adaptation was introduced in 2015 and energy poverty in 2020, the mitigation pillar remains the most developed, having been at the core of the initiative since its launch in 2008. Given its maturity, level of detail, and availability of financial data, this study focuses on the mitigation pillar.

The primary dataset used is the MyCovenant platform, which collects official SECAP submissions from CoM signatories. Municipalities are required to enter structured information on their mitigation actions, including, where applicable, estimated budgets, sources of funding, and financing mechanisms. Although CoM signatories may also report through the CDP-ICLEI Track platform, this analysis focuses exclusively on data submitted to MyCovenant to ensure internal consistency.

Within the mitigation pillar, three financial aspects were analysed: (i) the overall budget allocated to climate change mitigation actions; (ii) the sources of financing, including public funding, private investments, and national or European contributions; and (iii) the financial mechanisms employed, such as subsidies, loans, tax incentives, and other tools supporting implementation. All financial results are presented in aggregate form to preserve confidentiality, as individual-level financial data are not publicly accessible.

To explore the factors influencing financial effort, a set of external contextual variables was also considered for analysis. These include population size, territorial extension, degree of urbanisation, geographical region, climatic conditions, GDP per capita (income level), and climate ambition (GHG reduction target). These variables were retrieved from MyCovenant database and complemented with external sources, including Eurostat, Kummu et al. (2018), and guidance documents from the European Commission, for example, the climate zone classification used in the context of Nearly Zero-Energy Buildings (NZEB) standards.

The analysis draws on the 4th GCoM data release, updated to March 2023 (Baldi et al., 2023), and focuses on municipalities in the EU-27 with populations over 50,000 inhabitants and with 2030 or 2050 emission reduction targets. The structure and the validation methodology of the dataset follow the approach detailed by Kona et al. (2021) and Franco et al. (2024), including harmonisation, outlier treatment, and benchmarking against EDGAR data. The GCoM dataset is structured into three main components:

- df1 – Signatory organisations: includes general information on each signatory (e.g. location, population, commitment type, and status). Key identifiers such as *organisation_id* and *gcom_id* allow data integration across the datasets.
- df2 – Action plans: includes mitigation targets, budget data (if reported), and the breakdown of financing sources and mechanisms at plan and action level. It also includes variables related to the approval date, number of group members (for joint plans), and detailed descriptions of mitigation actions.
- df3 – Monitoring reports: contains financial monitoring data, including reported expenditures and spending progress on mitigation.

Each dataset includes both publicly accessible variables, downloadable from the Joint Research Centre (JRC) data catalogue (https://data.jrc.ec.europa.eu/collection/id-00354), and internal fields, available only to authorised users within the JRC. These internal datasets provide additional granularity, particularly on financial values and action-level details, not included in the public releases.

From the original set of 11,768 signatories, a subset of 426 located in the EU with populations above 50,000 and CoM2030[1]/2050[2] commitments were identified. Of these, 205 had submitted a SECAP. After cross-verification between the plan-level dataset (df2) and the action-level dataset (df2C), 203 SECAPs were selected for the final analysis, containing a total of 8572 mitigation actions, with an average of 40 actions per plan, although variability was high across cities. This figure exceeds the annual average of 27–28 actions reported in the general 2023 CoM assessment (Melica et al., 2024), suggesting that the selected sample represents a subset of particularly active signatories and detailed plans. However, the number of reported actions may also be partially influenced by city size.

While the dataset offers substantial insights, some limitations have to be acknowledged. First, not all fields are mandatory: CoM signatories have to identify and provide detailed data for at least three key mitigation actions, but other actions may be reported with minimal detail. Some budget fields and financing mechanisms are included in the optional fields (within non-key actions) and are often incomplete or inconsistently filled. As the data is self-reported, inaccuracies or omissions may occur, especially in the financial fields. To mitigate these issues, a cleaning and validation process was applied to the budget information, including checks on currency consistency for municipalities outside the Eurozone, where local currency values were sometimes incorrectly reported in Euro. In addition, inconsistencies were observed between plan-level and action-level financial totals, which required manual verification before inclusion in the final sample. This process reduced the initial 205 SECAPs to 203, which were retained for the descriptive analysis of budgets, funding sources and instruments. For the statistical analysis only, an additional completeness check and the

[1] CoM 2030 refers to signatories of the Covenant of Mayors for Climate and Energy, with a commitment to adaptation goals combined with a 40% mitigation target by 2030

[2] CoM 2050 refers to signatories of the new Covenant of Mayors for Climate and Energy, with a commitment to adaptation combined with climate neutrality by 2050 and a recommended interim target of 55% emission reduction by 2030

removal of outliers resulted in a final subset of 155 plans. All results are presented in aggregated form to preserve confidentiality. Despite these limitations, the dataset supports a robust and comparative assessment of local climate finance strategies across the EU. Further gaps and limitations are discussed in Section 4.2.

To investigate the relationships between selected contextual variables and the total budget allocated to climate change mitigation actions within SECAPs, a statistical analysis was conducted. The objective was to identify which characteristics of municipalities are most strongly associated with higher levels of planned investment. The dependent variable is the total mitigation budget per plan, as reported in the MyCovenant platform. All monetary values and explanatory variables were log-transformed to allow interpretation of results in terms of elasticities. An Ordinary Least Squares (OLS) regression model was applied across the subset of 155 plans retained for statistical analysis, which was further reduced to 136 complete and consistent cases after additional quality checks and outlier removal.

The explanatory variables considered include:

- Geographical area (Southern, Western, Central/Eastern, Northern Europe), based on the classification by the Publications Office of the European Union (2023);
- Climate ambition, expressed as the percentage reduction target in GHG emissions;
- Population (number of inhabitants);
- Territorial size (km^2);
- Degree of urbanisation (DEGURBA index), based on Eurostat 2021 data (https://ec.europa.eu/eurostat/web/main/data/database), classified as: 1 = cities, 2 = towns and suburbs, 3 = rural areas (NUTS level 3);
- Population density (inhabitants/km^2), derived from population and area;
- Climate zone, based on the EC recommendation for NZEB classification (Mediterranean, Oceanic, Continental, Nordic) (European Commission, 2016);
- Heating Degree Days (HDDs) and Cooling Degree Days (CDDs), Eurostat 2024 (NUTS3 level);
- GDP per capita, derived from the gridded dataset by Kummu et al. (2018) at 10 km resolution and aggregated at municipal (LAU) level;
- Number of mitigation actions per plan, retrieved from the GCoM action-level dataset (df2C).

All spatial variables (e.g. GDP per capita, DEGURBA index, population density, and climate zone) were harmonised at the administrative level corresponding to each SECAP. For individual plans, data were aggregated at the Local Administrative Unit (LAU) level of the municipality; for joint SECAPs, values were averaged or summed across the constituent LAUs, depending on the variable (e.g. mean for density and GDP, sum for population and area). While this approach ensures comparability across diverse plan geometries, it may introduce minor uncertainties due to differences in data resolution and the alignment between statistical and administrative boundaries.

The model allowed us to assess the extent to which these factors explain variation in planned investment across municipalities.

In addition to assessing the drivers of budget variation, this study examined the types of funding sources and financial instruments reported by municipalities in their SECAPs. The aim was to characterise the financial landscape underpinning mitigation actions and to explore how local governments mobilise resources to support their climate strategies. The analysis relied on structured fields from the MyCovenant database.

At the plan level, up to four funding sources could be declared per SECAP, recorded in the variables *financing_source_0* to *financing_source_3*. These fields (which are private data, internal to the Joint Research Centre) indicate the nature of the financial input, distinguishing between categories such as:

- Local authority's own resources (e.g., municipal budgets);
- National or regional public funds;
- European Union funds and programmes;
- Private sector contributions, public-private partnerships, or other sources.

Each entry could be optionally linked to a corresponding budget share (*share_overall_budget_0–3*), quantifying the proportion of the total plan budget covered by that source.

At the action level, 2050 mitigation actions (out of 8572) included at least one declared funding source using the same classification system, enabling comparison between aggregated and disaggregated financial reporting.

