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Local strategies and action plans towards resource efficiency in South East Europe

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ABSTRACT

The role of cities and their commitment to meet the European targets on energy and climate has steadily increased in the latest years as testified by the large number of ambitious initiatives undertaken by European cities to face multiple challenges towards sustainability. Many projects and initiatives have arisen all around Europe to support cities in the achievement of the Europe 2020 targets of smart, sustainable and inclusive growth. RE-SEEties "Towards resource-efficient urban communities in SEE" is one of the projects funded under the South East Europe program aimed to enhance the policy-making and strategic planning competences of municipalities in the field of energy efficiency, renewable energy sources and waste valorization.

This paper focuses on the methods developed and the main results achieved in the framework of RE-SEEties. The main focus is on the eight partner cities (The Local Government of Budapest District 18 – Hungary/HU, Municipality of Aigaleo – Greece/EL, Municipality of Potenza – Italy/IT, City of Nitra – Slovakia/SK, City of Skopje – Former Yugoslav Republic of Macedonia/FYROM, City of Miercurea Ciuc – Romania/RO, Municipality of Ptuj – Slovenia/SI, City of Ivanić-Grad – Croatia/HR) and how they were assisted by professional institutions in translating their commitments towards resource efficiency into Local Strategies and Action Plans. A critical comparison of these final results points out differences and similarities in the state-of-the-art of cities across South East Europe as well as a the level of ambition and difficulties faced to turn into resource efficient urban communities.

1. Introduction

European cities are responsible for about 70% of the overall primary energy consumption and represent the primary source of greenhouse gas (GHG) emissions in Europe [1]. In this framework, reducing the GHG emissions from municipal waste management can contribute to combating climate change [2]. This concept is strengthened by the resource-efficient Europe flagship initiative [3] and the communication of the Commission "Towards a Circular Economy" which call for a transition of current economy to new modes of consumer behavior [4].

On the one hand, cities are the major centers of population and infrastructure which are particularly vulnerable to extreme weather events and other effects of climate change [5], on the other hand, they are the basic units for policies that have significant impacts on the local and global environment [6]. As a matter of fact, local and regional authorities are the level of government where policies decided at higher levels are implemented turning strategies and visions into true action plans and demonstrating tangible results to citizens, as recently pointed out by the European Union (EU) Committee of the Regions [7]. It is in cities that low carbon innovations can be put in place, the behavior of individuals can be directly influenced and where multi-level governments and groups of interest may interact [8].

In the latest years the role of cities has changed from providers of services (such as waste collection and public transport) to main players on energy and climate issues. In particular, European cities and regions have undertaken local actions to mitigate climate change, e.g. through an increase of energy efficiency and a greater use of renewable energy sources. Brandoni and Polonara [9] point out that municipalities have an important role in the energy-planning process, contributing to promote the transition to a low-carbon society and promoting more sustainable energy behaviors among citizens. Moreover, more and more local authorities have been involved in international climate networks [10], such as the EU Covenant of Mayors [11], the Climate Alliance [12], the International Council for Local Environmental Initiatives (ICLEI) [13] and the C40 Climate Leadership Group (C40cities) [14]. More recently cities are trying to strengthen their resilience to the inevitable impacts of climate change signing up the

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Covenant of Mayors Initiative on adaptation to climate change (Mayors Adapt [15]) which foster cities to develop a comprehensive local adaptation strategy or integrate adaptation to climate change into relevant existing plans. These initiatives are very important considering that existence of climate change plans is very uneven across Europe and the number of urban adaptation plan is still low compared to mitigation plans [16].

Nevertheless there are still obstacles to "bringing solutions for global issues to the local level" [17] mainly due to the intrinsic complexity of a multi-level governance approach and the uncertainties related to the multiple actors, interests and interactions involved at municipal level. Stakeholders involvement is therefore essential to overcome these difficulties and to assure the effectiveness of the proposed strategies through the identification of public concerns, the mutual exchange of experiences and an increased cooperation with Municipalities and among communities (e.g., [18,17,19]).

Several initiatives have arisen all around Europe to help local authorities to develop local energy and climate action plans (e.g. [20,21]). Different definitions of action plans are available in literature, and generally refer to "a declaration of intent, a commitment to fulfill the action within a reasonable timeframe" [22]. In particular, climate action plans are "strategic plans that establish policies and programs for mitigating a community's greenhouse gas (GHGs) emissions which typically focus on transportation, energy use, and solid waste" [23]. Among them, the Sustainable Energy Action Plans (SEAPs) are implemented following specific principles set out in the Covenant of Mayors guidelines [24]. A SEAP is based on an in-depth recognition of energy consumption and emission inventory at the base year and provides a list of technical measures to be implemented by 2020, according to a predefined timetable, to reach the GHG emission reduction target set by the local administration. The proposed measures are accompanied by detailed information on energy savings, related emission reductions and investment costs. Marinakis et al. [25] performed a review on tools and methods for SEAP's development and elaboration based on relevant activities and European co-financed projects. Moreover they developed a methodology to support the elaboration of energy plans for local communities, implementing it in rural communities among four countries (Austria, Croatia, Greece and Portugal). Dall'O et al. [26] developed a comprehensive and effective tool to support the choices of public administrators in programming Sustainable Energy Action Plans. In particular they applied a multi-criteria methodology, Electre III, to compare different strategies. Damsø et al. [27] applied a quantitative content analysis approach to all Danish local action plans utilizing a coding scheme for each considered category. Within the MuSAE project [28] a tool was implemented to help municipalities in all aspects related to the energy and environmental planning.

Beyond Europe, the U.S. Department of Energy (DOE) in collaboration with the Vermont Energy Investment Corporation (VEIC) developed the Community Energy Strategic Plan (CESP) approach aimed at supporting the development of local energy plans [29].

There are numerous projects funded to support local communities in the integration of low-carbon strategies in all sectors of urban planning, as the Urban-LEDS project (An Urban Low Emissions Development Strategy) whose main output, "the GreenClimateCities methodology" aims to support local climate and energy planning [30]. An interesting attempt to provide strategic guidance for municipalities on how to improve resource efficiency and mitigate climate change in urban planning was made in the framework of the RE-SEEties project "Towards resource-efficient urban communities in SEE" funded under the South East Europe program. The main focus was on energy planning and waste management which were approached in a comprehensive way through five main pillars: policy making, financing of local investments, good practices, engineering tools to support deci-

