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Monitoring and evaluation of Sustainable Energy Action Plan: Practice and perspective

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ABSTRACT

The Sustainable Energy Action Plan (SEAP), promoted by the Covenant of Mayor, is a key tool for policies aimed at reducing fossil fuel consumption and GHG emissions, in accordance with the Kyoto protocol and its updates. To achieve an actual implementation of the SEAP and to obtain its expected targets, monitoring is a crucial component. SEAP monitoring has to look at both the progress of each single action and its global environmental effect, which requires more than one level of development. In the present paper, an integrated strategy for surveying, controlling and managing the SEAP through a "Monitoring and Evaluation" (M&E) process is introduced. The implementation in the city of Genoa, Italy, was used to test the efficacy of this approach and to assess its strengths and weaknesses. In particular, cost benefit analysis, bankability, peer review and participatory level were identified as key elements for obtaining an operative SEAP monitoring and for then fostering an effective environmental energy policy. Some recommendations were proposed to better outline the "Monitoring and Evaluation" methodology and to help other cities to define a strategy for SEAP monitoring and fulfilment.

1. Introduction

In consequence of the adoption of the Renewable Energy and Climate Change Package in 2008, the European Commission launched the Covenant of Mayors (CoM) initiative at the local government scale. This initiative had the aim of sparking and supporting the efforts of municipal administrations, a basic unit of the public administration, in the process of actualizing energy and climate change policies (Derissen et al., 2011). The CoM initiative, launched on 29th January 2008, and the planning tool it promotes, the Sustainable Energy Action Plan (SEAP), are located within this framework and foster the implementation of EU commitments for the Kyoto Protocol with unilateral and voluntary participation of European cities (Alberti and Marzluff, 2004).

During the last several years, the SEAP has become a key tool for developing municipal energy policies, and more than 6989 cities (October 2016) inside and outside EU have joined this initiative (Covenant map). CoM has therefore been assuming an increasing role in achieving the targets of the Kyoto Protocol and, now, of the Paris Agreement. In addition, CoM has been recently heralded by Canete (COP21: EU institutions strengthen alliance with cities through New Covenant of Mayors for Climate and Energy) as "the world's biggest urban climate and energy initiative". The success of this initiative and its ongoing evolution called Sustainable Energy and Climate Action Plan (SECAP) (Q&As for cities) do not remove the complexity and problems of the SEAP implementation.

The SEAP operates as a dynamic tool to be upgraded and optimized based on the obtained results of compliance with EU objectives concerning GHG reduction. From the methodological point of view, the SEAP is based on the results of the "Baseline Emission Inventory" (BEI), which quantifies the energy consumption and CO_2 emissions of an urban territory for the adopted reference year and identifies several short-term (ST) and long-term (LT) actions in different priority areas to be developed in order to obtain the expected GHG reduction. Planning, implementation and monitoring are the three integrated phases by which SEAP goals can be achieved through a coordinated initiative at the municipal level involving public institutions, private stakeholders and citizens.

Monitoring is a key component of the cyclical process of continuous improvement and refinement characterizing the SEAPs, conceived of as dynamic and evolving tools. In fact, during its implementation, the Sustainable Energy Action Plan has to address changing needs and face evolving scenarios. Technological innovation, public policies, economic situation and regulatory framework continuously change, thus demanding a corresponding evolution throughout the whole progress of the SEAP (Schenone et al., 2015). In this sense, the monitoring activities are a crucial opportunity not only to assess the level of implementation but also to evaluate the planning process and to tune the provided measures, according to changes and events.

Abbreviations: BEI, *Baseline Emission Inventory*; CEA, *Cost Efficacy Analysis*; CBA, *Cost Benefit Analysis*; CoM, *Covenant of Mayors*; CoMO, *Covenant of Mayors Office*; DBs, *Data Bases*, JRC, *Joint Research Centre*; MCDA, *Multi Criteria Decision Aid*; M&E, *Monitoring and Evaluation*; MEI, *Monitoring Emission Inventory*; SEAP, *Sustainable Energy Action Plan*

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Following the CoM vision, during the SEAP implementation, the local territory tends to increase its environmental quality through a process of continuous improvement and the relative assessment in subsequent steps. This perspective is well described by the term "monitoring and evaluation" (M&E) that, as clearly evidenced by Annecke (Annecke, 2008), properly represents this dual but integrated process. A successful implementation of the SEAP and, more generally, of an effective urban policy for real GHG emissions reduction, strongly depends on this iterative process of continuous checking and refinement. This result cannot be achieved through only monitoring activities tracking the SEAP actions progress, such as those stated in the CoM monitoring guidelines (Covenant of Mayors Office (CoMO) "Reporting Guidelines on Sustainable Energy Action Plan and monitoring"). Conversely, it requires a thorough integration of survey, control and planning. The word "evaluation" in this context means the assessment of the efficacy of each single action, the ranking of the options to maximize their impact and the decision concerning further steps to be promoted to strengthen the sustainable energy planning. This process is not simple, and diverse experiences (Kona et al., 2015) have shown that SEAP M&E deserves close attention because of the key issues that often hinder an effective implementation of this practice.

In this respect, starting from ideas proposed by the CoM about monitoring, the literature survey and a case study experience (Municipality of Genoa, Italy), the authors address a few main questions. Selected actions are supposed to be able to produce expected GHG reduction, but the track of their implementation and the updates showed that this is not sufficient. Then, after establishing the plan, is there another type of "step" that can be taken to periodically test whether the actions are still efficient or not, considering the current scenario? Monitoring is a tool that has to be considered within the framework of energy planning itself: but how it can become an efficient tool to contribute to the concrete realization of the measures?

After a literature review, this paper illustrates the strategy for SEAP monitoring and deploys the case of the Genoa SEAP for reflections based on field experience. Then, a discussion around the above mentioned main questions is provided, together with a set of recommendations that aim to improve the "evaluation side" of the monitoring process implemented so far.

2. Background and state-of-the-art

It is a shared idea that only through accurate monitoring activities and tracking progress can real SEAP implementation can be achieved. In 2014, the Covenant of Mayors Office (CoMO), in collaboration with the Joint Research Centre (JRC) of the European Commission, released the "Reporting Guidelines on Sustainable Energy Action Plan and Monitoring" document (Covenant of Mayors Office (CoMO) "Reporting Guidelines on Sustainable Energy Action Plan and monitoring"), a tool aimed to control and check the progress of SEAPs. For the implementation of a Sustainable Energy Action Plan in fact, after planning, has to take into account the changing and updating needs, the knowledge scenario and the related administration initiatives; simultaneously, the territory feedback and the economic and regulatory framework also need to be considered. In this sense, monitoring activities are supposed to be the way to control processes and to recalibrate objectives and instruments of implemented measures. The assessment phase deriving from the monitoring should be able to refine the approach in light of the needs and difficulties. Thus, through a multi-stage strategy, we are able to develop virtuous tools for the implementation of actions, according to the cyclic process depicted in Fig. 1.

