The Design of Local Actions Toward EU2050 Targets Performed on Municipal Budgets

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Abstract. The pathways in designing local interventions toward climate neutrality can be declined according to several approaches such as energy efficiency, climate adaptation/mitigation or the reduction of GHG emissions. In this research, the authors explored an economic approach oriented by sustainability criteria according to the Sustainable Development Goals provided by the Agenda 2030. In this scenario, the European initiative of the Covenant of Mayors (CoM) was selected because each CoM signatory develops an Action Plan, designing energy efficiency and climate interventions for climate change. The methodological proposal is based on the analysis of the investment expenditures related to the public energy efficiency interventions retrieved from the Municipal budget. This allows for the addressing of effective support in designing interventions oriented to couple the economics with climate neutrality. As a sample study area, the Basilicata Region was selected, where out of 131 Municipalities, 92 are CoM Signatories, that have designed energy efficiency interventions through their Sustainable Energy Action Plans (SEAP). The methodological proposal was applied to the CoM Municipality group and non-CoM ones to highlight the differences. The results achieved have been compared so as to remark: 1. The differences in terms of expenditure allocated and interventions planned by Municipalities' sample according to the methodological proposal and 2. The impact of the CoM initiative and whether SEAP represents an effective driver to boost energy transition in small municipalities.

Keywords: SEAP · Municipal budget · energy efficiency · small municipalities

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1 Introduction

Climate neutrality is the current target addressed globally through numerous sustainability initiatives, including different approaches such as energy efficiency, the reduction of GHG emissions or adaptation/mitigation to climate change [1–4]. Among these approaches, energy efficiency is the most adopted, with a wide range of measures, including reducing energy consumption, decreasing dependence on non-renewable energy sources, and limiting greenhouse gas emissions. In Europe, the framework related to energy efficiency was harmonized in 2008 with the "20–20-20 package" [5] a set of laws passed to ensure the EU meets its climate and energy targets for the year 2020 on three key targets: 20% cut in greenhouse gas emissions (from 1990 levels), 20% of EU energy from renewables and 20% improvement in energy efficiency.

In 2019, the EU presented the European Green Deal [6], striving to be the first climate-neutral continent. From the perspective of becoming a resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050, the European Green Deal also represents a way out of the COVID-19 pandemic [7].

Implementing energy efficiency measures poses several challenges, that cities and municipalities must address, to achieve the sustainability goals provided by the UN Agenda 2030 [8, 9]. The UN Agenda 2030 for Sustainable Development was presented in 2015, including the ambitious goal of developing "an action plan for people, planet and prosperity". The approach promoted by the UN Agenda is integrated and aims to address the social, environmental and economic challenges facing present and future generations. The 2030 Agenda includes 17 Sustainable Development Goals (SDGs), divided into 169 indivisible targets and which balance the three popular dimensions of sustainable development: economic, social and environmental. Nowadays, SDGs represent a challenge for both public and private organizations [10]. In particular, the 2030 Agenda emphasized the key role that national, regional and local public administration plays in achieving sustainability goals. Many authors and policymakers have focused their attention on this phenomenon [11, 12].

In this scenario, Municipalities and cities play a crucial role in promoting energy efficiency by encouraging and supporting businesses and residents to adopt sustainable practices. Public Administration (PA) is also a critical factor in facilitating and implementing sustainable policies and practices [13–16]. PA must ensure that sustainable policies are developed, implemented, and monitored effectively to reduce greenhouse gas emissions and limit energy consumption. Additionally, it can provide incentives to encourage citizens and organizations to adopt energy-efficient practices, such as offering tax credits and rebates.