For financial mechanisms, the dataset provides the variable *mitigation_action_instrument*, where municipalities indicate the type of policy or financing tool used for each mitigation action. Common entries include:

- Grants and subsidies;
- Public procurement;
- Third-party financing (e.g., Energy Service Companies, ESCOs);
- Carbon or energy taxes;
- Obligation schemes (e.g., national energy saving obligations on energy suppliers under articles 8 of the Energy Efficiency Directive, (Fawcett et al., 2019);
- Other mechanisms, not further specified.

While this classification is self-reported and varies in granularity, it enables a structured and comparative analysis of implementation approaches across local contexts. The presence or absence of specific instruments also provides insights into local capacities and preferences for financing mitigation strategies.

The results of this analysis are presented in Section 3, with data disaggregated by plan and action level. To complement this dataset-based analysis, a qualitative review of emerging financial instruments was also conducted, drawing primarily on the EU CoM SECAP guidebook on financing (Todeschi et al., 2025), complemented by academic literature and selected case studies from European municipalities. Instruments were chosen based on their level of innovation, their potential to overcome key investment barriers (e.g. limited upfront capital, low creditworthiness, administrative fragmentation), and evidence of effectiveness and replicability. The objective was to highlight innovative instruments that could help cities overcome common barriers to investment, such as limited upfront capital, low creditworthiness, or administrative fragmentation, as discussed in section 1.2. Examples include national or sub-national green bond programmes, blended finance arrangements, community-driven investment models, and public-private funding tools. The outcomes of this qualitative review are summarised in Section 3.4, which provides examples of innovative and alternative instruments and their implementation conditions.

3. Results

This section presents the main findings from the analysis of SECAPs. As mentioned, a total of 203 SECAPs were retained for the descriptive analysis of mitigation actions, budgets, and financing strategies, while a subset of 155 plans, filtered for data completeness and outlier removal, was used for the statistical analysis. The results are structured around three main components: an overview of the sample, an analysis of budgets and drivers of investment, and an assessment of financing sources and instruments.

3.1. Sample selection and contextual variables

Key figures from the dataset reveal a significant engagement in mitigation action: the 203 SECAPs include 8572 mitigation actions and a

total estimated investment exceeding €100 billion. These plans span 21 of the 27 EU Member States and collectively represent over 46 million inhabitants. The sample includes diverse city sizes, with most municipalities falling in the 50,000–250,000 population range. Additionally, 9 % of municipalities have over 500,000 residents, and the largest city in the sample exceeds 3 million. The GDP per capita among analysed cities shows a median of €22,000, with an interquartile range (IQR) from €17,500 to €29,600, confirming regional disparities across the EU. For this study, municipalities are categorised by population size as follows: small-sized (50,000–100,000 inhabitants), medium-sized (100,000–250,000), and large (>250,000). This classification reflects the distribution of the sample, where the majority of municipalities fall within the small- and medium-sized range. Fig. 3 illustrates the distribution of the analysed cities according to three contextual variables: population class, GDP per capita class, and climatic zone.

Fig. 4 presents the spatial distribution of the analysed SECAPs, classified by population size and GDP per capita (based on 2015 data from Kummu et al., 2018).

Fig. 5 shows the classification of municipalities by land area and degree of urbanisation (DEGURBA). While most cities are classified as DEGURBA level 1 (cities, 75 %), a considerable number are identified as level 2 or 3 (towns/suburbs or rural areas), due to joint SECAPs, where multiple municipalities, including small and rural ones, report under a shared action plan. The land area of participating authorities varies widely, with a median of 150 km^2 (IQR: 70–425 km^2).

A preliminary spatial analysis reveals marked geographic disparities in income levels. Cities in Western and Northern Europe generally report higher GDP per capita (averaging over €22,000), while those in Central and Eastern Europe tend to fall below €15,000. Among cities with more than 500,000 inhabitants (9.3 % of the sample), most are located in higher-income areas (three out of six in the "High" GDP class, above €30,000), though one is found in a low-income context. Despite these differences, action plans are submitted across all income groups, indicating that climate planning is not exclusive to wealthier municipalities. These trends reinforce the importance of tailoring financing strategies not only to city size but also to socio-economic conditions, an aspect explored further in Section 3.2.

3.2. Quantitative analysis of investment levels and drivers

This section presents a quantitative overview of the budget allocated to climate change mitigation actions in SECAPs, followed by a statistical analysis exploring the main factors that influence the level of planned investment across European cities. Building on the descriptive figures presented above, the quantitative budget analysis was conducted on a subset of 155 plans, retained after the exclusion of statistical outliers using the 1.5 IQR (interquartile range) rule. According to the rule, observations below the first quartile (q1) minus 1.5 times the IQR[3] or above the third quartile (q3) plus the 1.5 times the IQR have been considered outliers.

Budget figures were retrieved from two datasets: the plan-level database (df2) and the action-level database (df2C). For the df2 dataset, when the percentage of total budget allocated to the mitigation pillar was missing, a median value of 90.6 % (calculated from the available sample) was applied. Incomplete or inconsistent entries were excluded. Based on the cleaned sample, the total mitigation budget amounts to €24.3 billion, the median per-plan investment is €51 million, and the IQR is €157 million. Restricting the sample to Eurozone countries (to mitigate potential currency conversion errors) yields a total budget of €17.7 billion and a median of €43.5 million.

In parallel, the action-level dataset (df2C) contains investment cost estimates for 2065 out of 8572 mitigation actions. Aggregating these costs by plan produces consistent financial values for 167 action plans. The total mitigation budget across this sample is €97.3 billion, with a median per-plan investment of €38.2 million and an IQR of €279.7 million. When excluding outliers and focusing on Eurozone countries, the sample narrows to 118 plans with a total investment of €12.2 billion and a median of €26.6 million. The sharp decrease is due to the fact that the outlier exclusion criterion, based on budget distribution, removed several large-scale plans with exceptionally high investments. While this approach substantially reduces the total budget, it was applied to limit skewness and enable more robust statistical comparisons across most plans.

Despite structural differences between the two datasets, the resulting figures are broadly consistent. Most cities report investment budgets in the €10–100 million and €100–500 million ranges. Only a small share exceeds €500 million. Across both datasets, the median budget per plan converges around €50 million, though values vary considerably by city size, climate exposure, and socio-economic context.

Fig. 6 presents the average total budget per capita (€ per inhabitant) at the national level based on the df2 dataset ($n = 155$, excluding outliers). Notable differences emerge across countries. Italy, Portugal, Romania, and Slovenia display the highest average investments per capita, often exceeding €900. In contrast, Sweden, Germany, the Netherlands, and Ireland report considerably lower values, typically below €350 per capita. These divergences may reflect different administrative capacities, reporting accuracy, or cost structures in implementing climate actions. Additionally, countries with more established infrastructure may require smaller marginal investments, partially explaining lower values in high-income contexts.

To complement the descriptive analysis, we performed a statistical regression to identify the key drivers of budget variation across cities. An OLS model was applied using the total mitigation budget per plan (log-transformed) as the dependent variable, and a set of demographics, economic, and climatic variables as predictors. The results show that several variables are statistically significant predictors of budget variation (Fig. 7 and Table 1). These findings suggest that local financial effort is shaped not only by economic capacity, but also by demographic and climatic conditions. HDDs and CDDs are both positively and significantly associated with higher budgets ($p < 0.05$) in the regression model using total budgets per plan. This reflects an association observed when controlling for other factors, but it is not always apparent in the per-capita values shown in *Fig. 7*, where national averages may mask city-level variation. In contrast, wealthier cities may require less capital-intensive investments or already benefit from past interventions.

- Population size is the strongest positive predictor ($p < 0.01$), which is partly expected given that the dependent variable is the total budget per plan. The model was designed to assess factors associated with the overall scale of planned investments rather than per-capita effort, with differences in investment intensity per inhabitant captured in the descriptive analysis (Fig. 6a).
- Municipal surface area (km^2) shows a weak negative correlation with budget levels (not significant), possibly reflecting more dispersed or rural areas with lower density and different financing strategies (Fig. 6b).
- HDDs and CDDs are both positively and significantly associated with higher budgets ($p < 0.05$), even when controlling for GDP per capita, suggesting that greater heating or cooling energy demand is a strong driver of local investment needs (Fig. 6c and d).
- Climate ambition, measured as the percentage reduction target in GHG emissions, does not significantly affect the total budget in this model (Fig. 6e). Two clusters of data can be perceived, probably those corresponding to SECAPs linked to 2030 commitments, and those linked to 2050 commitments.
- GDP per capita is negatively associated with total budget ($p < 0.01$), indicating that high-income cities may plan less capital-intensive actions, or have already invested in past decades (Fig. 6f).