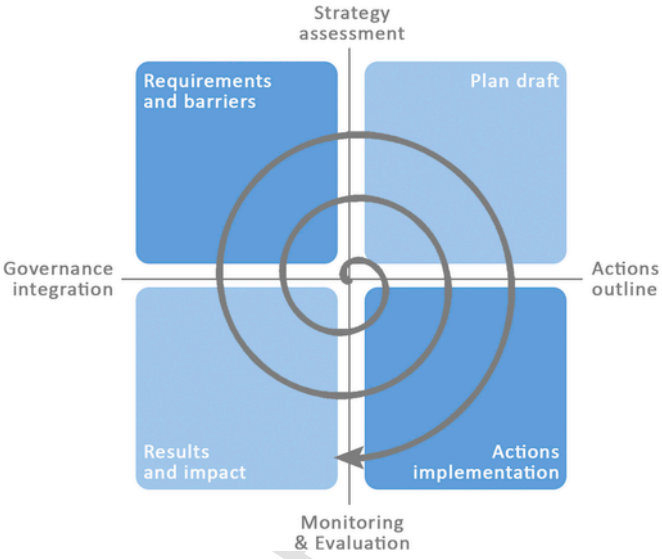


Fig. 1. Cyclical monitoring process of SEAPs.

From the operative standpoint, as stated in SEAP Guidelines (How to develop a Sustainable Energy Action Plan (SEAP) – Guidebook Part II _ Baseline Emission Inventory), CoM signatories are committed to producing two documents after the SEAP submission. The first one, to be submitted every two years, is an implementation report containing qualitative and quantitative information on interventions to evaluate, monitor and verify the status of the Action Plan (SEAP Implementation Status) and its effect; the second one is an update of the CO_2 emission inventory, named the Monitoring Emission Inventory (MEI), to be compared with the Baseline Emission Inventory (BEI) for monitoring the progress in terms of emission reductions every four years. CoM provides a monitoring template for the SEAP Implementation Status, in which every measure presents new fields to be filled in such as staff capacity allocation, overall budget spent so far and, where possible, main barriers encountered during SEAP implementation.

Therefore, according to CoM, the term "monitoring" is a process in which emission assessment and status of the administrative machine are tested. This can be sufficient for providing information about the adopted plan after a set of years; however, this would be not effective enough for a well-designed environmental plan. The word "monitoring" in the energy field quite often refers to the post-completion test of the different action implementations for waste recovery, plant efficiency, consumption reduction etc., becoming a synonym of energy "balance" compared with a reference year. Many methods were applied: Boonekamp (Boonekamp, 2004) added that the analysis of the trends is typically followed by influencing and explanatory factors, which are given as endogen or hexogen factors of misalignment.

Multi-criteria methodologies were also adopted, but, in this case, only for the SEAP planning phase and not for the monitoring phase (Dall'O' et al., 2013); scenario simulation, modelling tools and decision methods applied in the plan's preparation phase were not considered (Mirakyan and De Guio, 2013). Multi-criteria decision aids (MCDAs) are useful in determining the right mix of energy systems and technologies for optimizing investments within certain boundaries and constraints. However, they have mainly been applied for evaluating the efficiency of a single energy plant or technological solution and not of an entire strategy, taking into account a set of crite-

ria to be contemporarily respected (Lehtilä and Pirilä, 1996; Løken, 2007; Pohekar and Ramachandran, 2004; Tsoutsos et al., 2009).

The purpose here is to introduce an M&E practice into the SEAP process to control and foster the sustainable energy plan through a dynamic mechanism. A survey on what "monitoring" and "evaluation" means and the conditions under which each might be useful is needed for understanding not only the correct use of terms but also the underlying concepts. As mentioned previously, Annecke (Annecke, 2008) provided simple definitions of "monitoring" and "evaluation" that can better clarify a dual approach: "monitoring" (M) is a continuing operation that ensures that the plan is able to stay on track, while "evaluation" (E) is a periodic assessment of the relevance and performance of the plan. Both activities are part of M&E practices founded on the integrated or independent exigency to track implementation progress and learn from experience to design better in the future. Rossi et al. (Rossi et al., 2004) overcame the concept of monitoring as bare measuring of variations in the indicators at a certain 'work in progress' stage. In general, monitoring is part of the process to aid in decisions concerning whether programs are to be continued, improved, expanded or curtailed, and this is true for energy planning as well.

This last approach is very applicable to the case of the SEAP, which is expected to be *monitored* by the CoM in compliance with the European rules but also to be *evaluated* to ensure that it is efficient and dynamic. According to this perspective, *monitored* actions that form the Sustainable Energy Action Plan and the updating of the BEI are not sufficient to ensure the expected GHG reduction. Only a further phase, referred to as *evaluation*, allows the SEAP monitoring approach to be more complete and operative. The monitoring tool is required to be an efficient tool for contributing to the concrete realization of interventions; however, this result cannot be guaranteed by the simple tracking of trends. Feedback from the field needs to be understood and assessed, and the following decisions have to be steered in the proper direction. In this way, SEAP monitoring is to be included in M&E practices; then, other issues regarding the evaluation of the plan, its methodology and the expected outcome can be addressed.

3. The monitoring of the Sustainable Energy Action Plan

In this section, the method currently used to monitor the SEAP is analysed, and a practical implementation of this process is examined. Thus, the current approach for this issue will be exemplified, and its strengths and limits will be highlighted. This is not a trivial contribution because the definition of the monitoring method is very recent and is still open to refinements and corrections; few cites currently involved in the CoM have adopted a conscious procedure for managing the SEAP development. The following paragraphs not only describe a methodology and set a benchmark but also create the background for a critical analysis, aiming to determine more effective practice.