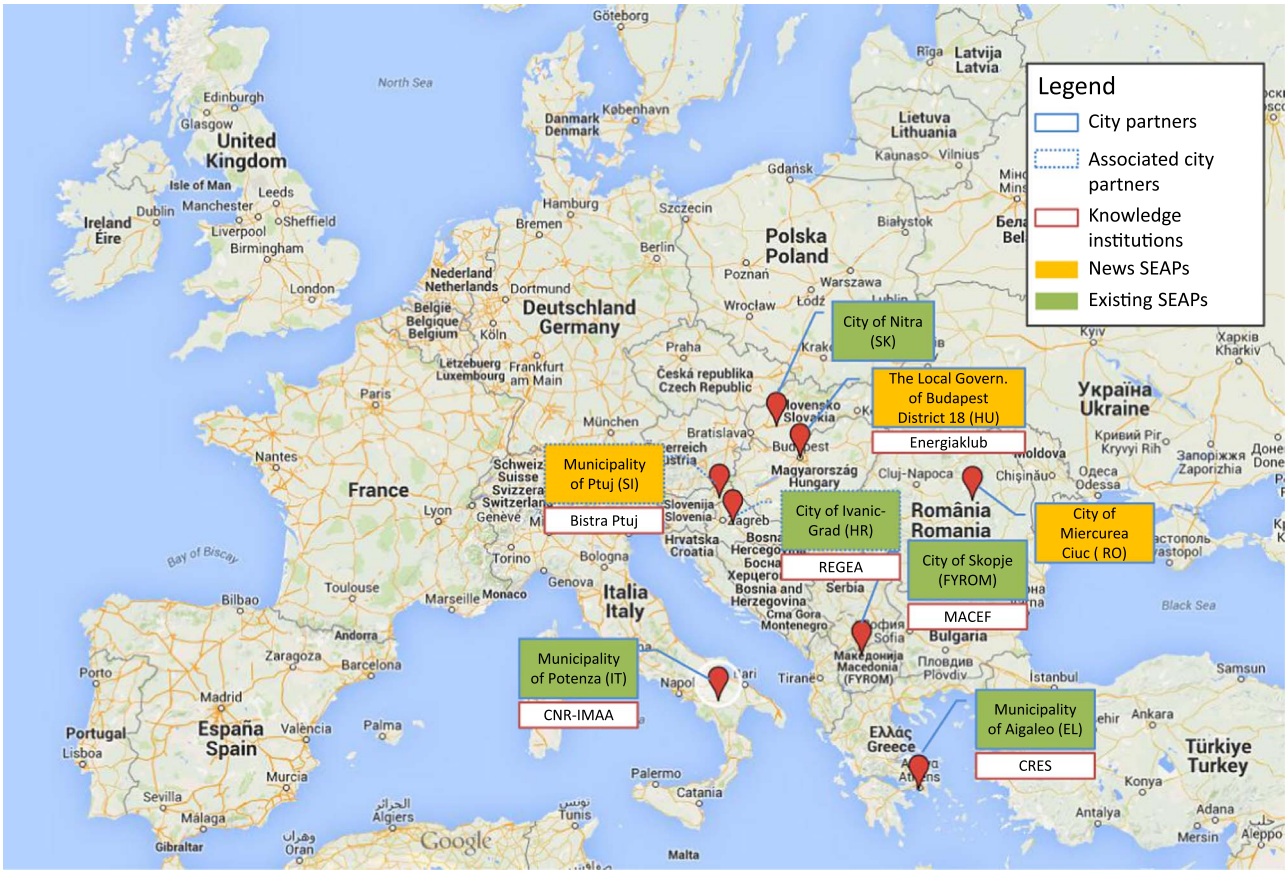

Fig. 1. : Overview of the RE-SEEties partnership composition and cities commitment in terms of SEAPs.

sion-making and criteria for assessment and monitoring of the proposed strategies [31].

The RE-SEEties project involved eight partner cities across eight countries (The Local Government of Budapest District 18 – HU, Municipality of Aigaleo – EL, Municipality of Potenza – IT, City of Nitra –SK, City of Skopje - FYROM, City of Miercurea Ciuc – RO, Municipality of Ptuj – SI, City of Ivanić-Grad – HR) and five knowledge institutions (CNR-IMAA - IT, CRES - EL, Energiaklub - HR, MACEF - FYROM and REGEA - HR), which worked together with the long-term vision to turn SEE cities into resource efficient urban communities (Fig. 1).

This paper focuses on the Local Strategy and Action Plans (LSAPs) [32], which represent the main outcomes of this extensive cooperative effort and shed light on the state-of art of urban energy planning and waste management in South East Europe as well as on the ambitiousness, level of maturity and problems encountered by municipalities in turning resource efficiency and climate targets into concrete strategies.

To this end, Section 2 introduces the methodological approach which was proposed by professional institutions to support partner cities in the identification of a comprehensive set of local strategies; Section 3 presents the main results achieved in terms of technological measures proposed for different sectors (municipal buildings, residential, commercial, transport sectors, lighting, utilization of renewable energy sources and waste management) and introduces some considerations on the financial sustainability of the proposed measures, Section 4 compares and discusses critically the overall set of results achieved throughout the eight cities while Section 5 provides the overall conclusions on the experience carried out deriving recommendations and lessons learned.

2. Methodology

The methodological approach aimed at the elaboration of Local Strategy and Action Plans (LSAPs) by partner cities was based on the development of case study profiles, a peer review process with the involvement of the relevant stakeholders and an intensive strategy building process throughout the project life cycle. Each LSAP was complemented by a feasibility study on the optimal future utilization of local and regional potential of renewable energy sources through selected technological solutions.

Partner cities were supported in the definition of their case study and Local Strategy and Action Plan through common templates and a comprehensive set of guidelines, which were included in the so-called 'Integrated Methodological Toolkit for Resource Efficiency' [33]. The Toolkit aimed to provide strategic guidance for municipalities on how to improve resource efficiency in urban planning focusing on multi-faceted aspects: policy making, changing behavior of selected target groups [34], data gathering and engineering tools, criteria for the evaluation of the developed strategy and its impact.

As a first step, partner cities selected one or more topics of specific interest in the field of waste management, energy efficiency measures and utilization of renewable energy sources (Table 1). This served as a basis for the development of the case study profile, in which each partner city defined mission, objectives and results obtained by the application of the proposed technical tools.

In particular, the resource consumption forecast enabled identification of the primary resources demands of each city as well as their overall GHG emissions based on existing surveys and methodologies for alternative future scenarios. The municipalities were supported by the expert partners in developing the methodology for resource consumption forecasting. At the end of this activity, each city gained a set of forecasts for energy consumption and waste production under alternative management schemes.

Many efforts were devoted to data gathering and their subsequent organization in *ad-hoc* data sheets. Relevant information on the city/municipality under focus concerned general characteristics (e.g. geography and climate), macroeconomic data (e.g. socio-economic indicators, both city specific and national, local Industry, small and medium enterprises – SMEs, and Agriculture), main administrative structures and local decision making processes (e.g. departments in charge of projects related to waste and energy).

In the next step, case study profiles were critically evaluated by independent experts through a peer review process aimed at evaluating and assuring the quality of work. On the basis of each topic, partner cities identified the key stakeholders (end users, policy makers, technology providers, utility companies, energy agencies and institutes) outlining their roles in the implementation of selected measures. The Assessment and Support Group (ASG), consisting of technical experts from five partners of the RE-SEEties team (MACEF, REGEA, CNR-IMAA, CRES and Energiaklub), provided the overall quality control of the peer review process and assisted cities with the elaboration and organization of peer review workshops.

Stakeholder platforms served as interactive discussions and brainstorming forums whereas the peer reviews events supported the knowledge exchange among partners.

The primary purpose of the peer review workshops was to discuss case study profiles and their main effects in terms of policy-making, technology innovation and behavioral change. Appropriate communication channels were selected to ensure support of local governments and an active participation of key stakeholders, experts and other

Table 1
Case study thematic areas.

City	Thematic areas
Aigaleo (EL)	1. Energy efficiency in public buildings and public lighting 2. Awareness raising campaigns among citizens regarding energy and waste
Budapest 18th District (HU)	1. Waste management – reduction of waste and waste to energy potentials 2. Energy efficiency and renewable energy sources in public buildings
Ivanić-Grad (HR)	1. Higher utilization of renewably energy sources (solar and geothermal) 2. Energy efficiency in public buildings 3. Awareness raising campaigns and capacity building activities regarding waste reduction
Miercurea Ciuc (RO)	1. Energy efficiency in public lighting and local district heating system 2. Higher utilization of renewable energy systems 3. Waste to energy for local waste treatment plant
Nitra (SK)	1. Energy efficiency in buildings and bankability of RUE and RES projects 2. Waste management strategies and waste to energy technologies 3. Awareness raising campaigns among citizens for reduction of waste
Potenza (IT)	1. Strategic energy and waste planning – analysis of integrated energy and waste management modeling and scenario analyzes 2. Behavior changing measures among citizens and local authority regarding waste and energy
Ptuj (SI)	1. Waste management strategies and waste to energy technologies 2. Awareness raising campaigns and capacity building activities regarding waste reduction
Skopje (FYROM)	1. Energy efficiency in public buildings 2. Integration of different local and regional energy strategies and plans

partners, offering a platform to facilitate exchange of knowledge and ideas on resource efficiency in terms of enhanced integrated policy-making and strategic planning at municipal level.

Assessments and recommendations from reviewers were included in the peer review reports as well as stakeholder viewpoints, in order to improve case study profiles, enhance the strategy building process and finalize the local strategies and action plans. The final outcomes of this process were synthesized in case conclusion reports.

Based on the case study profiles, partner cities identified the Local Strategies and Action Plans taking into account already existing or planned strategies and methodologies at local level. An important input for the implementation of LSAPs was represented by the Sustainable Energy Action Plans (SEAPs) which contain detailed information on how signatory cities of the Covenant of Mayors aim to reach the planned carbon dioxide (CO_2) reduction target by 2020.

At the time of RE-SEEties implementation, some partner cities had already submitted their SEAPs and were in the process to revise and update them whereas some other cities were still in the starting phase and aimed to benefit from the experience gathered from other partners to boost the undergoing process (Fig. 1). In particular, those cities which had already adopted a Sustainable Energy Action Plan and were keen to start working on waste management had the opportunity to propose actions also for this sector, giving added value to the new updated SEAPs. In the meanwhile great emphasis was given to valorize, at city level, the locally available renewable energy sources.