[3] IQR = q3-q1.

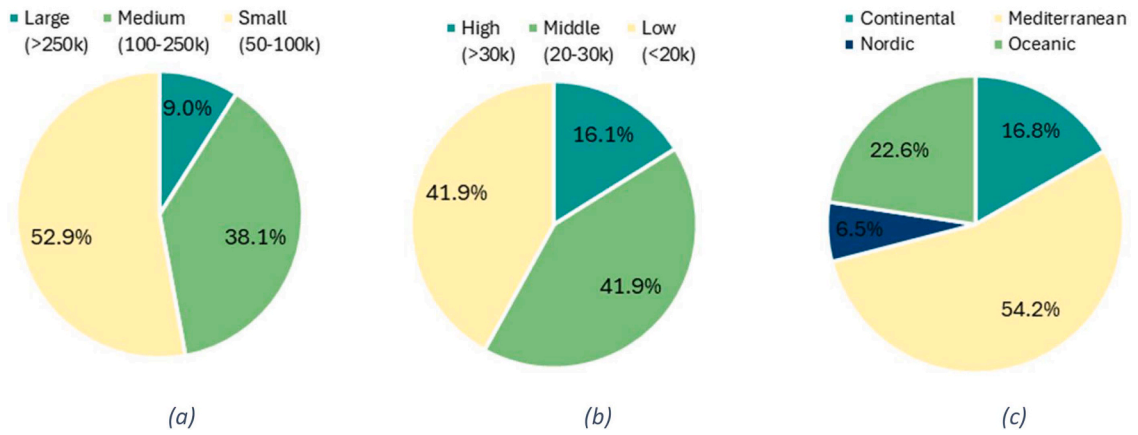


Fig. 3. Composition of the analysed SECAP by population class (a), GDP per capita class (b), and climatic zone (c).
Source: Own elaboration

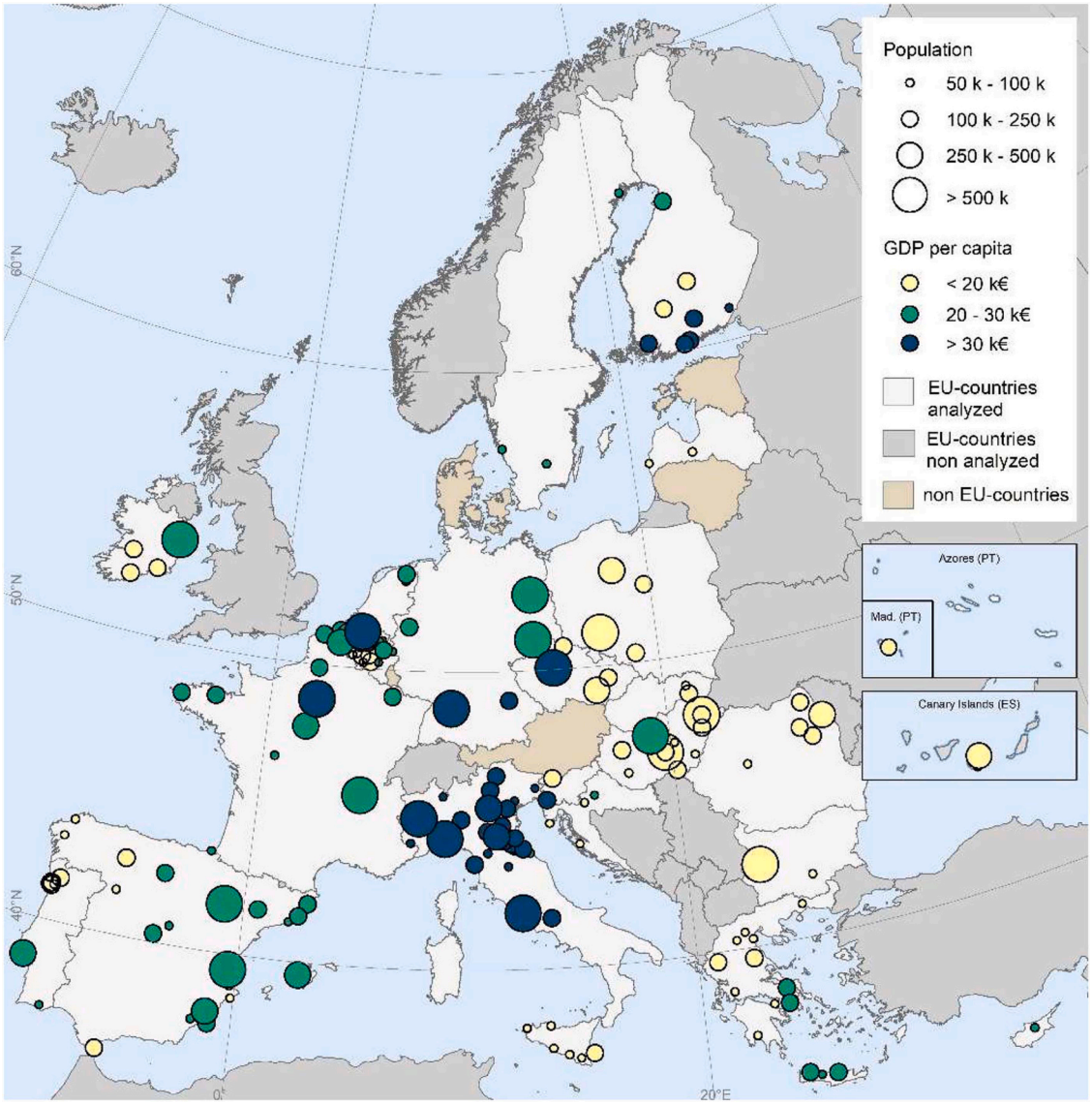


Fig. 4. Spatial distribution of analysed action plans by population size (four classes) and GDP per capita (three classes).
Source: Own elaboration

The R-squared value leaves room for further econometric investigation. The residual variation leading to a low R-squared (0.224)