3.1. Sustainable Energy Action Plan and monitoring reporting

A first guideline for the SEAP monitoring has come from the Joint Research Centre of the European Commission (Covenant of Mayors Office (CoMO) "Reporting Guidelines on Sustainable Energy Action Plan and monitoring"), which is the research centre committed to directing the CoM for all technical aspects. Following that guideline, to monitor SEAP implementation, a "Full Reporting" document and the Monitoring Emission Inventory (MEI) must be submitted every four years to evaluate the municipality's energy situation and the CO_2 emissions trend. The template in the SEAP monitoring foreseen by JRC are divided into three different main parts: 1) Overall strategy, committed to modifications and updating staff and financial capacities, 2) Emission inventory, related to monitoring GHG emissions, and 3) the Sustainable Energy Action Plan for directly evaluating the SEAP interventions development.

To monitor the SEAP actions progress, the updating activity of each measure has to be divided into the following phases:

1. Determination, within the municipal organization, of contact persons for each SEAP action through formal enquiry.
2. Encounters with contact persons to agree on procedures and timing and to request information needed for SEAP monitoring.
3. Technical meetings and information requests.
4. Qualitative and quantitative assessment of actions progress.

For the Monitoring Emission Inventory, the territory governance should be familiar with the data collection and processing tools and should encourage coordination with local organizations of citizens; the tools should also seize opportunities resulting from initiatives at local, regional and international levels.

The adoption of tools in support of local authorities to facilitate energy decision making is recommended, as well as taking on systems for internal recognition and data systematization. These "Decision Support Tools" allow, for instance, the functional mapping of energy consumption of the territory and intervention scenario simulations for different sectors' policies and programming. At the same time, for MEI filling, it can be helpful to use pre-existing databases from public administrations or private institutions for the purpose of optimizing available resources in planning inventories.

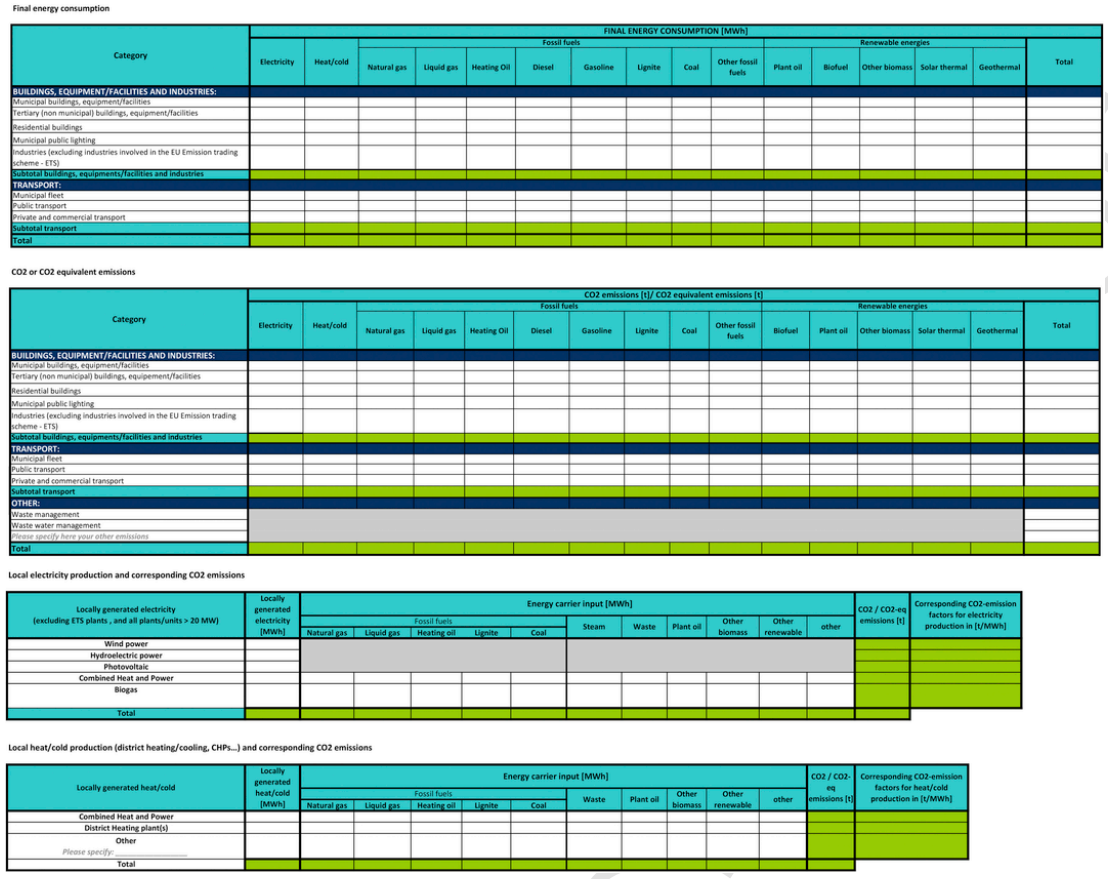
The MEI involvement of citizens is to be implemented as a general strategy by the municipalities based on three steps: population participation through public events focused on relevant subjects, workshops with citizens and their associations and, as a permanent initiative, the establishment of specific thematic associations involving diverse stakeholders. These actions promote a process of transformation to the new concept of a sustainable city.

From the operative viewpoint, the MEI (Fig. 2) appears to be an updated version of the BEI referring to a specific monitoring year in order to easily compare the two documents and to track the progress of SEAP implementation. As the Baseline Emission Inventory, the MEI calculates the current amount of final energy consumption and the associated CO_2 emissions in terms of energy carrier and sector such as building equipment facilities, industries, transport, agriculture, forestry and fisheries. Indicating the fuel emission factors makes it then possible to automatically evaluate the associated CO_2 emissions. Furthermore, information on energy supply (municipal green energy purchases, local/distributed electricity and heat/cold production generated from renewable energy sources and CHP plants) must be included in the related parts of the MEI template.

Just as with the BEI (How to develop a Sustainable Energy Action Plan (SEAP) – Guidebook Part II _ Baseline Emission Inventory), the MEI compilation is also quite complex because of the difficulty in collecting consistent and coherent data. In many cases, in fact, the availability of complete data sources with the same level of granularity (or aggregation) is almost impossible, thus making statistical processing or adoptions of other indicators necessary.