A common template was provided by the Assessment and Support Group to provide a reference structure for the elaboration of the Local Strategies and Action Plans suggesting to adopt a SWOT analysis to recognize the advantages and the drawbacks of technological choices, regulations and awareness raising activities (e.g., [35]).

The quality and relevance of the developed Local Strategies and Action Plans were supervised by the Assessment and Support Group (ASG) and resumed in the form of reports with recommendations. As extensively described in Salvia et al., [31], potential impacts of the proposed strategy on a city level were evaluated through an "evaluation grid" based on a set of social, environmental and economic indicators. These indicators were developed to examine multidisciplinary features of waste and energy measures (e.g. CO_2 reduction, pollution prevention, job creation, greening and urban renewal) but also to monitor their effects through observed trends of each specific indicator (qualitatively indicated as increase, decrease, and neutral).

As concerns energy, we identified the following eight main categories for which several criteria/indicators were identified (number reported in brackets): Transport (15 indicators), Buildings (11), Public lighting (5), Local energy production from renewable energy sources (4), Involvement of the private sector (2), Citizens involvement (2), Green public procurement (1) and Local economic impact (4). For each of these 44 energy indicators a monitoring method was also identified [36].

Analogously, nine main categories were identified concerning waste management consisting of 21 indicators: Waste reduction (4 indicators), Recycling (4), Reusing (1), Replacing (1), Waste to energy (1), Employment creation and financial effects (2), Effect on environment and society (5), Legal (1), and Citizens involvement (2).

Starting from this generally applicable evaluation grid, partner cities were encouraged to customize and apply their set of indicators in

Table 2
Overview of the main data and targets for partner cities (Source: Covenant of Mayors, retrieved on 18th March 2015).

	Population	Date of adhesion	Covenant status	Base Year	Sectorial $ktCO_2$	Total $ktCO_2$	tCO_2=/ capita	Final energy consumption per energy carrier (GWh)	Final energy consumption per capita (MWh/capita)	% reduction 2020
Aigaleo (EL)	120,000	9 oct 2008-	Action plan submitted	2005	Municipal: 4.1 Tertiary:209.3 Residential:185.8 Public lighting:5.3 Transport:96.2	500.8	6.7	Electricity: 277 Fossil fuels: 677	12.8	20%
Budapest 18th district (HU)	98,499	7 nov 2013	Signature	-		-	-		-	-
Ivanić-Grad (HR)	7714	24 feb 2009	Action plan submitted	2008	Buildings, equipment/ facilities and Industries: 41 Transport: 17	57.9	3.9	Electricity: 50.3 Fossil fuels: 186.8 Heat/cold: 1.4 RES: 2.2	16.4	21%
Miercurea Ciuc (RO)	37,980	22 feb 2013	Signature	-		-	-		-	-
Nitra (SK)	84,800	11-dec-2008	Action plan submitted	2005	Municipal: 6.4 Tertiary: 50.3 Residential: 91.1 Public lighting: 1 Transport: 93.1	242	2.8	Electricity: 117.4 Fossil fuels:729 Heat/cold:215.2 RES: 3.3	12.4	21%
Potenza (IT)	69,060	9 feb 2011	Action plan submitted	2009	Municipal: 6.5 Tertiary: 64.1 Residential: 89 Public lighting: 4.4 Transport: 166	330	4.9	Electricity: 178.1 Fossil fuels: 953.3 RES: 32.5	17.1	22%
Ptuj (SI)	24,708	22 Apr 2014	Signature	-		-	-		-	-
Skopje (FYROM)	600,000	29 mar 2010	Action plan submitted	2009	Buildings, equipment/ facilities and Industries: 962 Transport: 260	1222	2	Electricity: $1.6*10^{-3}$ Fossil fuels: $1.3*10^{-3}$ Heat/cold: $0.5*10^{-3}$ RES: $0.3*10^{-3}$	6.1	21%

order to monitor the implementation of local waste and energy strategy and the progress of case studies, as outlined in the Discussion section.

The assessment of these criteria allowed to derive recommendations for improving the draft strategies on the basis of a detailed analysis, general recommendations and lessons learned. The recommendations helped in the finalization of the strategies trying to achieve a positive impact on society.

The following section focuses on the results obtained by the application of this methodological approach in the partner cities, discussing in detail and comparing the technological measures identified in the Local Strategies and Action Plans in the field of energy efficiency, utilization of renewable energy sources and waste management.

3. Results

3.1. The state-of-the-art in partner cities

Before the end of the RE-SEEties project (30 September 2014) all the city partners had joined the Covenant of Mayors (Fig. 1) formalizing their willingness to contribute to the global effort to face climate change through a more efficient use of resources and reducing CO_2 emissions. In particular, during the course of the project, three city partners became signatories of the Covenant of Mayors: the City of Miercurea Ciuc (Romania) and the Budapest 18th district (Hungary) signed their adhesion in 2013, while the Municipality of Ptuj (Slovenia) joined it in 2014. The other five partners had already adhered to the Covenant of Mayors and submitted their Sustainable Energy Action Plan (SEAP), individuating precise targets of CO_2 reduction by 2020 and the appropriate measures for their achievement. Table 2 provides an overview of the main energy and climate figures of the RE-SEEties partner cities showing, in particular, the key results of the Baseline Emission Inventory (for the base year) and the CO_2 emission reduction targets for the analyzed sectors within 2020 (respect to the base year values).

These formal commitments have to be taken into account when characterizing the state-of-the-art of the partner cities. As a matter of fact, through the implementation of the actions included in the SEAPs municipalities can create the necessary cooperation framework for a common goal, gain financial and environmental benefits from energy efficiency and use of renewable energy sources, get access to national and European funding, adapt to the national and European energy and environmental legislation and cooperate with other national and European municipalities.

The main target for creating the Local Strategy and Action plans, in the framework of RE-SEEties, was to refresh existing SEAPs developed by five partner cities (Ivanić-Grad – HR, Aigaleo – EL, Nitra – RO, Potenza – IT, and Skopje – FYROM) with updated data on energy consumption and waste production. To this end, Buildings, Transport and Public lighting were the main sectors under focus. A common proposal that emerged from several discussions with technical experts and representatives of municipalities was to broaden the scope of SEAPs including also waste management and the related energy use. This choice allowed also to take into account the more recent legislation in the partner countries. A common approach was proposed to support data gathering and the application of forecasting methods developed during the RE-SEEties process (see, e.g. [33]) with the final aim to update and further develop existing SEAPs, helping to reschedule the priorities of each municipality taking into account the important energy-waste nexus (see e.g. [37,38]).

A summary of the main weakness and required improvements for the five partner cities in the process of updating their SEAPs is reported in Table 3.

Table 3
Weakness in existing SEAPs and possible improvements identified in partner cities.

City	Main weakness	Foreseen improvements
Aigaleo (EL)	• Only Buildings, Transport and Public lighting sectors were analyzed. • Limited possibility of intervention in the domestic and tertiary sector.	• Improving data gathering and using forecasting calculations to drive the update of the current SEAP • Engaging local stakeholders and data providers to improve the accessibility to the required data
Ivanić-Grad (SI)	• The SEAP was developed before the entry of Croatia in the EU with a different macroeconomic environment, new legislation and national energy targets. • Waste management was not considered	• Updating the SEAP according to the new legislation and national energy targets. • Introducing a component to deal also with waste management.
Nitra (SK)	• Data for several sectors must be estimated and improved • Lack of interest from stakeholders and unclear responsibility in the implementation of cross-sectoral measures • Lack of awareness among general public as concern the benefits of EE and RES, waste recycling and reuse, waste-to-energy technologies	• Updating data on energy consumption and waste production • Taking into account the new legislations fotr the implementation of cross-sectoral measures, including also waste management and the energy use of municipal waste • Promoting awareness raising campaign among selected target groups on energy and waste topics
Potenza (IT)	• The industrial sector was not analyzed because the actions were not been identified • Biomass consumption was generally underestimated because the sale and consumption are beyond the rules of the market • Some of the foreseen actions had not been implemented in the first two years (e.g. extension and duration of limited traffic zones) • The public procurement guidelines (published by the Ministry of Environment) were not systematically implemented by the Municipality	• Analyzing the impacts of local industries • Introducing data from the waste management cycle and the water cycle management in the CoM BEI • Adopting strategies that provide synergies between water and waste utilities as well as new models of residential construction and public housing • Introducing plans to raise awareness in schools with reward mechanisms, to achieve energy savings and separate collection targets • Improving the Biomass consumption estimates, mainly in Residential and Tertiary • Assessing the feasibility of a smart grid in the residential sector • Introducing new procedures in local public procurement (such as public green procurement GPP)
Skopje (FYROM)	• Data for several sectors must be estimated (e.g. on building stock and waste) • Unclear responsibility in the implementation of cross-sectoral measures • Lack of good demonstration projects on of EE buildings • Imported construction goods with non-certified origin and performances • Low awareness for waste recycling and production • Lack of interest from stakeholders	• Improving the energy efficiency of public buildings • Training energy managers in public buildings • Supporting municipalities in the definition of strategies and action plans • Setting up PPP financing models for the implementation of the planned measures