The authors among the initiatives related to energy and climate issues selected a European one, the Covenant of Mayors (CoM) started in 2008, gathering mayors and local administrators with the ambition to tackle the "20–20-20" targets provided by 2020 climate & energy package [5]. It is possible divide the initiative by two different commitment period: the first (2008–2020) pursued the targets provided by the 2020 climate & energy package, while the second (2020-ongoing) is pursuing the targets provided by the European Green Deal [6]. Previous researches [17, 18] remarked the relevant engagement within the CoM signatories of "small" Municipalities (i.e. under 10.000 inhabitants) classified as XS Signatories by CoM; coming mainly from Italy and Spain. CoM

Signatories translated their commitment in interventions with the Sustainable Energy Action Plan (SEAP) during the first period and now are developing a Sustainable Energy and Climate Action Plan (SECAP) including climate related interventions. These plans contain structured public and private interventions, related to energy efficiency and climate adaptation/mitigation related to a set of sectors (for example residential buildings, transport, and public lighting). They represent an opportunity to boost the local implementation of the Sustainable Development Goals provided by the UN Agenda 2030 [8], improve the resilience of the territories and support the technical skill weakness of the small municipalities.

The aim of this research is to provide a means of support for the design of energy efficiency interventions by way of economic analysis through the evaluation of Municipalities' budgets, coupling the 2050 climate targets with the economics issue.

The methodological proposal was applied to the Basilicata Region, which was selected because it has 92 CoM Signatories, that have developed 81 approved SEAPs, containing energy efficiency actions. These plans are suitable to define a sample where the methodological proposal has been applied, and compare the results achieved with non-CoM Municipalities.

The results achieved reveal the usefulness of the methodological proposal in design interventions according to a context-based approach and the replication of it in other contexts.

Moreover, the research contributes to the investigation concerning the impact of the CoM initiative on Municipalities compared to non-CoM ones, in supporting and developing public energy efficiency investments (see also [19]).

The structure of the research provided in Sect. 2, details the databases investigated for the analysis of the Municipal budgets, highlighting the share of public investments according to the CoM membership; Sect. 3 is related to the description of the study area; Sect. 4 the main outcomes which have presented an opening to the future perspectives of the research.

2 Dataset Investigated

In Italy, the government structure is divided into three levels: a national, a regional and a local government [11]. In recent years, the public accounting system has undergone numerous changes. In particular, Decree 118/2011 has decisively revised the accounting rules for local governments (LGs). Italian LGs, which include municipalities, provinces, mountain communities or consortia, draft their budgets every year to authorize expenditure [10].

This municipal budget consists of two main components: revenue and expenditure. Revenue comprises all financial resources available to the authority and is divided into current and capital revenue. Expenditure represents the financial resources to be allocated for the provision of services to citizens, for the ordinary functioning of the entity and for the realization of investments. Expenditure is divided into current expenditure, capital expenditure, expenditure for the repayment of loans, and expenditure for services on behalf of third parties.

For the purpose of this article, the authors chose to evaluate the energy efficiency initiatives proposed in the SEAP through the analysis of investment expenditure, in

order to assess the allocation of financial resources by municipalities. In particular, the investment expenditure item details the payments made for each mission or intervention, i.e., it consists of all the costs that the municipality incurs for the purchase of real estate or the construction of infrastructure and long-term projects in the municipality. The result also includes the so-called *residual liabilities*, which represent the debts of the municipal authority, i.e. expenditure committed but not paid during the year (see also [20]).

The authors investigated budget data in two different time frames: the first for the years 2005–2015 and the second for the period 2016–2021. Even though the reform changed the presentation of budget items to a large extent, we identified some similarities between macro-categories, allowing comparisons to be easily made (see Table 1).

Table 1. Comparison of Municipalities budget items (Source: "Open Bilanci" Database)

Categories in the first-time frame (2005–2015)		Categories in the second time frame (2016–2021)	
Education	Expenditure for school services and maintenance of buildings owned - excluding kindergartens	*Education and the right to study*	Amount of all expenditure on education and school buildings (excluding kindergartens)
Public lighting	Expenses for public lighting installations	*Energy and diversification of energy sources*	Expenditure on administration and operation of activities and services relating to the use of energy sources, including electricity and natural gas
Public buildings	Expenditure on public housing, on the operation of offices, on the provision of benefits to citizens in need, and on the construction and maintenance of facilities	*Public and local housing and social housing plans*	Expenses for the construction, purchase and renovation of public and social housing

The authors selected two databases detailing the public interventions and investments for the Municipalities of Basilicata Region. Databases are:

1. "Open Bilanci" a public web-database with a temporal coverage from 2005–2021 where Italian municipal budgets are collected and detailed in terms of investments, expenditure and interventions related to several sectors (road maintenance, public lighting and public buildings).