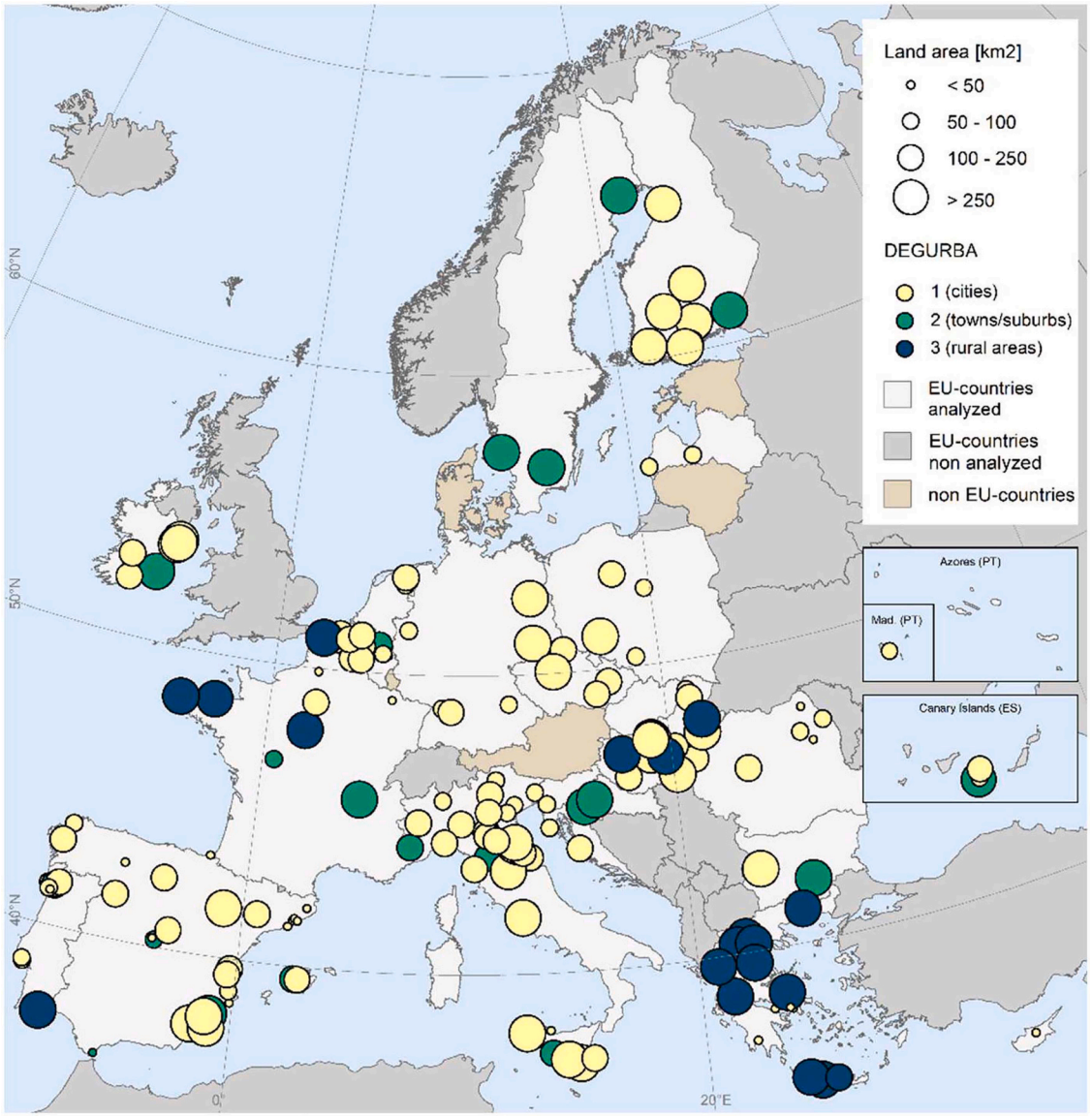


Fig. 5. Spatial distribution of analysed action plans by land area (four classes) and degree of urbanisation (DEGURBA index).
Source: Own elaboration

is mainly due to the limited variability inherent in cross-sectional data, combined with the high individual (cities) heterogeneity, where several idiosyncratic factors affecting the budget remain unobservable (Hair et al., 2019). Following data cleaning procedures, observations with missing values in key variables, specifically size and CDDs, were excluded from the analysis. As a result, the final dataset used comprised 136 complete observations.

3.3. *Quantitative analysis of funding sources and financial mechanisms*

Diversifying financing sources allows local authorities to enhance the stability, flexibility, and resilience of their climate strategies. Based on information reported at both the plan and action levels, this section explores how cities participating in the CoM allocate funding responsibilities across different actors and institutional levels.

According to the CoM dataset, the main categories of financing sources include:

- Local authority's own resources: this includes funding directly allocated from municipal budgets, typically used for actions already integrated into local investment plans or for co-financing externally supported projects.
- External – Public: encompasses financial contributions from national, regional, or EU programmes (e.g., structural/cohesion funds, recovery and resilience funds, and national climate funds), often tied to specific eligibility or reporting requirements.
- External – Private (only in df2): captures investments from private sector actors, either as direct financing (e.g., corporate investment) or through partnerships, including energy service companies (ESCOs) and project developers.
- Public-private partnerships (only in df2C): specific contractual arrangements in which public and private entities share responsibilities and risks in financing and implementing climate change mitigation actions.
- Not allocated/Other: this includes plans or actions where funding sources are either missing, undefined, or labelled under generic categories like "other", limiting comparability across plans.

At the plan level, 201 out of 203 SECAPs provide information on at least one funding source. Fig. 8 shows the most frequent combinations of

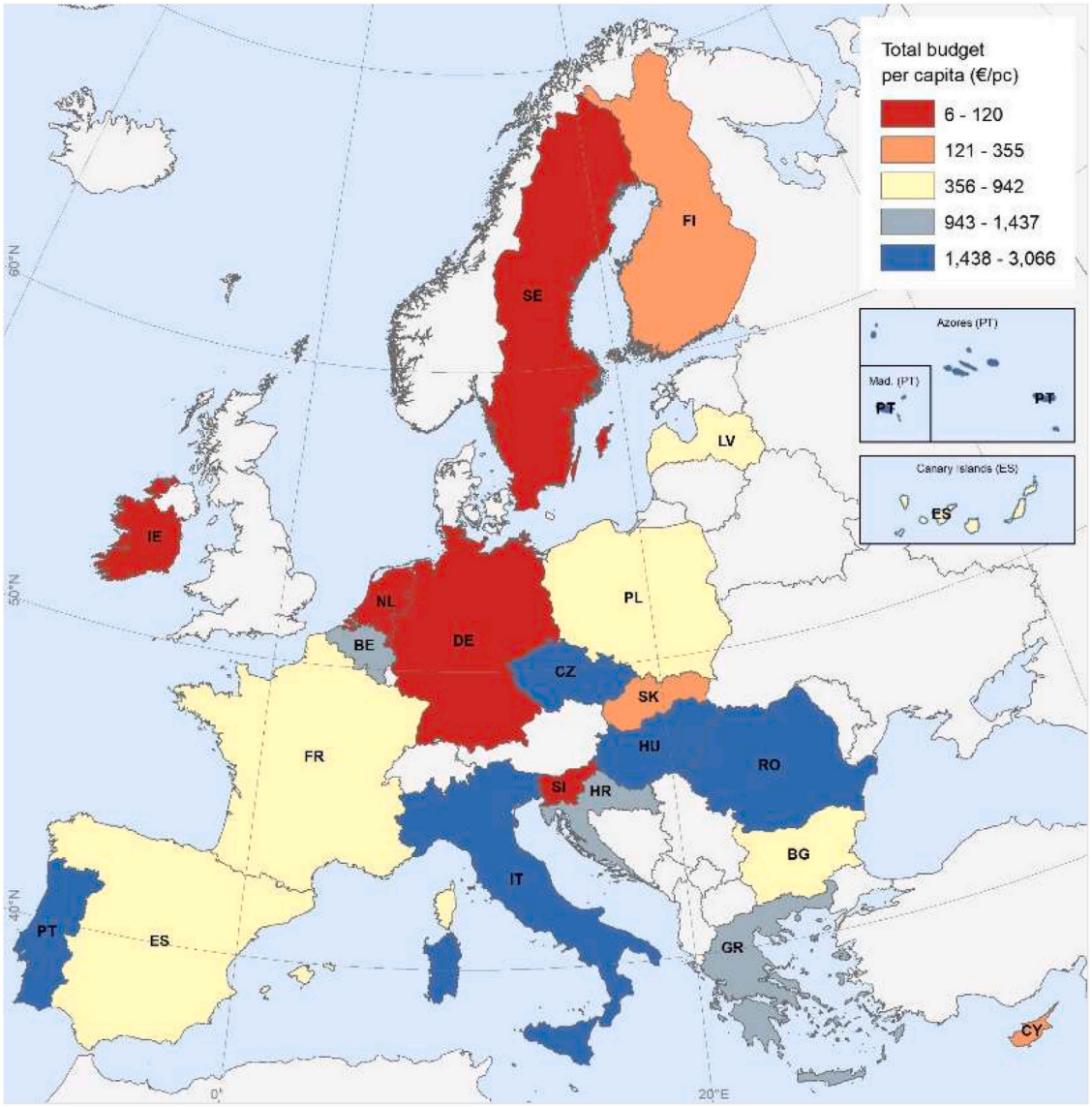


Fig. 6. Total budget per capita (€/pc) for the mitigation pillar at EU-country level.
Source: Own elaboration using df2 (n = 155 plans, no outliers)

sources across plans. The majority of SECAPs rely on local authority resources, either alone or in combination with external public support. However, in 28 % of cases, a significant share of the total budget remains unallocated, reflecting uncertainties in project development or limited technical capacity.

At the action level, out of 8572 reported mitigation actions, 2050 include at least one identified funding source (approximately 24 %). The classification includes additional detail: local authority's own resources (typically covering municipal infrastructure investments and financed through local taxation or transfers from the national budget); regional, national, or EU funds and programmes; public-private partnerships (co-financed initiatives involving both public and private stakeholders); and other (residual or undefined sources).