3.2. The Genoa SEAP monitoring

When applying the above described methodology to a real condition, i.e., to a particular city and its sustainable energy plan, several elements need to be detailed and specified, starting from the refer-



Final energy consumption

Category	FINAL ENERGY CONSUMPTION [MWh]															
			Fossil fuels								Renewable energies					
	Electricity	Heat/cold	Natural gas	Liquid gas	Heating Oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES:																
Municipal buildings, equipment/facilities																
Tertiary (non municipal) buildings, equipment/facilities																
Residential buildings																
Municipal public lighting																
Industries (excluding industries involved in the EU Emission trading scheme - ETS)																
Subtotal buildings, equipments/facilities and industries																
TRANSPORT:																
Municipal fleet																
Public transport																
Private and commercial transport																
Subtotal transport																
Total																

CO2 or CO2 equivalent emissions

Category	CO2 emissions [t]/ CO2 equivalent emissions [t]															
			Fossil fuels								Renewable energies					
	Electricity	Heat/cold	Natural gas	Liquid gas	Heating Oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biofuel	Plant oil	Other biomass	Solar thermal	Geothermal	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES:																
Municipal buildings, equipment/facilities																
Tertiary (non municipal) buildings, equipement/facilities																
Residential buildings																
Municipal public lighting																
Industries (excluding industries involved in the EU Emission trading scheme - ETS)																
Subtotal buildings, equipments/facilities and industries																
TRANSPORT:																
Municipal fleet																
Public transport																
Private and commercial transport																
Subtotal transport																
OTHER:																
Waste management																
Waste water management																
Please specify here your other emissions																
Total																

Local electricity production and corresponding CO2 emissions

Locally generated electricity (excluding ETS plants , and all plants/units > 20 MW)	Locally generated electricity [MWh]	Energy carrier input [MWh]											CO2 / CO2-eq emissions [t]	Corresponding CO2-emission factors for electricity production in [t/MWh]
		Fossil fuels					Steam	Waste	Plant oil	Other biomass	Other renewable	other		
		Natural gas	Liquid gas	Heating oil	Lignite	Coal								
Wind power														
Hydroelectric power														
Photovoltaic														
Combined Heat and Power														
Biogas														
Total														

Local heat/cold production (district heating/cooling, CHPs...) and corresponding CO2 emissions

Locally generated heat/cold	Locally generated heat/cold [MWh]	Energy carrier input [MWh]										CO2 / CO2-eq emissions [t]	Corresponding CO2-emission factors for heat/cold production in [t/MWh]
		Fossil fuels					Waste	Plant oil	Other biomass	Other renewable	other		
		Natural gas	Liquid gas	Heating oil	Lignite	Coal							
Combined Heat and Power													
District Heating plant(s)													
Other													
Please specify _____													
Total													

Fig. 2. Structure of the MEI template.

ence year. Taking from the monitoring process that the Municipality of Genoa started autonomously just after the SEAP submission to the European Commission, the city arrived at the four-year monitoring deadline of the MEI with a solid background of information, not only related to what was required by the Covenant but also to the general status of the current sustainability actions and the ongoing monitoring steps.

Based on the current governance process, it was decided to report the MEI to year 2011, for which SIRA, the Environmental Information System of Liguria Region (which Genoa belongs to), makes available complete energy balances at regional, provincial and municipal levels, and from which it is possible to obtain information on the final energy consumption of Genoa's territory.

These data were then integrated and improved for some sectors and energy sources with data provided directly from other parties. SEAP monitoring then used the sectors that had been recommended by JRC (Covenant of Mayors Office (CoMO) "Reporting Guidelines on Sustainable Energy Action Plan and monitoring") and already applied in the Action Plan. The sectors of buildings (EDI), lighting (ILL), transport (TRA), local energy production (PEL), district heating and cooling (DIS), urban planning (PT), public procurement (PRO) and participation and awareness (PIN) were all analysed, and the related measures were monitored and evaluated.

According to European directives, the Italian Ministry of Environment and Protection of Land and Sea has developed the "Green Public Procurement National Action Plan" (NAP GPP), to which all public authorities are obliged to comply. Green procurement aims to minimize the use of non-renewable resources, raw materials, and energy from fossil fuels in order to reduce CO_2 emissions, the use of hazardous substances and waste. The Genoa City Council intends to commit at least 30% of expenditures to green purchasing; however, it was technically impossible to quantify the initiative with precise data, and the attributed CO_2 reduction was considered irrelevant in respect of the total amount. Similarly, the 0.5% attributed to PIN and PT was esteemed considering the multiplication effect expected by this type of action (namely, planning, programming, awareness increasing etc.), whose impact cannot be predicted through a strictly quantitative approach but that represent an unquestionable contribution to the overall goal of the action plan. In fact, several experiences evidenced the relevance of urban planning for pursuing energy efficiency and environmental sustainability in historic cities such as Genoa (Fernández-Maldonado et al., 2016).

The SEAP actions monitoring was conducted with an approach designed to analyse both the progress of every single action and its environmental impact. In particular, the actions progress assessment consisted of the verification of improvement updates of the SEAP interventions to 2014, both qualitatively through the definition of eight classes (not started yet, in definition phase, started, in progress, advanced, completed, postponed and cancelled) and quantitatively through progress percentages. On the other side, the environmental monitoring concerned the energy savings and associated CO_2 emission reductions to 2014 in each sector (Table 1) due to each action, as required by the JRC Monitoring Guidelines. In addition, where possible, values of energy production from renewable sources are shown.

It should be underlined that the percentage allocation of CO_2 savings was obtained by assessments varying from case to case to preserve the uniqueness of cases and the specificity of estimates. This al-

Table 1
2014 energy savings and CO_2 emission reductions in Genoa Municipality territory.

Sectors	Energy savings [MWh]	CO_2 emission reductions [tCO_2]	RES production [MWh]
EDI	100177	34580	411
ILL	13295	6422	–
TRA	133873	34104.5	–
PEL	20493	9897	20493
DIS	0	0	–
PT	0	7673	–
PRO	0	0	–
PIN	0	8512.5	–
Total	**267838**	**10118**	**20904**

lowed highlighting the presence of critical issues affecting the performance of the actions. Moreover, by the comparison between the interventions progress and the corresponding environmental improvement, it was possible to better understand the critical issues and identify possible corrections or improvements.

Regarding the progress of Genoa's SEAP actions (Table 2), for a total number of 86 interventions, almost all have been completed, started or at least defined. The description of all the SEAP actions, divided in short or long term, can be found in Schenone et al. (Schenone et al., 2015). During the monitoring, critical issues emerged related to interventions no longer valid due to updates of administrative policies or due to extreme difficulty in the implementation so that some actions needed to be deleted. Moreover, at the end of 2014, four actions related to local electricity production had not started yet, mainly due to technological hurdles and realization difficulties.