2. CoM dataset, provided by the Global Covenant of Mayors for Climate and Energy (GCoM) containing a collection of action plans and monitoring reports from MyCovenant platform in the context of the GCoM initiative.

'Open Bilanci' database was examined in order to collect budget data useful for our analysis. The principle of cash management was chosen, which considers the income and expenditure that the municipality has received (receipts) and paid (payments) during the year, regardless of the year in which receivables (assessments) and payables (commitments) arose.

Analyzing the complete collection of plans and monitoring reports provided by the EU Joint Research Centre [21], in April 2023, it counts 10425 Signatory and 68% of them have submitted to CoM an Action Plan. Considering the Signatories with an Action Plan submitted, 67% of them are classified by CoM as XS Municipalities (i.e. with a resident population under 10000 inhabitants). This majority of XS Municipalities is proved considering that Italy is at first place among CoM Countries in terms of XS CoM Signatories (no. 2545), followed by Spain (no.1492). Italy and Spain both represent over 90% of the whole XS Municipality class. However, this relevant engagement of XS Municipalities has set a CO_2 emissions target reduction in the range of 20–30%, close to the 20% of 20–20-20 target, but far from the current target (55%) provided by the European Green Deal. In order to understand how the relevance of public interventions is planned by the CoM signatories, the authors evaluated the occurrences of the SEAP/SECAP sectors. Results from the CoM database, highlight that XS Signatories have a preferential interest in developing actions related to sectors basically "public" like public lighting or municipal building equipment facilities. Instead, considering "private" sectors (involving not only public actors but also a private company, stakeholders etc..), there is a relevant development of interventions related to the improvement of the energy production (including r.e.s. technologies) and energy efficiency of the buildings toward the green transition.

3 Study Area

The authors selected the Basilicata Region in the South of Italy (see Fig. 1) be-cause of 92 Municipalities on 131 are CoM Signatories. Among them, 81 have developed a SEAP including interventions related to the energy efficiency and represent a suitable sample to be compared to non-CoM in order to validate the methodological proposal. CoM provide for its signatories, three typologies of adhesions:

- As an individual signatory;
- As a group of signatories committing individually (joint SEAP - option 1), where each signatory in the group individually commits to reducing CO_2 emissions;
- As a group of signatories committing collectively (joint SEAP - option 2), where the group of signatories collectively commits to reducing CO_2 emissions.

It is relevant that considering the two Provinces (Matera and Potenza), all Municipalities from Matera Province are CoM signatories submitting a joint SEAP committing individually while for Potenza Province the whole of CoM Signatories are individual ones.