Fig. 9 illustrates the most common funding configurations among actions. While local budgets and public funds, often linked to municipal infrastructure projects, remain the most cited sources, around 8 % of actions rely (partially or entirely) on public-private partnerships, indicating a more limited interest in collaborative financing models. However, a small share of these actions (around 5 %) still reports ambiguous or undefined sources, limiting transparency and replicability.

Although reporting accuracy varies significantly (especially at the action level) these figures still offer valuable insights into how municipalities conceptualise and report their financing strategies. As discussed in the EU CoM SECAP guidebook (Davide et al., 2025; Todeschi et al., 2025), reliable information on funding sources is essential for enabling cities to align projects with appropriate instruments and attract co-financing. However, many cities still lack systematic financial planning or dedicated technical capacity, which may explain the frequent reliance on generic or incomplete entries.

In addition to financing sources, CoM signatories also indicate which financial instruments are used to support the implementation of mitigation actions. These instruments differ in terms of funding structure, institutional arrangements, and allocation mechanisms, and provide insight into how cities operationalise their climate investments. The classification is based on the variable *mitigation_action_instrument* from the MyCovenant dataset. Among the 8572 mitigation actions analysed, approximately 1700 actions include information on the type of financial instrument used. The most frequently reported categories include:

- Grants and subsidies: direct public support used to reduce capital costs for cities or households. This is the most common instrument, appearing in 46.2 % of cases with valid entries.

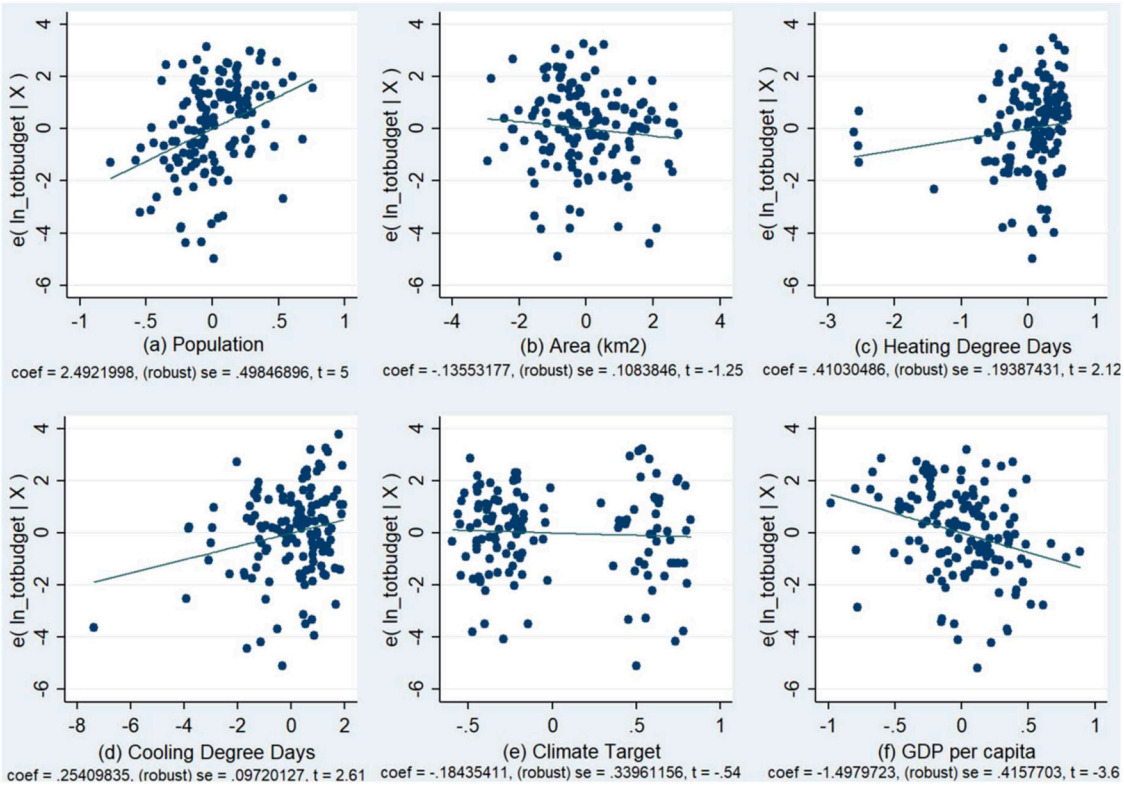


Fig. 7. OLS residual plots for predictors of total mitigation budget (log-transformed).
Source: Own elaboration

Table 1
Results of OLS regression on total mitigation budget per plan - Dependent variable: log(Total Budget).

Dependent variable:	Total Budget
Population (log)	2.492***
	(0.498)
Size (km^2) (log)	−0.136
	(0.108)
Heating Degree Days (log)	0.410**
	(0.194)
Cooling Degree Days (log)	0.254**
	(0.0972)
Target ambitious (dichotomous var)	−0.184
	(0.340)
GDP (log)	−1.498***
	(0.416)
Constant	18.11***
	(5.119)
Observations	136
R-squared	0.224
VIF test (mean)	3.22

Note: Robust standard errors in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

- Public procurement: refers to the contracting of goods or services by local authorities (e.g., energy-efficient buildings, retrofits, and mobility systems), reported in 37.2 % of cases.
- Third-party financing: involves external actors, such as ESCOs or developers that finance and implement actions recovering costs over time. This approach is used in 11.7 % of reported cases.
- Energy suppliers' obligations: regulatory schemes requiring utilities or energy providers to deliver savings or invest in efficiency. These exist in a limited number of EU Member States.
- Energy carbon taxes: although rarely reported (0.4 %), this category includes instruments based on fiscal disincentives linked to carbon intensity.

Fig. 10 presents the relative frequency of each instrument, confirming the strong reliance on public support mechanisms (grants and procurement), with more innovative instruments playing a minor role.

Fig. 11 explores how instruments are distributed by sector. Procurement dominates in municipal and transport projects, while grants are prevalent in residential and tertiary sectors. Third-party financing is mostly used for energy production and buildings, aligning with the nature of ESCO-type models.

Fig. 12 shows the sectoral breakdown within each instrument type. Grants and procurement span all sectors, while more innovative instruments (e.g., carbon taxes, supplier obligations) are sparse and sector specific.

While grants and procurement dominate, other instruments such as crowdfunding, green bonds, and energy performance contracts are rarely mentioned, despite their potential to overcome common barriers such as limited upfront capital or fragmented responsibilities (Bertoldi & Boza-Kiss, 2017). This limited uptake highlights that more innovative instruments remain marginal in reported SECAPs.

These results underscore the dominance of traditional instruments, primarily publicly funded, in local mitigation efforts. While they reflect institutional familiarity and funding availability, they also suggest untapped potential for scaling more market-based and performance-driven mechanisms. The limited presence of carbon taxes, third-party models, or supplier obligations or public–private partnerships (PPPs) for infrastructure projects points to systemic challenges in design, capacity, and regulatory frameworks, which need to be addressed if local governments are to unlock diversified climate finance pathways.

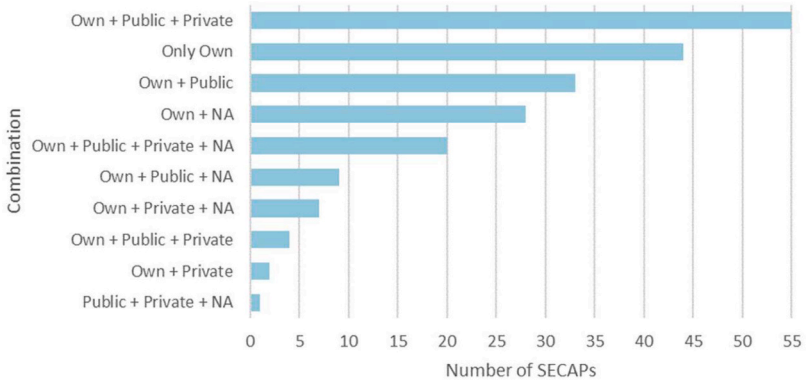


Fig. 8. Main combinations of financing sources at plan level (n = 201 SECAPs).
Categories: Local authority's own resources (Own), External – Public (Public), External – Private (Private), Not allocated (NA).
Source: Own elaboration.