3.2. Local Strategy and Action Plans

The Local Strategy and Action Plans (LSAPs), developed by the eight partner cities within the RE-SEEties project, contain an overview of potential measures for the reduction of CO_2 emissions by 2020, including energy and waste management measures aimed at improving existing infrastructures.

In the elaboration of LSAPs, cities took into account the time frame for the implementation of the proposed measures, the responsible bodies and tried to estimate the associated investment costs, energy and waste saving potentials, CO_2 reductions and possible financial instrument.

A critical analysis of the proposed technological measures points out a variety of responses by partner cities in terms of level of detail, manner of implementation and number of the proposed actions with reference to the analyzed sectors: municipal buildings, residential, commercial and transport sectors, lighting, utilization of renewable energy sources and waste management, as described in detail in the next sections.

3.2.1. Municipal and public buildings

Six out of eight partner cities identified several measures aimed at improving the energy efficiency of public buildings, in particular where the insulation is generally absent or insufficient to ensure an adequate thermal comfort.

Most of the interventions proposed aim at improving the energy performance of municipal buildings through thermal insulation of the external cladding and the building roofs and floors, introduction of energy saving lamps and interventions regarding the heating and cooling systems (e.g., replacing radiators and equipping them with thermostatic valves) as well as replacement of existing windows and doors with more energy-efficient types. In particular, great attention is given to control power and heat demand using both technical devices (e.g. energy control units for power in most of the partner cities, natural gas and water consumption in Nitra, walled thermometers in every room of the buildings owned by the city of Skopje) and behavioral change of the occupants of public buildings (e.g. awareness raising activities in Miercurea Ciuc, distribution of a manual on correct energy behavior among municipal institutions in Nitra, the slogan "1 °C saves up to 6% energy" per each walled thermometer installed in Skopje).

Some of these cities (e.g., Aigaleo, Nitra, Budapest 18th district, Skopje) aim to extend the above interventions to other state-owned buildings and facilities which are characterized by a significant potential for energy efficiency (for instance pumping stations, waste and wastewater treatment facilities etc.). In particular, the Municipality of Aigaleo intends to install solar systems for hot water production, promote passive ventilation, shading systems and the related automatisms in buildings with high occupancy levels, whereas the Municipality of Potenza aims to increase energy efficiency of the local hospital and install a coupled heat and power (CHP) plant at the municipal swimming pool. The Ministry of Health of the Republic of Macedonia has an ambitious plan to renovate all hospitals in the country after a preliminary inspection of the current status of these buildings which will produce its effect also in Skopje.

In addition, the Municipality of Aigaleo aims to continue the process of connecting all municipal buildings to the natural gas network in order to reduce the consumption of diesel oil and reduce CO_2 emissions whereas the City of Nitra aims to promote the energy certification of universities and other large buildings with an annual consumption exceeding 400 MWh (50,000 m^3 of natural gas).

An overview of the proposed measures is provided by Table 4, in which missing data appears as "n.a." (not available). In particular, Table 4 points out that the interventions proposed in the Local Strategy and Action Plan of Miercurea Ciuc are more a "wish list" than planned technology interventions being characterized by a lack of quantitative information.

3.2.2. Residential

As concern the Residential sector the main initiatives are funded by national programs.

In the Budapest 18th district, the main proposed measures deal with the renovation of different typologies of buildings through façade, roof and cellar ceiling insulation, window replacement, upgrade of the heating system, installation of condensing boiler and thermostatic valves as well as interventions on mechanical systems in residential buildings in order to reduce losses.

In Greece the program "Energy efficiency in the household sector" aims at improving energy efficiency of existing buildings, especially in regions of low and medium incomes, which were built before 1980 and thus present a significant potential for energy upgrading. In this framework, 500 households within the Municipality of Aigaleo are identified to be included in this program through awareness-raising activities aimed at reaching 50% of energy saving compared to their current final energy consumption. The program "Green neighborhoods" funds the upgrading of apartment blocks in order to become CO_2 neutral. In Aigaleo a pilot apartment block with 48 old households has already been upgraded and 1000 households, in two additional building blocks, could be further included in this program. Moreover, the expansion of the natural gas network started in 2005 will allow the connection to the network of about 50% of residential buildings in Aigaleo, until 2020, achieving substantial savings on energy bills and CO_2 emissions mainly due to the replacement of old diesel boiler.

In Croatia, the Government established in 2014 to support financially the energy reconstruction of family houses with co-financing grants. These financial resources combined with local and regional budgets will allow the City of Ivanić-Grad to support financially up to 10% of the total investment costs. The measure includes facade-walls refurbishment and thermal insulation for 950 residential buildings as well as the construction of a low energy settlement (Poljana) within the municipal boundaries.

In the City of Nitra approaching the 20% target of energy savings and the subsequent reduction of CO_2 emissions will require the insulation of 77% of apartment house areas. Energy savings are expected in apartment houses and detached houses using solar thermal collectors. A further measure is the introduction of a tax-bonus for certified energy efficient households.

The Municipality of Potenza will promote different initiatives to help citizens to realize energy improvements, estimating a possible reduction of 16,453 tCO_2 by 2020 through the process of energy requalification of buildings.

The first measure foreseen by the City of Skopje aims to build new energy efficient flats for low-income families by 2020, taking advantage from the national governmental program for social housing. The second measure foresees the installation of thermostats and controls in 50% of central heating households.

A full prospect of the proposed measures is provided by Table 5.

3.2.3. Commercial

Commercial buildings include a large variety of buildings for different purposes. Only two cities (Aigaleo and Skopje) identified some specific measures for this sector (Table 6).

Within the "Building the future" Greek program, the Municipality of Aigaleo intends to involve citizens for carrying out multiple interventions to improve energy efficiency in buildings within the city limits in order to decrease CO_2 emissions of 2.8 kt CO_2.

The city of Skopje aims at reducing the energy demand of heating, air conditioning, cooling and lighting through different measures involving, for instance, the integration of passive heating and cooling systems in new buildings, the utilization of waste energy for heating/cooling in existing buildings. Moreover, it aims at stimulating measures to improve thermal insulation in buildings of the commercial and service sector in line with the standards for passive and low-energy houses.

Table 4
Proposed measures to improve energy efficiency of municipal and public buildings in partner cities.