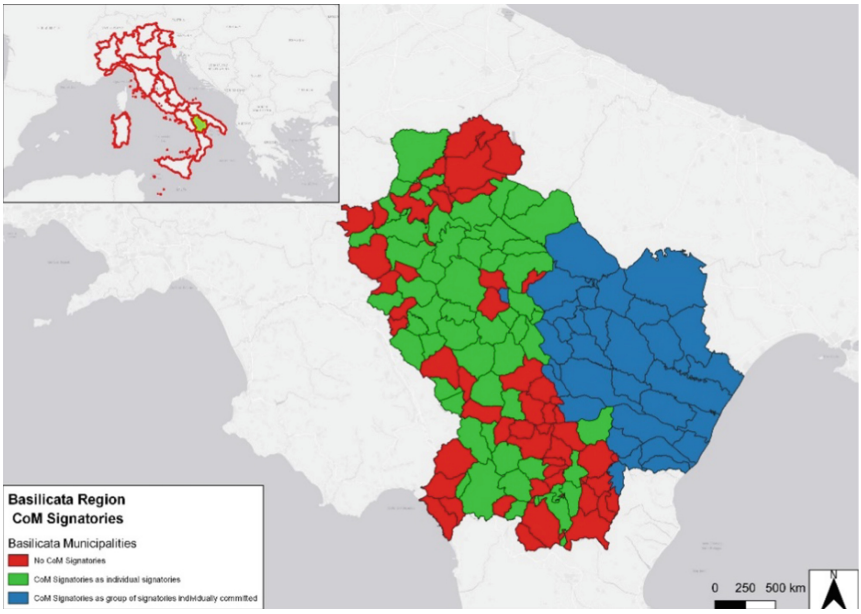

Fig. 1. Study area

Analyzing SEAPs submitted over the years by the Signatories (see Fig. 2), the timespan between 2014 and 2017, registered a significative increase in terms of SEAPs submitted. This increase had a boost also by European and international legislation framework on energy and climate issues as Paris Agreement, Pact of Amsterdam or Urban Agenda for EU [22, 23].

In detail actions developed within the SEAPs can be categorized into four sectors: Local Electricity Production, Municipal Buildings, Residential Buildings, and Transport. A detailed explanation of the recurrent actions developed in each sector is:

- Local Electricity Production Sector: the actions in this sector are mainly focused on the installation of photovoltaic systems to generate electricity locally.
- Municipal Buildings Sector: in this sector, the actions are geared towards improving the energy efficiency of the buildings owned by the municipality. The approach is to replace and improve the building envelope and lighting systems with more efficient LED technologies.
- Residential Buildings Sector: the actions in this sector are geared towards reducing electricity and thermal consumption in residential buildings. The approach is to improve the energy efficiency of buildings by replacing the building envelope, increasing energy efficiency in space heating and hot water systems, and improving lighting systems with LED technologies.
- Transport Sector: the actions in this sector are focused on reducing the carbon footprint of the transport system. This is achieved by replacing the vehicle fleet with less

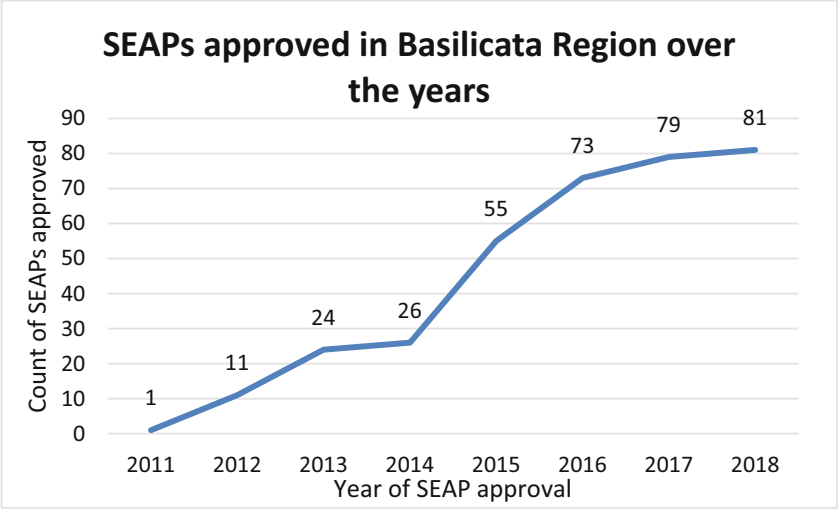

Fig. 2. SEAPs approved in Basilicata Region over the years.

polluting and more efficient ones and promoting the modal shift to walking and cycling.