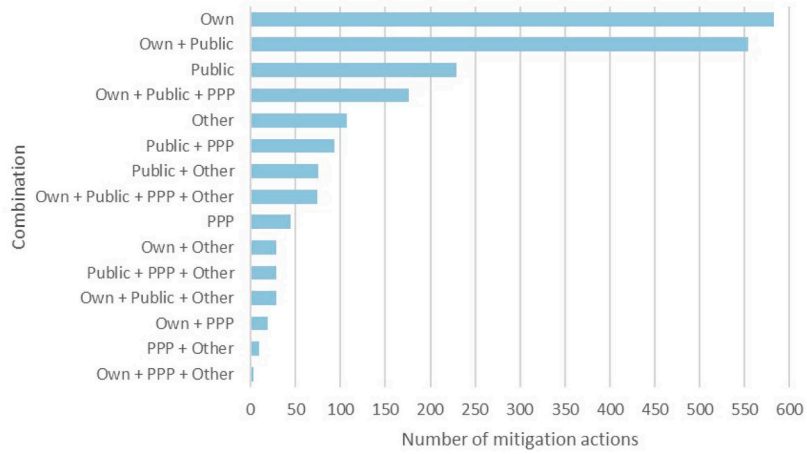


Fig. 9. Main combinations of financing sources at action level (n = 2050 actions).
Categories: Local authority's own resources (Own), External – Public (Public), Public-private partnerships (PPP), Other.
Source: Own elaboration.

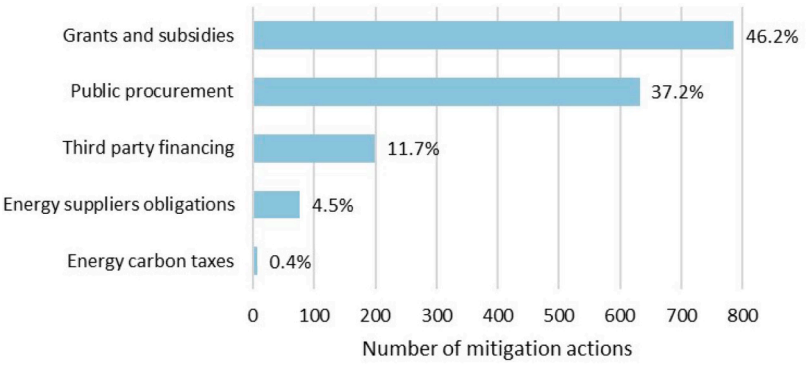


Fig. 10. Share of actions by type of financial instrument.
Source: Own elaboration

3.4. Qualitative analysis of complementary instruments

In addition to the quantitative findings on budget levels, funding sources and instruments, a qualitative review was conducted to identify complementary (innovative and alternative) financial instruments that could address common barriers to investment. Instruments were selected for their relevance, replicability, and alignment with the main financing challenges identified in the EU CoM SECAP guidebook on financing (Todeschi et al., 2025). Table 2 illustrates some promising tools, implementation conditions, and examples from European cities, based on insights from the literature.

These instruments vary in maturity and complexity, but they share the potential to scale climate investment at local level, especially when paired with technical assistance and enabling frameworks.

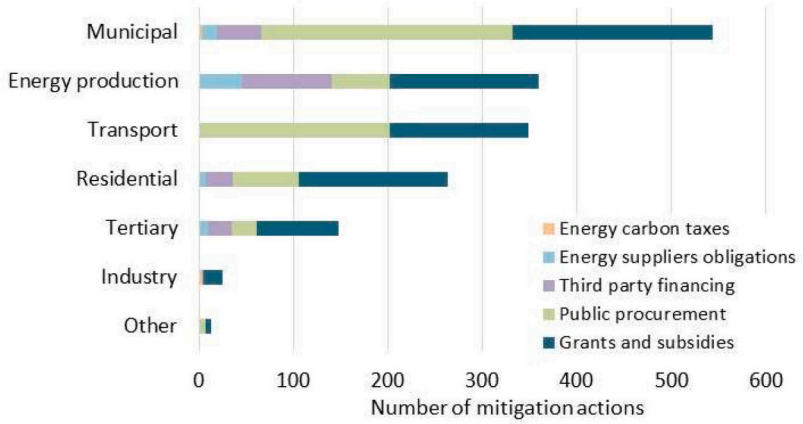


Fig. 11. Financial instruments by sector of intervention.
Source: Own elaboration

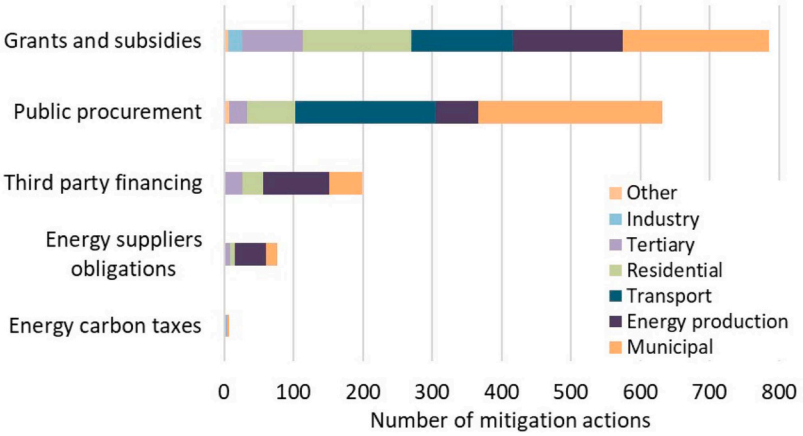


Fig. 12. Sectoral allocation per financial instrument.
Source: Own elaboration

Table 2
Complementary financial instruments for local climate change mitigation action (based on literature review).

Instrument	Description	Example	Key Actors	Instrument-Specific Barriers
Public-Private Partnerships (PPPs)	Long-term partnerships between public authorities and private actors to finance, build, and operate complex infrastructure, including renewable energy systems	Braedstrup district (Denmark) heating PPP with solar thermal, seasonal storage, and heat pumps*	Local governments, district heating utilities, technology providers, citizens	Complex coordination across actors, long procurement processes, risk allocation issues
PPPs and Citizen Financing	Hybrid mechanisms combining long-term public-private contracts with citizen-driven financing (e.g., crowdfunding) to fund renewable energy and infrastructure projects	Copenhagen PPPs and citizen investment schemes for climate neutrality (Ulpiani et al., 2023)	Local governments, private investors, citizens	Legal complexity, ensuring transparency, maintaining citizen trust and engagement
Energy Performance Contracts (EPCs)	Contracts where an ESCO finances and implements energy efficiency measures, repaid via guaranteed savings; bundling can help smaller municipalities	EPC for public lighting in 79 municipalities, Province of Huelva, Spain Stelmakh and Novikova (2017)	Provincial authorities, ESCOs, municipalities	Need for reliable systems to measure and verify energy savings, performance risk, limited capacity in public administrations
Green bonds	Bonds issued to fund green investments; pooling models allow access to capital markets	Kommuninvest pooled green bonds for 295 municipalities (Sweden) (Gancheva et al., 2024)	Local governments, national pooling entities, investors	High transaction costs, need for project standardisation, limited expertise in smaller cities
Mini-bonds	Bonds issued by municipalities to retail investors to fund local projects	Lithuania urban waste mini-bond pilot (Bužinskė, Stankevičienė, Zopiatis and Nguyen, 2025)	Municipalities, retail investors	Regulatory barriers, limited investor confidence, small-scale applicability
Crowdfunding / cooperatives	Citizen-financed climate projects with strong local ownership, often via energy coops or platforms	Melpignano solar cooperative** (Italy)	Citizens, cooperatives, local authorities	Limited scalability, administrative burden, reliance on strong community engagement
Pay-for-Performance (P4P)	Contracts where payments depend on verified energy/emission results	Energy Savings Meter Programme in Germany (Tzani et al., 2022)	Municipalities, funders, auditors	Measurement complexity, administrative overhead, uncertainty of returns

* https://r-aces.eu/use_case/braedstrup-district-heating/
**http://www.coopcomunitamelpignano.it/.

4. Discussion

This section reflects on the main empirical findings of the study, explores data limitations, and identifies future opportunities and enabling conditions to strengthen climate finance at the local level.