City	Typology of intervention proposed	Implementation beginning/ end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	Energy certificates in municipal buildings and municipal facilities	2012–2018	1.5 MEuro for municipal buildings and 30,000 Euro for municipal facilities	855 tCO_2/year (845 tCO_2 for municipal buildings and 10 tCO_2 for municipal facilities)	Municipality of Aigaleo National funding
	Connection of all municipal buildings to the gas network	2011–2020	n.a.	477 tCO_2	Municipality of Aigaleo
Budapest 18th district (HU)	Complex modernization of 15 buildings	n.a.–2020	350 HUF/kWh	7371 MWh 1686 tCO_2/year	n.a.
	Improvements of heating systems	n.a.	Implementation costs: 300 kHUF per institution. Investment cost: 18 MHUF	111 tCO_2/year	n.a.
Miercurea Ciuc (RO)	Investments for controlling demand heating in rooms	n.a.	n.a.	n.a.	n.a.
	Windows check and investment in triple glazed windows in case of refurbishment	n.a.	n.a.	n.a.	n.a.
	Raise awareness of occupants	n.a.	n.a.	n.a.	n.a.
Nitra (SK)	Comprehensive technical improvement of municipal buildings	2014–2020	39,226 MEuro	8266.25 MWh/year 1661.52 tCO_2	City of Nitra
	Energy management unit of buildings owned by the City of Nitra (a) and by the Higher Territorial Unit (b)	2014–2020	(a) 250 MEuro (b) n.a.	(a) 3378 MWh/year 679 tCO_2 (b) 25,040 MWh/year, 5033 tCO_2	(a) Energy Agency in Nitra (b) Higher Territorial Unit
	Manual on energy saving for municipal institutions	2014	0.5 MEuro	1203 MWh/year 245 tCO_2	Energy Agency in Nitra (EAN)
	Thermal insulation of selected buildings of the Higher Territorial Unit	2011–2020	17,005 MEuro	6119 MWh/year 1229 tCO_2	Higher Territorial Unit (VÚC)
	Energy savings in civil service buildings by enforcing energy certification	2014–2020	n.a.	9859 MWh/year; 1981 tCO_2	Higher Territorial Unit (VÚC)
	Introduction of solar systems to universities	2014–2020	1854 MEuro	850 MWh/year 170 tCO_2	n.a.
Potenza (IT)	Municipal requalification	2012–2020	n.a.	3.13 $ktCO_2$	n.a.
	Improve energy efficiency at Saint Carlo Hospital	2012–2020	n.a.	1.47 $ktCO_2$	n.a.
	Introduction of a 18 kW CHP plant at the municipal swimming pool	2010–2011	n.a.	180 tCO_2	n.a.
	Requalification of the National Boarding School	2012–2013	n.a.	52 tCO_2	n.a.
	Replacement of boilers in the municipal schools	2012–2020	n.a.	175 tCO_2	n.a.
Skopje (FYROM)	Installation of thermometers in rooms of the City-owned buildings	2011	750 Euro	2728 MWh	City of Skopje
	Installation of thermostat sets in all the City-owned buildings	2011–2020	1.07 M Euro	8287 MWh.	City of Skopje Regional funds (EIB, KfW)
	Hospital renovation	2011–2020	25.2/68.23 MEuro	1.5/4.07 ktoe 10.8/23.3 $ktCO_2$	National Government Ministry of Health National Energy Agency Donors International financial institutions

Table 5
Proposed measures to improve energy efficiency in Residential in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	The program "Energy efficiency at household buildings"	2011-2020	n.a.	70 kWh/m^2/year per building 2.94 ktCO_2	National funding
	The program "Green neighborhoods"	2011-2020	n.a.	521 tCO_2	National funding
	Expansion of the natural gas network	2011-2020	40,000 Euro	7.9 ktCO_2	Municipality of Aigaleo Natural gas distribution company
Budapest 18th district (HU)	Complex modernization	n.a.	32,624 MHUF	Condominiums heated by district heating: 27,650 MWh 7.6 ktCO_2; Gas heated condominiums: 53,708 MWh 15.9 ktCO_2 Family homes: 78,691 MWh 15.9 ktCO_2	n.a.
	Improvements of heating systems	n.a.	39,575,000 HUF	12,313 MWh 2.6 ktCO_2	n.a.
Ivanić-Grad (HR)	Implementation of the program for retrofitting of family houses	2014-2020	2,093,750 Euro	6700 MWh 1.3 ktCO_2	Environmental protection and EE Fund City budget Zagreb County Commercial banks ESCO
	Development of low energy settlement Poljana	2014-2020	1,252,800 Euro for construction (not inclusive of land purchase costs)	157 MWh 31.08 tCO_2	City budget Environmental protection and EE Fund Croatian Bank for Reconstruction and Development EU Structural Funds Operational program for environment
Nitra (SK)	Thermal insulation of buildings	2014-2020	75,630 MEuro	27,735 MWh/year 5575 tCO_2;	City of Nitra Služby Nitra s.r.o. OSBD Nitra
	Solar thermal collectors in apartment and detached houses	2014-2020	15,162 MEuro (apartment houses), 10,710 MEuro (detached houses)	11,440 MWh per year, 2.3 ktCO_2 (apartment houses) 5480 MWh per year, 1.1 ktCO_2 (detached houses)	City of Nitra Služby Nitra s.r.o. OSBD Nitra
	Tax-bonus for households producing an energy performance certificate	2015	n.a.	n.a.	City of Nitra
Potenza (IT)	Energy requalification of buildings	2012-2020	53 MEuro	16,453 tCO_2 avoided	n.a.
Skopje (FYROM)	Social housing project	2011-2017	3.06/3.87 MEuro	0.19/0.24 ktoe 1.69/2.15 tCO_2	National budget Donors
	Installation of thermostat sets on radiators in residential buildings	2011-2020	n.a.	27,389 MWh 6.71 tCO_2	City of Skopje Regional funds ESCO companies

Table 6
Proposed measures to improve energy efficiency in Commercial in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	The program "Building the future"	2011-2020	n.a.	20 kWh/m^2/year per intervention 2.8 ktCO_2	National funding
	Expansion of natural gas network	2011-2020	n.a.	1.3 ktCO_2	Municipality of Aigaleo; The natural gas distribution company
Skopje (FYROM)	Energy performance of non-residential buildings	2011-2020	0.35 MEuro	0.21/0.56 ktoe 1.41/3.87 ktCO_2	Company owners Financial institutions EE Fund
	Stimulation measures to improve thermal insulation Commercial and Service buildings	2013-2020	n.a.	11,230 MWh 2.75 ktCO_2	Budget of The City of Skopje

Table 7
Proposed measures to improve energy efficiency in Transport in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	Conversion of 25 diesel-driven heavy trucks to use a mixture of biofuels	2011–2020	250,000 Euro	13 tCO_2/year	Municipality of Aigaleo National funding
	Replacement of 25 diesel-driven heavy trucks with natural gas vehicles	2011–2020	3,750,000 Euro	99 tCO_2/year	Municipality of Aigaleo
	Replacement of 25 petrol-driven heavy trucks with hybrid or electric vehicles	2011–2020	294,000 Euro	9.3 tCO_2/year	Municipality of Aigaleo
	Promotion of national policies for energy saving and CO_2 emissions reduction from public and private transport	2010–2016	100,000 Euro	4,742 tCO_2/year	Municipality of Aigaleo National funding European funding
Budapest 18th district (HU)	Replacement of vehicles to hybrid or fully electric vehicles	n.a.	n.a.	n.a.	n.a.
	Purchase of electric vehicles	n.a.	n.a.	n.a.	n.a.
	Development of electric charging stations	n.a.	n.a.	n.a.	n.a.
	Use of biofuels in municipal vehicles	n.a.	n.a.	n.a.	n.a.
	Regulation of sustainable mobility for workers	n.a.	n.a.	n.a.	n.a.
	Reduction of transportation needs	n.a.	n.a.	n.a.	n.a.
	Support to cycling	n.a.	n.a.	n.a.	n.a.
	Increase of pedestrian traffic	n.a.	n.a.	n.a.	n.a.
	Promotion of environmentally friendly vehicles	n.a.	n.a.	n.a.	n.a.
Ivanic-Grad (HR)	Measures for improving public bus transportation	2014–2020	n.a.	1088 MWh, 270 tCO_2 (diesel) 1012 WMh, 271 tCO_2 (gasoline)	City budget Environmental Protection and EE Fund EU programs Croatian Bank for Reconstruction and Development
	Measures for improving bicycle transport	2014–2020	n.a.	1088 MWh, 270 tCO_2 (diesel) 1012 WMh, 271 tCO_2 (gasoline)	City budget EU programs
	Improvement of rail transport	2014–2020	n.a.	1633 MWh, 406.5 tCO_2 (gasoline) 1518 WMh, 405.2 tCO_2 (diesel)	City Budget EU Structural and Cohesion Funds Operational program for transport
	Introduction of the car-sharing model for increasing the number of passengers in private cars	2014–2020	n.a.	759 MWh, 202.6 tCO_2 (diesel) 816 MWh, 203.25 tCO_2 (gasoline)	City budget Environmental Protection and EE Fund EU Programs EU Structural and Cohesion Funds Operational program for transport Development banks
	Introduction of an automated parking payment system in the city	2014–2020	n.a.	759 MWh, 202.6 tCO_2 (diesel) 816 MWh, 203.25 tCO_2 (gasoline)	City budget EU programs
Miercurea Ciuc (RO)	Public transport survey	n.a.	n.a.	n.a.	n.a.
	Design the cycle route network in an appropriate way	n.a.–2020	n.a.	1.6 $ktCO_2$	n.a.
Nitra (SK)	Brochure “Eco-driving for municipal employees “	2014	0.05 MEuro	n.a.	Energy Agency in Nitra
	Conversion of buses to use Compressed Natural Gas (CNG)	2014–2020	8.16 MEuro	279 tCO_2/year	Arriva Transport Nitra
	Brochure “Eco-driving for public bus drivers”	2014	50 Euro	n.a.	Energy Agency in Nitra
	Increase of passenger numbers using public transportation	2014–2020	n.a.	74,800 MWh 18,625 tCO_2	Arriva Transport Nitra Municipal Energy Agency City of Nitra
	Measures limiting traffic in the City’s center	2014–2020	n.a.	19,475 MWh 5.2 $ktCO_2$	City of Nitra
	Building bicycle ways in the City	2014–2020	1.5 MEuro	Estimated reduction of individual travel: 5 – 10%	City of Nitra
	Eco-driving campaign for driving schools and other target groups	2014	50 Euro	n.a.	Energy Agency in Nitra
	Promotion campaign for cycling and walking	2020	200 Euro	n.a.	Energy Agency in Nitra
Potenza (IT)	New Plan of Integrated Urban Public Transport	2011–2013	n.a.	7,064 tCO_2	n.a.
	Public elevators	2010–2013	n.a.	10,388 tCO_2	n.a.