The authors classified SEAPs interventions concerning data related to investments in Municipal budgets in the three macro-categories previously defined: education, public lighting and public buildings. Education includes investments in energy efficiency interventions in schools related to the installation of Renewable Energy Sources (RES) technologies and improvements in building energy performance; public lighting is referred to as the expenditure's investment of streetlamps and public buildings are related to the investments on the renovation (including energy efficiency interventions) of the public buildings. All these technological solutions produce a territorial impact, that should be taken into account in order to balance the different interventions sector according to territorial characteristics [24–26].

4 Results and Discussions

Several considerations can be made by analyzing the budget data of the municipalities of the Basilicata Region. The sample was divided into two categories: in the first category, investment expenditure in the three sectors selected (public lighting, education and public building) for municipalities in the province of Potenza was analyzed; in the second category, expenditure by municipalities in the province of Matera was examined. In addition, the two categories were divided into municipalities that joined the CoM and municipalities that did not join the CoM, in order to assess the general impact of joining the initiative.

The first analysis was conducted on investment expenditure expressed in absolute terms in the three selected sectors for the municipalities of the province of Potenza. There are 62 signatory municipalities and 38 non-signatory ones in this province. From

the graph on average, the investment expenditure of signatory municipalities is higher than that of non-signatory municipalities in the public lighting sector (see Fig. 3).

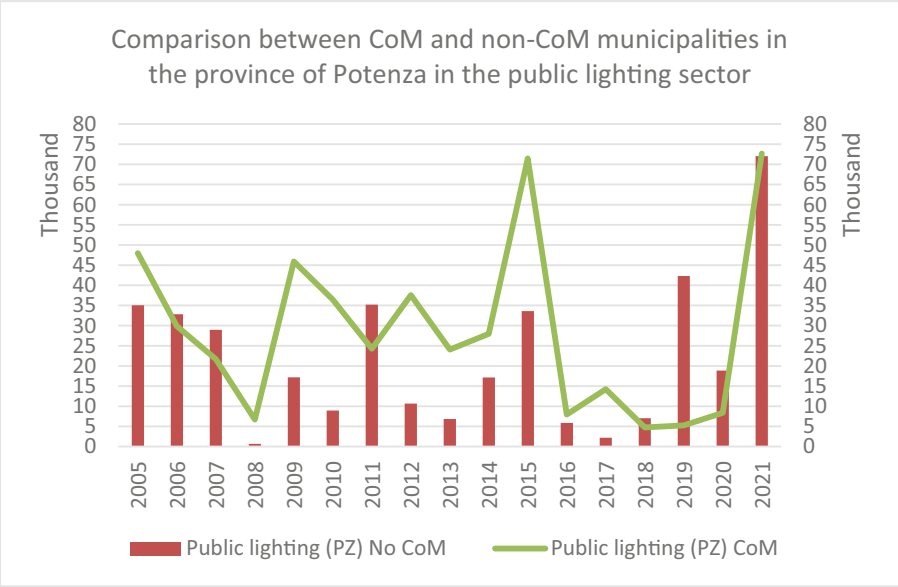

Fig. 3. Averages of investments per year in the public lighting sector (for the period 2005–2021) expressed in thousand euros for the Municipalities in the province of Potenza.

In the Education sector, this increase is even more pronounced (see Fig. 4). In the public building sector, in contrast, there has been a decrease in investment expenditure in recent years. The education sector stands out as the most advantageous investment opportunity for municipalities participating in the CoM initiative. In terms of budget analysis, CoM member municipalities in the province of Potenza and Matera tend to invest more in this sector on average. This could be attributed to the spatial planning aspect, as the Basilicata Region comprises areas with low-density housing, where public education buildings and administrative offices are the primary public buildings. As a result, municipal governance prioritizes energy efficiency investments in buildings associated with public education. The public lighting sector also seems to confirm the positive role of CoM in investment. However, in recent years, a decrease in investments is noted, only to be increased in 2021 (Fig. 5).

The province of Matera is composed of 31 municipalities and all of them have joined the CoM, which is why the analysis conducted did not include a comparison between CoM and non-CoM, but rather an exploratory analysis by assessing the trend of investment expenditure in the three selected sectors (see Fig. 6).