For the quantitative results, the sector with the highest energy consumption and from where the most of the GHG emissions derive is the civil sector (public administration, commercial, residential and public lighting), representing 77% of the total, compared to 23% of the transport sector (Fig. 3a). Regarding CO_2 emissions, the civil sector has a slightly higher weight, accounting for 79% of total emissions. In the civil sector, the leading cause of fuel consumption and emissions is due to the residential buildings, which accounts for 44% of the energy consumption and 42% of emissions; public administration accounts for 27% of the energy consumption and 31% of the emissions (5% in both cases), followed by public lighting (3% of fuel consumption and 4% of CO_2 emissions) (Fig. 3b).

As presented in Fig. 4, comparing BEI (2005) and MEI (2011) CO_2 emissions in terms of fuel, a significant reduction in the consumption of natural gas (−5.3%) and gasoline (−8.7%) can be noticed. Observing the sector comparisons, from 2005 to 2011, there was a reduction of 7.2% in the civil and 2.3% in the transport sectors in terms of CO_2 emissions..

This experience highlighted some critical aspects in SEAP monitoring, which should be discussed in order to learn from them and to determine general elements capable of steering other cities facing the

Table 2
2014 Genoa's SEAP actions progress.

Progress state	No. of actions
Not started yet	4
In definition phase	12
Started	15
Ongoing	18
Advanced	11
Completed	18
Postponed	6
Cancelled	2

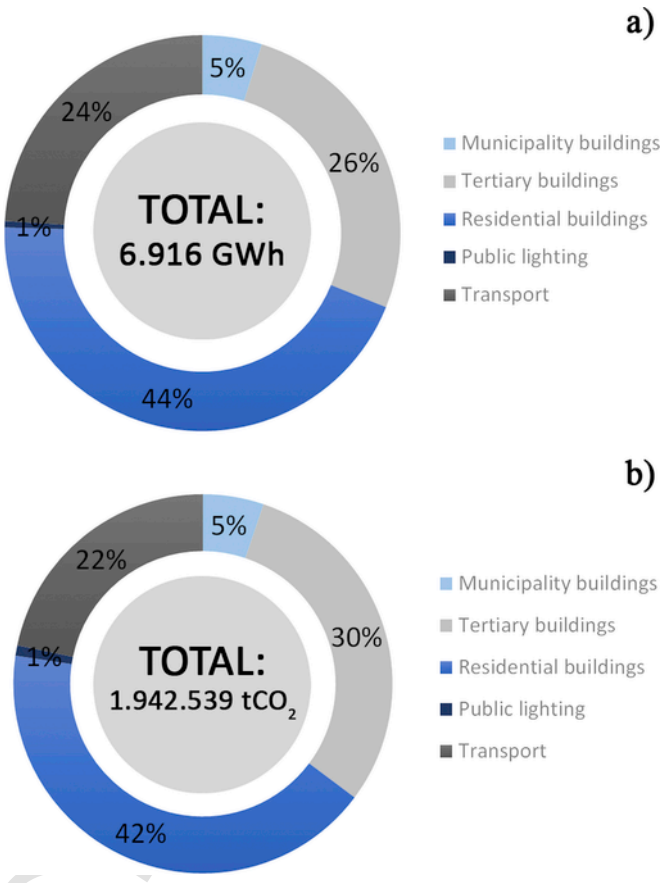


Fig. 3. Sector impacts in 2011: a) final energy consumption; b) GHG emissions in Genoa Municipality territory.

same issues. In this sense, the practice in Genoa represents a relevant benchmark to test methods and check operative options aiming to a local sustainable energy policy, thus giving general meaning to the specific trial.

In general, difficulties or delays in actions implementation were due to:

- procedural factors, such as appeals in tender procedures,
- boundary conditions, such as lack of funding or market changes (e.g., the decrease of electricity costs impacted district heating and cooling interventions)
- difficulty in activating governance process, related to the retrieval of data, the involvement of the sector operators and sometimes inherent complexity of the action;
- the need to raise awareness and capitalize on technological opportunities, which are processes that cannot necessarily be achieved in a very short time.

Concerning the results from a monitoring perspective, almost all short-term measures have started, and several have been completed, while long-term ones are mostly at the design phase (for EDI, ILL, PEL, PT, PRO, PIN sectors). For the district heating and cooling sector (DIS), actions present a sharp slowdown with respect to the expected trend at the SEAP writing. In fact, in recent years, due to the decrease in electricity costs, the construction of new cogeneration plants was not as convenient as estimated in 2009, i.e., the year in which the CoM was signed. For the mobility system (TRA), it should be specified that the sector has emitted smaller quantities of carbon dioxide in recent years compared with the expected trends (due to the

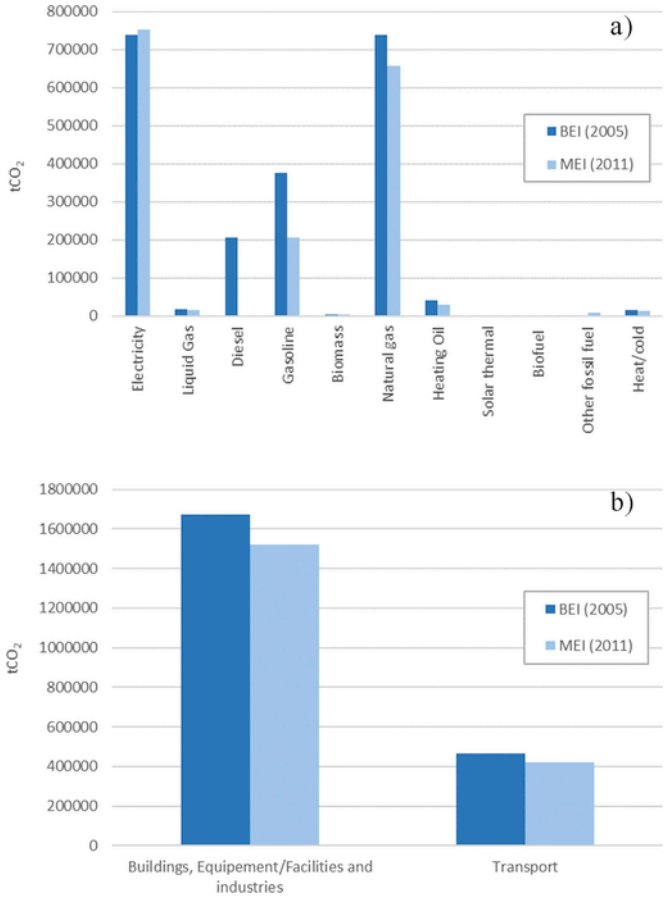


Fig. 4. Comparison of CO_2 emission BEI and MEI data in terms of: a) fuel; b) sectors.

global economic crisis), even lower than what was forecast based on actions implementation.