(continued on next page)

Table 7 (*continued*)

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Skopje (FYROM)	Replacement of the bus fleet with natural gas buses	2010–2020	n.a.	106 tCO_2	n.a.
	Connection (shortcut)	2011–2020	n.a.	11.62 GWh/year 2.89 $ktCO_2$	City of Skopje Donations Funds National Government
	Tunnel connection	2011–2020	n.a.	32.80 GWh/year 8.16 $ktCO_2$	City of Skopje Donations Funds National Government
	Procurement of vehicles owned by the City of Skopje according to the Green Public Procurement criteria	2011–2020	n.a.	1.11 $ktCO_2$	City of Skopje
	Introduction of tram transport	–2020	150 MEuro	0.47 ktoe 1.46 $ktCO_2$	City of Skopje National Government International financial institutions Donors
	Procurement of electric vehicles	2014–2020	0.25 MEuro	n.a.	City of Skopje PE Gradski Parking

3.2.4. Transport

The Transport sector is typically responsible for a significant release of CO_2 emissions. All the partner cities, except Ptuj, planned a series of measures for reducing the carbon impact of this sector promoting the use of public transport and reducing the use of private cars (Table 7).

The Budapest 18th District intends to increase the number of 'pedestrian zones' and 'reduced traffic zones'. Similarly, the City of Nitra will introduce traffic restrictions in the city center to improve mobility and logistics (supply and transit traffic) in these areas. Several measures aimed to discourage the use of individual motor vehicles (e.g. parking policies, pedestrian areas and other zones of limited access to motor vehicles) will be pursued by the City of Skopje which is also evaluating the effects of introducing trams in the current public transport system.

Public bus transportation has been promoted in Ivanić-Grad through multi-faceted interventions (LED displays on all bus stops, public parking lots for buses, minibuses during evenings and the bus stop shelters). In Miercurea-Ciuc, second hand buses have replaced older and less efficient buses whereas a public transport survey will be carried out to fit better passengers‘ needs thus increasing the average occupancy rate of public transport means.

The City of Potenza will invest in the implementation of a new plan for integrated urban public transport system and in public elevators while the City of Ivanić-Grad is more focused on the improvement of rail transport through the construction of a new rail side-track and a free parking lot for park & ride passengers, the modernization of railway infrastructures, the adjustment of railway timetable according to needs of citizens, and the implementation of an integrated tariff system with unified tickets for train and bus transportation.

Furthermore, some cities (e.g. Ivanić-Grad, the Budapest 18^{th} District, Nitra and Miercurea-Ciuc) aim to improve cycling through multi-faceted initiatives: studying integrated bicycle routes throughout the entire city, marking and maintaining bicycle tracks – possibly separated from traffic roads – in the entire municipal area, setting up bicycle garages equipped with video surveillance in the proximity of the railway station to enable park & ride systems, promoting bicycle rental, secured bicycle depositories and repair services. In addition, promotional and educational activities are planned to encourage the use of bicycles, especially on short distance travels (Ivanić-Grad and Nitra).

Car-sharing is promoted by Ivanić-Grad as well as the introduction of zones with an automated parking payment within the city center in order to contribute to reduce the use of private cars.

As concern technology innovation, the Municipality of Aigaleo aims to replace existing vehicles with more energy efficient ones after the end of their lifetime. Moreover, it aims at converting diesel-driven heavy trucks in order to use a mixture of biofuels and replacing them with hybrid natural gas vehicles and electric vehicles. Buses fueled by natural gas will replace existing diesel buses in Potenza whereas the City of Nitra intends to convert 32 city buses to compressed natural gas (CNG). In Skopje, the adoption of the Decision on Green Public Procurement criteria for the city-owned vehicles will allow the purchase of low CO_2-emission vehicles or alternative fuel vehicles (in particular, 5 electric vehicles will be procured and subsequently rented to citizens and tourists).

The Budapest 18^{th} District intends to purchase few demonstration electric-powered cars and biofuels vehicles to raise awareness on environmentally friendly vehicles. n the City of Skopje, two new infrastructures (respectively, a bridge across the river and a tunnel under a square) are planned to reduce the distance between city neighborhoods.

3.2.5. Lighting

Energy saving in public lighting generally consists in the replacement of existing lamps with new energy saving lamps.

The Municipality of Aigaleo planned to replace, by 2020, all existing

lamps with new ones, according to the technological evolution of lamps, reflectors, integration of renewable energy and smart adjustment of the intensity of public lighting.

The energy management agency in the city of Miercurea Ciuc funded a feasibility study in order to refurbish the street lights with low-voltage lighting system and smart metering of lighting needs, which will allow to reduce considerably the electricity consumption.

In order to make more efficient public lighting, the City of Nitra planned the installation of control systems to reduce the illumination intensity of the most powerful lamps (150 W) as well as modernization measures aimed to the replacement of a selected number of lamps and the installation of new lamps with higher optical efficiency, the replacement of the pole-based electrical equipment and, eventually, of plastic and cast-iron socket-poles with new steel ones. Also the City of Potenza intends to requalify the urban public lighting and replace votive lamps in the local cemetery.

The planned measures in the city of Skopje concern the upgrade of the lighting system in 300 classrooms in educational institutions, in the City-owned buildings, in all households of the city as well as in commercial and service buildings.

EU Regulation 244/2009 on lighting products prescribes that by the year 2016 traditional incandescent lamps will not be produced anymore, replacing them with energy saving lamps. In compliance with this regulation, conventional lamps will be replaced with energy saving lamps in all the buildings owned by the City of Skopje by 2017.

A full prospect of the proposed measures is provided by Table 8.

3.2.6. Utilization of renewable energy sources

In the Budapest 18th District, about 1200 t of biomass are produced each year and can be used to heat institutional buildings (e.g. sports centers). As concerns the solar source, in latest years the Local Government had submitted several tenders in order to boost the installation of solar systems in local government buildings.

The Municipality of Aigaleo intends to prepare a study on the main energy consumers and plans a strategy for the implementation of renewable energy sources, investing mainly on photovoltaic and solar systems.

The city of Ivanić-Grad planned to finance the installation of 1400 solar thermal collectors, of which 43% in existing residential buildings and 57% in the commercial sector by the end of 2020 and the utilization of geothermal energy for balneology and space heating purposes. Moreover, it aims to extend the current exploitation of geothermal energy in a local hospital for medical rehabilitation in order to develop a large medical wellness facility with a large hotel and indoor and outdoor swimming pools fed by geothermal water.

In Miercurea-Ciuc, the City intends to realize a biogas coupled with a gas engine CHP system in the local sewage plant, which will allow to produce the heat and power needed. The available biomass (agricultural and forest residues and short rotation coppice plantations) will be used for running the municipal district heating system, allowing to connect half of the public buildings to the new district heating system. Moreover, Miercurea Ciuc aims to invest in PV systems and valorize the geothermal potential in individual houses for heating purposes. Ground source heat pumps require sufficient land availability and are generally a feasible option for public buildings only.