4.1. Key findings and implications

This study offers a comprehensive overview of how European cities are planning and financing climate change mitigation through SECAPs. The analysis confirms a broad engagement of European cities in climate mitigation planning. However, several findings underscore persistent structural and institutional challenges as to the funding and financing of SECAP actions.

First, the results confirm that urban dimension and climatic conditions are among the strongest predictors of financial effort. Larger cities systematically allocate higher total budgets for mitigation, likely due to greater institutional capacity and economies of scale. These findings are consistent with earlier studies (Gouldson et al., 2015; Rivas et al., 2021; Ulpiani et al., 2023), which emphasise the influence of demographic and environmental conditions over economic wealth. Similar conclusions are found by Rivas, Urraca and Bertoldi(2022), who identify population size, fiscal capacity, and local socio-economic factors as key determinants of municipal environmental expenditure in European cities.

This dynamic also reflects broader concerns around financial justice. As highlighted by Dafermos (2025), climate finance often prioritises profitability and risk reduction, potentially reinforcing disparities between territories with high investment capacity and those facing structural limitations. In the European context, this may penalise smaller or less affluent municipalities, despite their climate ambition. These disparities highlight the need for multilevel coordination to ensure that EU and national frameworks actively channel support towards smaller municipalities that show high climate ambition but limited investment capacity.

In contrast, GDP per capita shows a significant inverse correlation with total planned investment. This may reflect a saturation effect, where wealthier cities have already implemented major infrastructure upgrades, a shift toward more cost-efficient solutions or going the last mile with behavioural change-related actions (Gouldson et al., 2015; Kona et al., 2018). Climate ambition targets, by contrast, did not significantly predict investment levels, pointing to a possible disconnect between strategic goals and financial planning. These findings are consistent with Kona et al. (2018), who observed that cities with lower emissions or socio-economic constraints often report more modest financial trajectories and future ambitions.

Second, the study highlights a heavy reliance on traditional public funding instruments, notably grants and public procurement, which together account for over 80 % of mitigation actions that include financing details. This reflects a limited diversification of financial tools and reinforces the findings of previous studies (e.g., Pablo-Romero et al., 2018), which link such patterns to barriers like low municipal creditworthiness, fragmented governance, and weak technical capacity to design and implement more complex financial schemes.

About 24 % of mitigation actions include at least one declared funding source, while approximately 5 % fall under generic categories (e.g., “other” or “not allocated”). This limited data availability reflects widespread difficulties in designing structured financial strategies at the local level and in aligning project pipelines with available funding streams. The persistence of these challenges suggests a systemic capacity gap, especially among small and medium-sized cities, which often lack the institutional resources or technical expertise to access and coordinate external financing.

Despite the availability of EU support programmes such as ELENA and LIFE, as well as international instruments, the uptake of market-based and performance-oriented mechanisms, including third-party financing, carbon taxes, and national-level schemes such as energy supplier obligations, remains marginal. These tools, although promising in theory, face practical barriers to implementation at the local level. Their limited use confirms the structural gaps already discussed in the EU CoM SECAP guidebook on financing (Todeschi et al., 2025), which emphasises the need to transition from project-by-project financing to more systemic, blended approaches capable of attracting private capital and fostering long-term investment pipelines. This limited uptake reflects both a lack of technical expertise and a regulatory environment that does not yet fully support the deployment of market-based or performance-driven tools at the local level (Economidou et al., 2023). Further capacity-building and institutional support would be needed to promote their integration in SECAPs.

The results confirm that cities are actively engaged in climate change mitigation, but their financial strategies remain concentrated on conventional instruments. While larger, more exposed cities are mobilising significant resources, many municipalities (particularly smaller and lower-income ones) still face major barriers in accessing and deploying diversified financing tools.

Beyond conventional socio-economic indicators such as GDP, other contextual factors may also influence local engagement in climate action. Recent studies highlight how political dynamics and internal leadership within municipal organisations can play a decisive role in shaping climate ambition and implementation capacity (Friedländer, 2025; Jakobsen et al., 2025). Likewise, higher levels of education and civic awareness have been associated with stronger public support for sustainability policies and local participation in climate initiatives (Gouldson et al., 2015). Although these dimensions were not directly captured in the present dataset, they represent important avenues for future research on local climate governance.

Similar patterns and barriers have also been reported in local-level climate initiatives outside Europe, such as those analysed through the CDP-ICLEI Track and the State of Press-Williams et al. (2024), confirming that reliance on public funding and limited access to private capital are common global challenges for urban climate investment.

4.2. Data gaps and limitations

While this study offers a robust and large-scale analysis of how European cities finance climate change mitigation, some limitations must be acknowledged, both in terms of data quality and reporting scope.

First, the analysis relies entirely on self-reported data submitted by local authorities through the MyCovenant platform. Although the platform provides a structured template, the level of completeness and accuracy varies significantly across cities. Financial fields, especially at the action level, are often incomplete, inconsistently filled, or rely on generic categories (e.g., “other” or “not allocated”), limiting the granularity and comparability of results. This issue is particularly relevant for financial instruments, which are reported in only 20 % of the actions and often lack standardised definitions.

The reliance on self-reported data inevitably introduces uncertainties, as completeness and accuracy vary widely across municipalities. To ensure data reliability, all financial information underwent a cleaning and validation process, including cross-verification between plan- and action-level datasets. Remaining gaps mainly reflect optional fields at the action level and incomplete reporting for non-key measures. Although the filtering and validation steps improved comparability, they may bias the sample towards municipalities with stronger technical capacity or more advanced reporting practices. Nevertheless, the remaining uncertainties are consistent with large-scale self-reported datasets and do not undermine the comparability of the main trends discussed in this study.

In this context, it should be noted that some of the fields analysed in this study are non-mandatory fields, especially at action level. Signatories need to report all action-level related fields (including financing information) for at least three key actions, whereas the information on other actions is optional. Further information on how actions are

planned to be financed might be found in the SECAP document (i.e. not within the reporting platform), however, this study is limited to the self-reported data and has not explored the PDF documents uploaded by the analysed municipalities to the platform.

Also, there is limited information on how budget estimates are calculated, especially in cases where total investment is not directly associated with disaggregated action costs. To address this, the analysis included only plans with sufficient financial detail and cross-checked data across two datasets (df2 and df2C). However, this filtering reduces the size of the usable sample and may bias the results towards more advanced or better-staffed municipalities.

The identification of funding sources and mechanisms remains largely declarative. Many cities indicate the presence of a certain funding type (e.g., national, EU, or private) without specifying the programme or delivery channel, and a substantial share of actions lacks any indication of financing source. Similarly, the use of innovative tools, such as third-party financing, carbon pricing, or supplier obligations, is reported infrequently and often without detail, making it difficult to assess their actual implementation or effectiveness.

Moreover, some contextual variables were derived from external sources with different spatial resolutions and then adjusted to the municipal scale. Depending on the original dataset and the size of the municipalities, this required either aggregation or disaggregation, which may introduce additional uncertainties. Future analyses could benefit from more harmonised socio-economic and territorial datasets to better contextualise financial planning.

Finally, given the limited completeness of the sample used to carry out the econometric analysis, a potential sample selection bias could arise since the estimates are limited to particularly active signatories. Despite these limitations, the findings presented here offer valuable insights into the prevailing financial practices and institutional capacities of European cities, which rely predominantly on traditional public funding mechanisms and show limited diversification of financial tools. They highlight the need for developing administrative capacity and technical knowledge of city officials to ensure more consistent and actionable financial planning; for strengthening collaboration between different governance levels, for example providing information and tools; for using climate funds to finance pilot and demonstrative projects. Future research could take advantage of greater data availability to expand the sample to other signatories (including towns below 50,000 inhabitants and cities less advanced in climate action), conduct longitudinal (panel) data analyses and include a broader set of explanatory variables.

4.3. *Future opportunities and enabling conditions*

Enhancing the financial capacity of municipalities and scale up climate action, it is essential to move beyond traditional grant-based approaches and adopt a more diverse and systemic mix of financial instruments. The results of this study show a heavy reliance on public funding (especially grants and procurement mechanisms) which, while effective for early-stage actions, are not sufficient to meet long-term investment needs. Diversifying financial strategies, integrating financing into SECAP planning, and mobilising private capital will be crucial to match climate ambition with real implementation capacity. Three operational priorities emerge to enable a more mature and diversified local climate finance ecosystem.