In other words, while some actions suffered a procedural gap, others had their reference scenario totally changed. This shows how formal monitoring cannot express the actual picture of the situation, justifying a municipal roadmap revision.

4. Discussion and recommendations

The growing concern about the quality of the urban environment has stimulated research in the area of evaluation of sustainable energy programmes, even if the extent of its concrete benefits depends upon whether the programmes meet the proper requirements to be operatively implemented (Clinch and Healy, 2001). This idea can be applied to the SEAP process, which was shown to suffer from the same problem. The monitoring procedure requested by CoM requires an updated calculation of the BEI (MEI), provided with data collected in the different databases, and a report on the status of the Action Plan implementation, through updates on interventions by the Municipality and involved stakeholders, to evaluate the reduction of GHG emissions and qualitative and quantitative actions progress so far (Fig. 5). However, starting from the experience implemented in Genoa, information about the actual efficiency evaluation of the selected actions (and much more if we consider their value with time) is still lacking. For this purpose, significant attention is paid here to the "evaluation side" by a set of proposals aiming to improve the monitoring procedure provided for the SEAP so far.

As shown by Genoa's SEAP progress up to 2014 in Fig. 6, in terms of both actions progress in percentage and CO_2 emissions reduction, very few sectors correspond to the expected values: the best trend currently belongs to the PIN, PT and PRO sectors, which contain only initiatives not calculated in a strictly deterministic way. Although the calculation of the actual reduction effects was uncertain, even in the PRO sector, some actions were proposed; thus, it is possible to take into account the implementation status of the actions (%), even if they were not associated with a precise CO_2 decrease.

In absolute terms, TRA and EDI are running well, but considering that they are the decisive ones, the most energy must be devoted to them. This acknowledgement should determine a consequent governance strategy for Genoa in implementing "core" actions. Is this already the case? Are they easy to implement, and what is the level of feasibility of the interventions they promote? Are there any "enhancement factors" that can be crucial for their realization (which implies a large part of the overall efficiency)?

In current literature, identified "enhancement factors" mainly refer to the *cost benefit and cos -efficacy analyses* (not required by the CoM yet), the *bankability* requirements (assumed as a key factor in fund assignment for the "EU Smart City Initiative" since 2011), the opportunity of *peer reviewing* activities made by third parties (for instance in a second step in the M&E deployment) and the expectation of a stronger *participatory level* (the actual degree of consensus can make an action efficient). Difficulties met in implementing the Genoa SEAP are mainly due to limited attention initially given to these elements. Their adequate consideration can then result in a more effective SEAP M&E practice.

In the energy field, many references about the application of *cost benefit analysis* (CBA), *cost efficacy analysis (CEA)* and *multi-criteria decision aids (MCDAs)* can be found; they are tools considered either alone or implemented together as contributors to the decision-making procedure but are not sufficient as "stand alone" criteria.

As noticed by Hanley and Spash (Hanley and Spash, 1993), at the very beginning (in the 1930s), CBA was born as a process of estimating benefit and market information to aid budget allocation, where expenditure plans are subject to an appraisal that can include a CBA/CEA component. Above all, for the scope of SEAP, the consideration of alternative instruments for developing actions and achieving goals is interesting. Applications of CBA/CEA can be more or less sophisticated, but generally speaking, they are often not implemented by local bodies mainly because of problems with the weights used for evaluation. Uncertainty (for instance related to energy prices and available technologies) and inequality (different conditions of access to affordable energy services) are difficult points for administrations to manage, but the use of economic analysis, within an M&E practice perspective, is crucial for the periodic assessment of the plan; consequently, all indicators should be focused on that. On the other hand, CBA can be applied in a very simple way because the main goal of the process, i.e., GHG reduction, is clearly stated at the submission of the plan. The cost analysis is very useful for calculating the effective costs of realizing the actions, bringing them to the present net value, and selecting the most efficient projects from a portfolio of alternative options that are still profitable. The case of cogeneration in Genoa shows how these considerations are crucial in energy planning. This process can provide a sort of financial prioritization of the actions list, selecting those that are the most promising because of the lesser economic burden for a certain expected GHG reduction so that efforts can be focused on key actions that are evaluated to be more efficient in terms of the cost/benefit ratio.

Looking at Table 3, within the most relevant actions, the majority (that should have been accomplished by 2014) have not yet con-