In the City of Nitra, the main planned measure deals with the installation of photovoltaic modules on 15 buildings (the Municipal Office and other 14 school buildings).

In Potenza, different measures are planned in order to exploit renewable source for electricity and heat production, through thermal solar and photovoltaic plants for public buildings, the promotion of small wind plants, the realization of a central biogas and a biomass CHP system in a local school.

In Ptuj and surroundings, forests cover about 21% of the total area (compared to the 58% national average value) which is not enough to cover the yearly wood consumption for heating thus requiring the import of additional biomass. An additional source of biomass is represented by waste biomass which is collected separately for the whole region and can be utilized to feed the district heating system of Ptuj. The solar source is considered strategic in Ptuj through passive solar systems (mainly applied in new buildings, both private and public), active solar systems (mainly solar collectors for sanitary water) and photovoltaic panels which have a potential noteworthy in public buildings. Geothermal energy in Slovenia is quite well exploited both in terms of hydrogeothermal (energy of hot water) and petrogeothermal (energy of hot rocks). In Ptuj there are currently three wells which utilize geothermal energy for thermal water whereas the potential for geothermal heat applications is still under study for further exploitation.

In Skopje, all City-owned buildings will be provided with solar hot

Table 8
Proposed measures to improve energy efficiency in public lighting in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	Gradual replacement of existing lamps with energy saving lamps	2005-2020	796,000 Euro	2.3 $ktCO_2$	Municipality of Aigaleo
Miercurea Ciuc (RO)	Refurbishment of the street lights with low-voltage lighting system	n.a.	n.a.	15 tCO_2/year	n.a.
Nitra (SK)	Installation of a control system	2014-2015	249,634 MEuro	60 MWh 15,12 tCO_2/year	Department of Communal Activities and Environment Elcomp s. r.o.
	Replacement of a selected number of lamps	2014-2015	20 MEuro	21.45 MWh 5.4 tCO_2/year	Department of Communal Activities and Environment Elcomp s. r.o.
Potenza (IT)	Requalification of the urban public lighting	2012-2020	n.a.	1,456 tCO_2	n.a.
	Replacement of votive lamps at cemetery	2010-2012	n.a.	148 tCO_2	n.a.
Skopje (FYROM)	Modernization of the lighting system in 300 classrooms in City-owned educational institutions	2011-2020	405,000 Euro	52.2 MWh 0.047 $ktCO_2$	City of Skopje Donors
	Installation of energy-saving lamps in City-owned buildings	2011-2017	n.a.	462.5 MWh 0.39 $ktCO_2$	City of Skopje
	Installation of energy saving lamps in all households in the city	2011-2018	n.a.	275,557 MWh 252.13 $ktCO_2$	
	Installation of energy-saving lamps in Commercial and Service buildings	2013-2017	n.a.	4,850 MWh 4.437 $ktCO_2$	Commercial and Service fundings

Table 9
Proposed measures to improve the utilization of renewable energy sources in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving/electricity production from RES and CO_2 emissions avoided)	Funding for measure implementation
Aigaleo (EL)	Study on significant energy consumers in public and private municipal buildings and planning a strategy for the implementation of RES/solar systems	2011–2014	30,000 Euro	n.a.	Municipality of Aigaleo Significant private consumers
	Study for the implementation of RES systems in public buildings	2011–2014	30,000 Euro	n.a.	Municipality of Aigaleo National funding
	Explore possibilities for RES growth through new funding tools	2011–2014	15,000 Euro	n.a.	Municipality of Aigaleo European funding
Budapest 18th district (HU)	Biomass for municipal application	n.a.	400 MHUF	210 tCO_2	n.a.
	Municipal solar energy production (< 50 kW)	2011–2020	490 MHUF	Electricity production 518,000 kWh	n.a.
	Municipal solar energy production (> 50 kW)	n.a.	5 bln HUF	Electricity production 11,000 MWh 6.3 $ktCO_2$	n.a.
	Solar systems in residential buildings (a) condominiums and family homes (b)	n.a.	a) 8.27 bln HUF b) n.a.	a) Energy saving 13.60 MWh, 8 $ktCO_2$ b) Energy saving 5378 MWh, 3.1 $ktCO_2$	n.a.
	Municipal use of solar collector	2014	60 MHUF	Energy production 256 MWh 52 tCO_2	n.a.
	Solar collector in residential buildings	n.a.	3.575 bln HUF	Energy saving 7,900 MWh 1.9 $ktCO_2$	n.a.
Ivanić-Grad (HR)	Subsidy scheme for installation of solar thermal collectors for Residential and Commercial	2014–2020	440,000 Euro	Energy savings: 2,423 MWh (Residential), 3,230 MWh (Commercial) 1,131.40 tCO_2	City budget Environmental Protection and EE Fund Private sector Commercial banks
	Utilization of geothermal energy for balneological and space heating purposes	2014–2020	70 MEuro	5,256MWh 3,269 tCO_2	EU Structural and Cohesion Funds Operational programs for tourism Croatian Bank for Reconstruction and Development Environmental Protection and EE Fund Private investors
Miercurea Ciuc (RO)	Realization of a biogas coupled with a gas engine CHP system in the local sewage plant	n.a.	n.a.	605 tCO_2	n.a.
	Use of biomass for heat production	n.a.	n.a.	20 $ktCO_2$	n.a.
	Use of PV systems on public buildings	n.a.	n.a.	n.a.	n.a.
	Use of ground source heat pumps	n.a.	n.a.	n.a.	n.a.
Nitra (SK)	Installation of PV systems on selected municipal buildings	2014-2020	0.4 MEuro	150 MWh 0.38 $ktCO_2$	City of Nitra Municipal Energy Agency
	Renovation of the piping system	End of 2014	2 MEuro	7000 MWh/year 1.4 $ktCO_2$	Municipal Heating Company
	Refurbishment of the heat-lines including heat-transfer stations in a residential area	End of 2014	17 MEuro	7000 MWh/year 1.4 $ktCO_2$	Municipal Heating Company
	Refurbishment of boiler-units or alternative modification into the central energy block	End of 2014	30 MEuro	7500 MWh/year 1.5 $ktCO_2$	Municipal Heating Company
	Centralized management of the entire central-heat supply system	End of 2014	0.1 MEuro	n.a.	Municipal Heating Company
Potenza (IT)	Thermal solar and PV plant for public buildings	2010–2020	n.a.	4937 $ktCO_2$	n.a.
	Central biogas	2010–2012	n.a.	832 $ktCO_2$	n.a.
	Promotion of small wind plants	2012–2020	n.a.	25 $ktCO_2$	n.a.
	Biomass CHP in a municipal school	2012–2020	n.a.	906 $ktCO_2$	n.a.
Ptuj (SI)	Use of waste biomass to feed district heating	n.a.	n.a.	n.a.	n.a.
	Solar and PV systems	n.a.	n.a.	n.a.	n.a.
	Exploitation of geothermal energy	n.a.	n.a.	n.a.	n.a.
Skopje (FYROM)	Installation of solar collectors for the supply of hot water in the City-owned buildings	2011–2020	500 Euro/m^2 solar system	8189 MWh Energy saving 7.49 $ktCO_2$	City of Skopje
	Solar collectors and geothermal heat pumps in existing buildings	2011–2020	22.8/82 MEuro	0.7/2.51 ktoe Energy saving 7.45/26.8 $ktCO_2$	National Government Ministry of Economy Donors Private sector EE Fund International financial institutions
	Wider exploitation of renewable energy	2010–2015	1.5 MEuro	0.09 ktoe Energy saving 0.9 $ktCO_2$	National Government Ministry of Economy Donors
	Stimulation measures for using renewable	2013–2020	n.a.	112306 MWh Energy saving	City of Skopje

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Table 9 *(continued)*

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Environmental assessment (energy saving/electricity production from RES and CO_2 emissions avoided)	Funding for measure implementation
	energy sources in thermal energy production Subsidies for installing solar thermal collectors in households	2007–	150,000 Euro/ year	2.75 $ktCO_2$ 0.02 ktoe Energy saving 0.2 $ktCO_2$	National Government

water collectors by 2020, according to the recent national Law on Energy. In addition geothermal heat pumps will be installed to provide efficient heating and cooling for buildings. According to the rulebook on energy performance of buildings, another measure proposed by Skopje concerns the introduction in new buildings (or in those subject to major renovations) of one or more highly efficient alternative systems including: decentralized systems for energy supply based on the utilization of renewable energy sources; combined systems (i.e. cogeneration systems) for simultaneous single process generation of heating, electrical and/or mechanical energy; central heating or cooling systems; and heat pumps. Moreover suited measures will promote the use of solar thermal systems for hot water and heat pump installation in the commercial sector (hotels, private hospitals and other buildings operating with huge quantities of hot water) as well as to stimulate the use of renewable energy sources in thermal energy production (e.g. incentives on the purchase of solar panels in households).