The initial evaluation of investments related to public energy efficiency measures has revealed the positive impact of the initiative on small municipalities. This impact is evidenced by increased investments in education and public lighting. Moreover, the

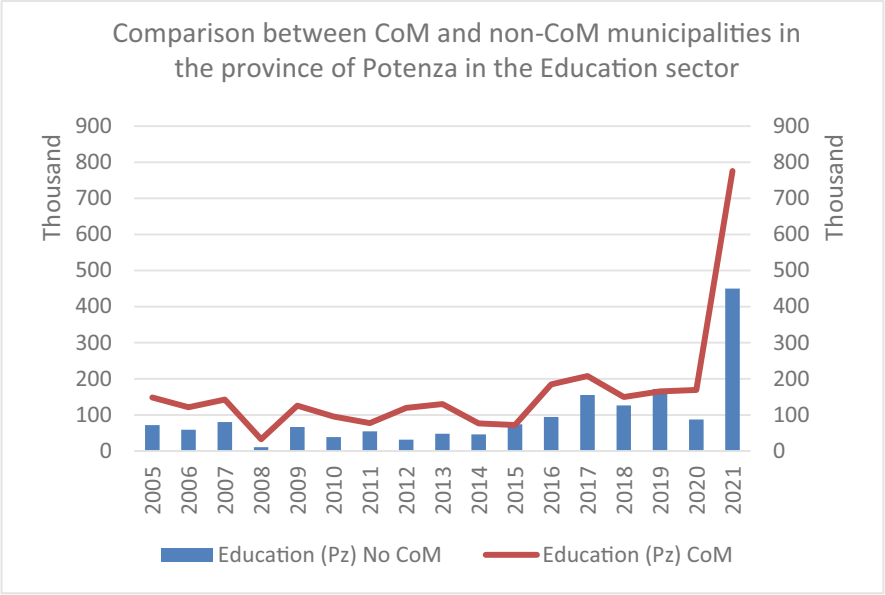

Fig. 4. Averages of investments per year in the Education sector (for the period 2005–2021) expressed in thousand euros for the Municipalities in the province of Potenza.

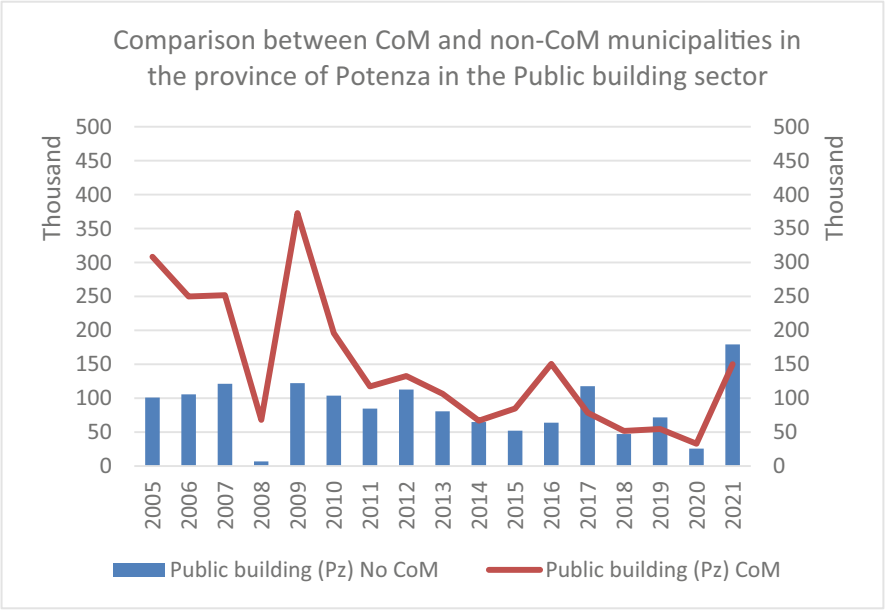

Fig. 5. Averages of investments per year in the Public Building sector (for the period 2005–2021) expressed in thousand euros for the Municipalities in the province of Potenza.