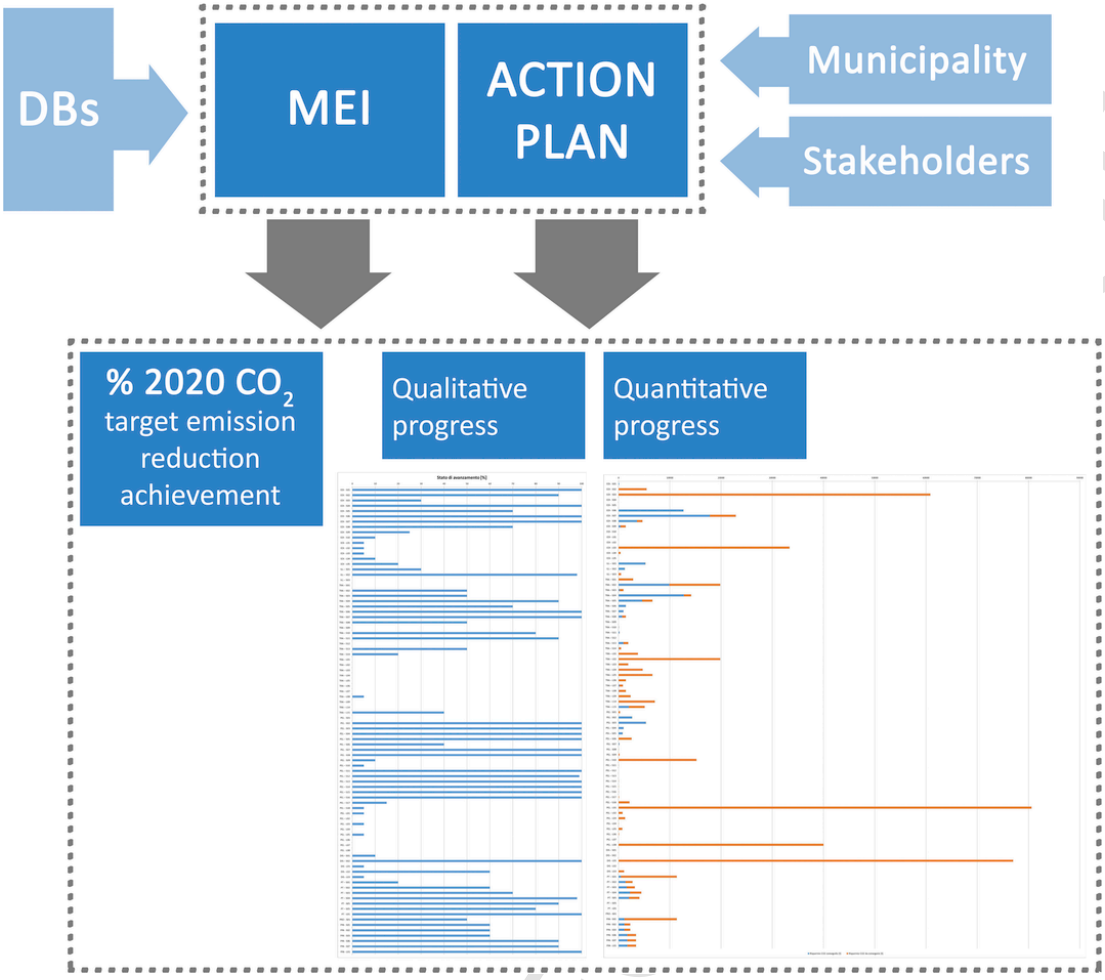


Fig. 5. Monitoring process flowchart.

cluded. Therefore, some questions arise: What is the relationship between an action's "status" and their consequences in the overall efficiency of the plan? Starting from the steps already performed in the current monitoring process, the answer to this question is not evident; therefore, it is not clear what is useful for the Municipality governance evaluation. If there will not be any opportunity to proceed with them, is the plan, according to the new MEI, still valid? Is the plan able to provide the target CO_2 reduction today?

The case of Genoa shows how this is a point that is lacking in the SEAP monitoring: the sole control of the actions' advancement did not provide a selection in terms of the cost-effectiveness relationship to prioritize a core of meaningful initiatives. In this way, the monitoring process did not match an "evaluation side" point, and it did not allow the administration to consciously decide on the following steps. Therefore, it is strongly recommended to address this issue from the first stages of the SEAP development and to introduce an evaluation step to properly address CBA when monitoring.

Even if MCDA methods are more frequently used for optimization rather than for evaluation, they are often associated with CBA and CEA (Diakoulaki and Karangelis, 2007) and were helpful to determine the right mix of energy systems and technologies for optimizing investments within certain boundaries and constraints (Lehtilä and Pirilä, 1996; Løken, 2007; Pohekar and Ramachandran, 2004; Tsoutsos et al., 2009). In this sense, MCDA methods appear to fit the needs of SEAP monitoring because they consider the investment cost as the primary criterion (Wang et al., 2009).

The link between sustainable policy and financing is often unclear. Wiser and Pickle (Wiser and Pickle, 1998) noticed that scarce long-term financial foresight can have negative impacts on costs and reduce effectiveness of the programmes even though energy policies are carefully designed. However, how can financial affordability be managed by municipalities? What type of economic framework and professional support should be implemented? CoM experience shows that during the development of sustainable energy plans, the financial aspects are neglected and misunderstood, whereas a supporting financial strategy is absolutely necessary. The consequences of this oversight deeply affect the implementation of the measures and, more generally, the overall efficacy of the plan. CoM requires a financial balance at the moment of the SEAP submission for each planned action, but economic uncertainty and short-sighted political scenarios usually disturb the approach to this prerequisite. Nevertheless, during the monitoring phase, the opportunity to remedy this weakness arises because over time, evaluations of actions' feasibility can be achieved: after technical, political and administrative requirements are met, financial issues can be clarified and made precise. In this way, through a long-term public commitment, loan agreements, public markets bonds and institutional debts can be structured from internal and external resources in a large number of ways, above all for actions regarding renewable energies (Bender et al., 2011; Eze, 2010).

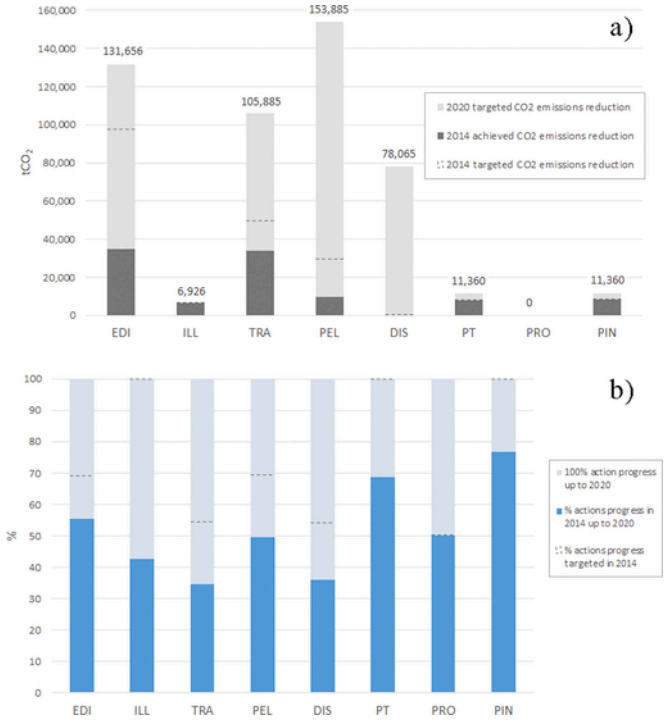


Fig. 6. Genoa's SEAP progress by 2014 compared to the expected reduction by 2020 for each sector: a) actions progress in percentage; b) CO_2 emissions reduction.

The lack of appropriate financial planning for the SEAP measures is also due to the accuracy of *bankability* estimations: these are usually taken into account for large plants and infrastructures, as in Arowolo (Arowolo, 2006), but bankability often constitutes a prerequisite even for EU project funds' assignment, where competences apt to carry out business plans and risks analysis are expected. All of these features are currently neglected in the Action Plan. This gap must be corrected in a serious M&E process: the performance of the entire plan is heavily affected by those actions that are shown to be ineffective from the cost-benefit and bankability viewpoints; the plan's reviewers need to address this type of problem to give a formal assessment. Therefore, the bankability is inherent the SEAP management and implementation, not less than its preparation.