(1) Project preparation and aggregation capacity. Technical and administrative barriers can be overcome by establishing regional or national project-preparation hubs that pool expertise from several municipalities. These hubs (modelled on ELENA, the City Gap Fund, or national technical-assistance schemes) would provide end-to-end support for feasibility studies, cost–benefit analysis, and tender preparation. Aggregating smaller projects into investment pipelines (e.g. for public building renovation or district heating) increases the average project size, reduces transaction costs, and enhances access to commercial finance. This approach, promoted in the Guidebook on Financing SECAPs (Todeschi et al., 2025), directly tackles the limited bankability and fragmentation observed in most SECAPs.

(2) Risk-sharing and access to capital. Financial barriers such as low municipal creditworthiness and high perceived risk can be addressed by developing national or regional guarantee funds and revolving credit lines capitalised by public development banks (EIB, KfW, national green funds). These mechanisms de-risk private participation by covering part of the default risk and enabling blended-finance models that combine grants with loans or equity. Pooling smaller investments into thematic or regional portfolios (e.g. energy renovation or sustainable mobility) can further attract institutional investors and strengthen the link between city-level projects and national funding programmes.

(3) Regulatory and institutional alignment. Institutional barriers remain among the strongest deterrents to financial diversification. Another important constraint stems from national fiscal rules and EU deficit limits, which restrict municipal borrowing capacity and may discourage loan-financed climate investments. Eurostat has issued guidance on the statistical treatment of Energy Performance Contracts (EPCs), clarifying when investments carried out by ESCOs and repaid by municipalities can be considered off-balance-sheet, providing an example of a policy measure designed to mitigate such constraints (Eurostat & European Investment Bank, 2018). Simplifying and harmonising eligibility criteria across EU and national programmes, creating standardised EPC and PPP contract templates pre-approved by competent authorities, and establishing single-entry digital platforms for funding applications would substantially reduce administrative burden and approval time. Urban investment platforms at regional level could act as coordination interfaces between municipalities, financial intermediaries, and public investors, ensuring greater efficiency and transparency in the allocation of funds.

As illustrated in Table 2, instruments such as PPPs, EPCs, green or mini-bonds and cooperative schemes demonstrate how these enabling conditions translate into practice: technical assistance supports design and aggregation, guarantee schemes share risks, and standardised procedures enhance replicability at scale. Together, these measures form a coherent strategy for overcoming the structural barriers that currently limit the diversification of local climate finance.

Municipalities are uniquely positioned to coordinate climate investment, estimate local needs, and leverage different sources of finance. However, smaller ones often face institutional and operational constraints. Previous studies have shown that regions and provinces can play a crucial role in supporting them through technical and financial assistance. In the Covenant of Mayors, Territorial Coordinators (CTCs) have enabled access to funding, expertise and economies of scale, particularly in countries with a fragmented municipal structure (Melica et al., 2018). This underscores the importance of designing financial and technical instruments that are accessible also to municipalities with limited capacity.

Beyond the instruments analysed in this study, the global discourse on urban climate finance points to the need for further innovation and coordination. As noted by McKellar (2023), the infrastructure investment gap for climate change mitigation in cities remains significant, and bridging it requires a shift toward treating infrastructure not just as public service provision, but as a strategic business case capable of attracting blended and commercial finance. Emerging performance-based mechanisms such as carbon crediting schemes could complement traditional funding channels by monetising verified emission reductions at the urban scale (City Climate Finance Gap Fund,

2023). While still under development, these tools could offer additional revenue streams and align city-level mitigation actions with broader carbon finance frameworks, further expanding the financial toolbox available to municipalities. However, for both voluntary carbon markets and mechanisms under Article 6 of the Paris Agreement, it should be noted that when carbon credits are sold, the corresponding emission reductions can no longer be claimed by the city. While cities can engage in voluntary or performance-based carbon crediting mechanisms, the implementation of Article 6 of the Paris Agreement formally applies only to Parties (national governments). Subnational entities may participate under national authorization, but corresponding adjustments are made at the level of Nationally Determined Contributions (NDCs), not city targets (UNFCCC, 2025).

Stakeholders have stressed the importance of better aligning climate planning with financial strategies (OECD et al., 2018; Zhang & Khor, 2023). Key barriers include the difficulty of monetising resilience benefits, particularly relevant for adaptation actions (Venner et al., 2025), along with high transaction and due diligence costs, and the complexity of designing long-term investment pathways. Although this study focuses on mitigation, these challenges reflect broader systemic issues in urban climate finance that also affect the development of diversified funding strategies. Overcoming these challenges requires not only technical support, but also governance frameworks that enable stable and predictable financing conditions. Strengthening the role of local authorities in coordinating and structuring climate investments (backed by national governments, multilateral banks, and intermediary actors) will be essential to scale up inclusive and effective climate finance at the local level, recognising that in some countries municipalities have limited financial autonomy (Lucchitta et al., 2024).

5. Conclusions

This study offers a large-scale empirical analysis of how European cities finance climate change mitigation through SECAPs. By examining 203 action plans from municipalities with over 50,000 inhabitants, the study provides a comparative, cross-country assessment of investment levels, funding sources, and the use of financial instruments across the EU. The findings confirm strong engagement in climate action but also highlight significant limitations in financial planning, instrument diversification, and data consistency.

The results show a strong dependence on public funding mechanisms, particularly grants and procurement, which account for over 80 % of actions that report financing instruments. While effective in early-stage implementation, these tools may not be sufficient to meet long-term investment needs. The statistical analysis reinforces that larger, more climate-exposed cities tend to invest more, suggesting that demographic and environmental conditions are stronger drivers of budget allocation than economic wealth or declared ambition levels.

The study also highlights the underutilisation of innovative and alternative instruments, such as third-party financing, green bonds, and pay-for-performance models, which remain marginal despite their potential to attract private capital. These findings align with prior literature and confirm the persistence of institutional, budget and regulatory barriers, such as low administrative capacity and fragmented governance. Although mechanisms like ELENA offer technical and financial support, their uptake remains limited.

Some data limitations should be noted. As the study relies on self-reported data from the MyCovenant platform, differences in how cities interpret and populate financial fields, such as public vs. total investment estimates, affect comparability. Many cities do not systematically distinguish between internal budgets, leveraged capital, or co-financing sources. Additionally, the use of financial instruments is declared in only a minority of actions, and often without sufficient detail to assess operational deployment.

Building on these findings, further research could address gaps that remain in the current understanding of SECAP financing strategies. Additional variables, such as the political orientation of city governments or access to national climate finance programmes, could help explain variation in budget levels. Moreover, the study focused on the mitigation pillar, which remains the most developed and consistently reported section of SECAPs. In contrast, actions related to adaptation and energy poverty are still limited in number and scope, and in many cases are reported in qualitative terms or without associated financial information. As policy frameworks evolve, particularly with the upcoming implementation of the Social Climate Fund (SCF) and the growing emphasis on climate resilience, these pillars are expected to gain increasing relevance. These developments create new opportunities for addressing energy vulnerability through dedicated resources and support the emergence of novel instruments such as resilience bonds, or insurance-linked mechanisms. Future efforts could also focus on better integrating financial planning across mitigation, adaptation and energy poverty to systematically support all aspects of local climate action.

The insights provided by this study also respond to several knowledge gaps identified in recent urban climate finance dialogues, including how cities apply financial instruments in practice, how they align investment needs with financing sources, and how new mechanisms, such as cooperative models, crowdfunding, or carbon crediting, can complement traditional approaches. Addressing operational barriers such as long-term planning constraints, risk perception, and limited monetisation of resilience remains essential for unlocking new finance streams and building inclusive strategies across all SECAP pillars.

Overall, this study underscores the need to strengthen the financial dimension of local climate planning by enhancing the skills and resources of local authorities, promoting innovative models, and embedding financing strategies at the heart of SECAP development.

CRediT authorship contribution statement

Valeria Todeschi: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Gema Hernandez-Moral:** Writing – review & editing, Writing – original draft. **Enrico Clementi:** Writing – review & editing, Validation, Formal analysis. **Paolo Bertoldi:** Writing – review & editing, Supervision, Conceptualization. **Giulia Melica:** Writing – review & editing, Supervision, Conceptualization.

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.

Data availability

Data will be made available on request.

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