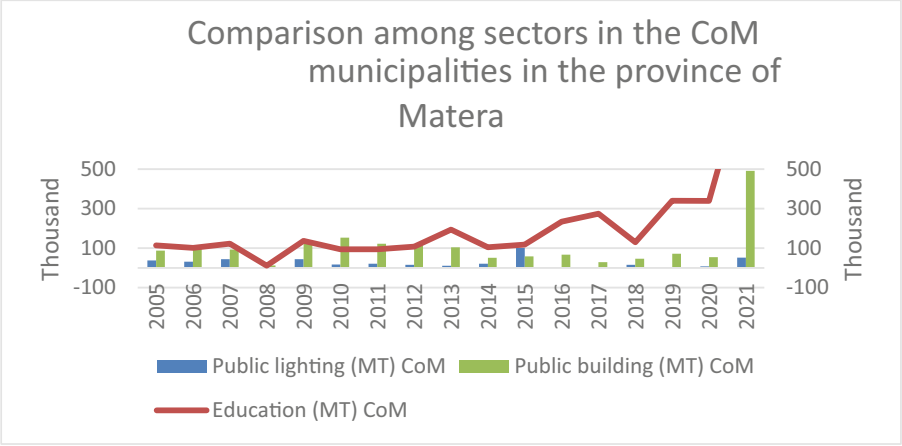

Fig. 6. Averages of investments per year in the three sectors (for the period 2005–2021) expressed in thousand euros for the Municipalities in the province of Matera.

initiative has encouraged investment policies in energy efficiency, addressing the technical capacity weaknesses of small municipalities and implementing measures to reduce CO_2 emissions in line with EU 2050 targets. The voluntary approach adopted by CoM has resulted in increased investments, promoting the incentive to plan interventions for reducing energy consumption and supporting the development of a "green conscience" among citizens through these interventions [27, 28]. Additionally, municipal budget data can be a useful tool to monitor the implementation of the SEAP and could be considered as an additional indicator for inclusion in the CoM monitoring reports.

5 Conclusions

The research has provided a methodological proposal as means of support for the design of energy efficiency interventions by way of economic analysis through the evaluation of Municipalities' budgets, coupling the 2050 climate targets with the economics issue.

The methodological proposal was applied to the Basilicata Region, on a sample of energy efficiency interventions deriving from 131 Municipalities, where 81 of them have developed energy efficiency interventions within their SEAPs. A comparison on the economic performance of the energy efficiency interventions between CoM and non-CoM Municipalities was performed.

The results achieved reveal the usefulness of the methodological proposal in design interventions according to a context-based approach and the replication of it in other contexts.

Moreover, the research contributed to the assessment of the effective and positive impact of the CoM initiative on Municipalities compared to non-CoM ones, in supporting and developing public energy efficiency investments.

The three sectors for CoM Municipalities during the timespan considered have a stock in investment over than no-CoM ones. However, they had different trends in investments:

education sector had a steady growth, public building sector a decreasing growth while public lightning sector a fluctuating increase.

Education and public building sectors for CoM and non-CoM Municipalities registered an increasing trend after the 2020 compared to the previous years, a reason of it are the financial opportunities related to the boost gained by the National Resilience and Recovery Plan.

Limitations of the research are related to the limited size of the sample, that should be extended to improve the results achieved.

Future perspectives to be investigated are related to the analysis of other actions and investments related to other sector than three evaluated (education, public lighting and public buildings), in order to achieve an "urban vision" (see also [29]) of the SEAP impacts. Other interesting assessments are related to other intervention categories (including private investments (i.e. the transport sector (see also [30–32] that is one of main SEAP sector [33, 34], especially for those small Municipalities with tourism specialization [35–37]).

This assessment can be extended to other CoM and non-CoM Municipalities in order to understand what categories (public or private) drive the investments toward the EU2050 targets and whether other EU funded programs contributes [19, 38].

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