Peer reviewing can be adopted for policy or plan impact evaluation (Pang et al., 2014). In literature, according to the definition of Chen (Chen, 2002), the concept of "peer reviewing" is utilized to measure a step or a product as a decision management unit in which efficiency needs to be assessed. In this sense, a two-step procedure can be foreseen. The first step is made internally by the planners (along the lines of the monitoring adopted so far) and the second step is made by external experts, who might be responsible not only for the rules to be compliant to but also for evaluating whether the plan is still performing. Figures collected at the reference year (cost-benefit ratio, energy/fuel prices, discount rate etc.) can change according to hexogen factors, compromising measure feasibility and efficiency over time. An efficient M&E practice should involve a peer review to assess this type of issue, to stop some initiatives (for lack of cost-effectiveness or bankability, for instance) and to suggest new actions to introduce or old ones to adjust. The interval of four years, stated by the CoM, for the plan to be revised within could be meaningful for this peer review as well. As far as Genoa is concerned, the external review would have permitted tuning local dynamics with general trends and to re-orient decisions and investments, preventing the monitoring process from becoming only a bureaucratic fulfilment. Starting from the Genoa experience, two alternatives of peer reviews can be adopted: an autonomous and informal process, freely entrusted to third parties by the municipalities, or a more structured one (managed for instance by the JRC), completely independent from the local background but implying an increase of complexity and an extension of times.

Another important aspect, which is crucial for actions to achieve the CO_2 reduction target, is the *participatory level* that the municipality is able to activate during the four-year period to realize the SEAP measures. The M&E process, after the first period of the plan's implementation, must be able to judge the degree of *stakeholders' involvement* that is necessary to accomplish the actions. If institutional settings about environmental issues cannot be managed by municipalities, Bai et al. (2010) suggest that increasing public participation and networking are positive points for the local bodies. This seems to be an urgent need for a better understanding of how the evolutionary process of urban policies management could be co-steered: public participation or civic models of engagement can reduce conflicts and encourage local initiatives, especially with regards to RES projects and ICT innovation (Denis and Parker, 2009; Higgs et al., 2008). In Genoa municipal initiatives, citizens' direct involvement (for instance, through so-called living labs) has produced fruitful results, so this prerequisite can be inserted into the SEAP M&E practice as a crucial point in the selection of priority actions. From the M&E point

Table 3
Relevant actions in connection with their status.

Action code	Action title	Short- or long-term	To be completed by	Progress status	Target result [tCO_2]	Achieved result so far [tCO_2]
EDI – S03	Building regulations	S	2014	started	60844	0
TRA – S02	Resident permit parking policy: extension of blue areas	S	2014	in progress	19850	9924
PEL – S10	Wind-farm installation within Genoa municipality territory	S	2014	in definition phase	15214.5	0
TRA – S04	Infrastructure interventions	S	2014	advanced	14178	12760
EDI – S07	Multi-service technology agreement for local health centres of Liguria Region	S	2014	in progress	12760	17825
EDI – S06	Retrofitting for heating systems (conversion from heating oil to natural gas)	S	2014	completed	12664	12664
TRA – S05	Environmental islands	S	2014	started	6616	4631
EDI – S02	Tenders/out-contracting for management of heating systems	S	2014	in progress	5474	0
PEL – S03	Re-powering of energy from biogas plant at Monte Scarpino landfill facility	S	2014	completed	5331	5331
ILL – S01	Energy efficiency measures for street lighting	S	2014	in progress	5224	5224

of view, the interest in stakeholders' mobilization and cooperation refers to the feasibility aspect: the possibility to share solutions and experiences among citizens is certainly a key factor for the actions' viability and flexibility and therefore their efficiency and effectiveness. Enhanced public participation, networking and learning across cities can make actions performing better (Campbell, 2009; Hildingsson and Johansson, 2016). In addition, an attentive evaluation process must reveal how many actions can count on this precondition and so be "labelled" to be rethought, improved or cancelled.

5. Conclusion and policy implication

Because of the innovative nature of the SEAP, the related monitoring activity stands out as breaking new ground. In this sense, the monitoring needs to be continuously validated in terms of both content and method, developing a new dynamic strategy to assess and control the progress in urban energy policy. Moreover, the SEAP monitoring has to look at both the progress of each single action and its global environmental effect because it requires more than one level of examination and defines a whole process for a durable reduction of GHG emissions from urban areas.

The activity implemented in the city of Genoa is representative of that challenge and is a helpful test case for other cities addressing the same issues. The analysis of obstacles and opportunities faced by the city of Genoa in monitoring may help other cities in defining a strategy from its very beginning and implementing the long-term process of SEAP, thus facilitating the dissemination and replication of best practices. That experience led the authors to propose some recommendations to better outline the M&E methodology.

The approach to the SEAP monitoring has been first analysed with a general meaning and the phases needed for its implementation have been highlighted. The MEI development is a key element of this monitoring strategy, and, despite its complexity, is an opportunity to involve citizens and create a fertile network of cooperation in collecting data regarding energy sustainability. Then, a practical application to the Municipality of Genoa has been analysed to identify methodologies that can have a general value and guide other cities involved in similar activities.

The effectiveness of the analysis of MEI and SEAP Implementation Status can be positively influenced and completed by a CBA/CEA procedure, which is able to improve the M&E strategy and to facilitate selecting the best option. Bankability assessment has been demonstrated to be a key issue to achieving real implementation of the planned initiatives; otherwise, actions often suffer financial weakness. To measure the efficacy of the SEAP, peer review is an operative tool that can also tune actions in accordance with changing external factors that can compromise measure impacts over time. Attentive selection of actions grounded on citizenship participation is able to produce fruitful long-term results and to enhance the SEAP monitoring impact on the municipal environmental policy.

The urban process towards a sustainable use of energy needs a combined implementation of the SEAP actions and of their monitoring, which requires an organic transformation involving public administrations, business, academics and citizens. The core of this transformation is a process through which the progress of sustainable energy planning is assessed and directed, according to a well-defined M&E practice. The implementation of this "Monitoring and Evaluation" process is full part of the SEAP and a key point for its successful implementation, which dynamically involves all of the phases from the very beginning to the accomplishment. More than just an option, this good practice is a necessary condition to effectively pursue energy sustainability as a perspective for fruitful environmental management.

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