An overview of the proposed measures is provided by Table 9.

3.2.7. Waste management

In the local action plan of Budapest 18th district three main aspects are considered for waste management: information campaigns among governmental employees to cut the waste produced in public buildings, a joint prevention program with the Municipality of Budapest for reducing the overall municipal waste, and the use of repair services for equipments.

The Municipality of Ivanić-Grad planned several interventions for waste management. Separate collection of paper and cardboard will be carried out through door-to-door collection by the municipal company in charge of waste management. According to the new national Law, the municipality will ensure the collection of biodegradable waste with special concern to two groups that generate the largest quantities: households and legal entities (SMEs, industry, shopping centers, hotels and restaurants). To ensure separate collection of bio-waste, suited bins will be also distributed free of charge. Also in compliance with legal obligations, packaging waste started to be collected separately in February 2014 through the distribution of free collection bags amongst households and the organization of waste collection on a regular (weekly) basis. Another planned measure is the provision of new waste drop-off points within the city, especially for textile and other solid wastes still improperly managed, the setting up of a new recycling yard in Ivanić-Grad and the on-demand collection of bulky waste through the distribution of coupons. Moreover, educational programs will be held for local officials and a team of waste management experts will be set up to support the City involvement in EU and national projects.

According to the Miercurea-Ciuc local action plan, the first important measure is related to waste prevention. In Romania, construction and demolition waste is not handled properly although the high potential of reusing this waste for asphalt mixtures or to recycle other building materials. It is also necessary to improve solid waste management practices of households in order to avoid uncontrolled burning of municipal waste and promote the use of waste containers and conferment of secondary raw materials to recycling points in the town. To this end, Miercurea-Ciuc actively takes part to the activities of waste management planning carried out at regional level. Waste-to-energy options are not considered feasible in Miercurea Ciuc due to low waste density. Waste from agriculture, forestry and wood industry can be valorized energetically through the biomass-fired CHP plant foreseen by a local district heating project.

In the City of Nitra, part of the municipal solid waste (MSW) which is currently landfilled (only 10% of the whole MSW is sorted and recycled) will be used to produce energy. Energy recovery from MSW can be achieved in two main ways: through mechanical screening of the high calorific fraction and subsequent combustion in cement industry and, in a more innovative way, through gasification which convert waste into Syn-Gas that can be fed directly to gas engines or gas turbines (achieving greater electricity conversion efficiencies than incineration/steam turbines). Gasification is also much more scalable than incineration and there are systems which specifically address the requirements of small to medium size towns and cities.

In the City of Potenza, the Municipal Agency for Environmental Protection has adopted some specific measures to reduce the amount of undifferentiated waste and increase the separate collection targets from 24% to 70% through the reorganization of the service. The proposed integrated waste management system includes the pre-treatment of undifferentiated waste by mechanical screening with subsequent incineration of the dry fraction and biological treatment of the moist one. Also for the Municipality of Ptuj the energy potential of waste materials is rather high and very promising, dealing with about 20,000 t per year that means the power of plant of around 20 MW, according to the average low calorific value.

The city of Skopje deals with considerable quantities of construction and demolition waste which asks for large volumes of landfills. Private sector investments in the collection, storage and processing of specific waste streams will be boosted through voluntary incentive schemes and applying taxes on old tires, used oils and lubricants, packaging waste, electrical and electronic waste, etc. Moreover waste cooking oil from restaurants in the city of Skopje will be collected and further converted in biofuel which will be utilized by the municipality for its own need or sold.

The proposed measures in the waste management sector are reported in Table 10.

3.2.8. Financial sustainability of the proposed measures

As pointed out by the SEAP Guidebook [24] and strengthened also by [39], financial resources are absolutely necessary to implement the actions foreseen in a plan which can involve relevant investments.

To this end, within RE-SEEties, cities were asked to examine the financial sustainability of the proposed measures in their LSAPs. The main idea was that capital investment and further project activities initiated by the project itself can also be funded by a large number of European and national programs and funds. Thus cities were encouraged to make an overview of the available funding mechanisms grouping them according to the geographical scope (i.e. regional, national, EU). It has to be pointed out that these represent potential financial resources which might be available after the project lifetime.

The City of Ivanić-Grad pointed out the availability of several sources to finance energy and waste management measures in the form of grants and loans through various national and European programs. It is expected that those funds will significantly increase with the accession of the Republic of Croatia to the European Union. In this case, two levels of funding were identified The first level deals with National financing mechanisms, which include Energy Performance

Table 10
Proposed measures for waste management in partner cities.

City	Typology of intervention proposed	Implementation beginning/end (years)	Cost assessment	Funding for measure implementation
Budapest 18th district (HU)	Information and training	n.a.	n.a.	n.a.
	Development of a joint prevention program with the Municipality of Budapest	n.a.	n.a.	n.a.
	Promoting the use of repair services	n.a.	n.a.	n.a.
Ivanić-Grad (HR)	Introduction of separate collection of paper in households	2014–2020	65,000 Euro	Municipal Waste Agency City of Ivanić-Grad Environmental Protection EE Fund EU programs
	Introduction of separate collection of bio-waste in households	2014–2015	65,000 Euro	Private sector
	Capacity building for city experts regarding preparation of waste management projects	2014–2020	25,000 Euro	
	Introduction of separate collection of packaging waste in households and legal entities	2014–2020	13,000 Euro	Municipal Waste Agency City of Ivanić-Grad Environmental Protection EE Fund
	Construction of new "green islands" for drop-off of textile and other wastes	2014–2015	25,000 Euro	EU programs
	On-demand bulky waste pickup	2014–2015	2500 Euro	
	Construction of a new recycling yard	2014–2015	130,000 Euro	Municipal Waste Agency City of Ivanić-Grad Environmental Protection EE Fund EU programs EU Structural Funds - Operational program for environment
Miercurea Ciuc (RO)	Waste prevention	n.a.	n.a.	n.a.
	integrated waste management	n.a.	n.a.	n.a.
Nitra (SK)	Waste-to-Energy technologies	2014–2020	n.a.	City of Nitra Nitra Communal Services Energy Agency in Nitra
Potenza (IT)	Re-organization of waste collection	n.a.	n.a.	n.a.
	Mechanical screening and incineration of the dry part of MSW	n.a.	n.a.	n.a.
	Biological treatment of the moist fraction of urban waste	n.a.	n.a.	n.a.
Ptuj (SI)	Waste-to-Energy technologies	n.a.	n.a.	n.a.
Skopje (FYROM)	Reorganization of the waste system	n.a.	n.a.	City of Skopje
	Treatment of waste water	n.a.	n.a.	City of Skopje
	Treatment of waste collectors for waste water treatment	n.a.	n.a.	City of Skopje
	Through PPP, safe stripping of waste from demolition and industrial waste	n.a.	n.a.	City of Skopje
	Collecting used cooking oil and transformation into fuel	n.a.	n.a.	City of Skopje

Contracting (EPC) and Energy Service Companies (ESCO), the Environmental Protection and Energy Efficiency Fund (EPEEF) and the Croatian Bank for Reconstruction and Development (HBOR). The second one includes European financing mechanisms, which revolve around EU funds and programs, development banks and specialized funds and that can be structured in the following groups: EU pre-accession assistance (known as IPA funds), EU Structural and Cohesion funding for Croatia, Specialized European programs, European development banks, Regional development funds that operate in the Western Balkans region.

The Municipality of Aigaleo was one of the first signatories to the Covenant of Mayors in Greece (2008) and based all the project activities on a wider concept of local energy planning and strategy. Nevertheless, funding the proposed activities is a typical problem for the municipal authority which aims to access to financial resources provided by one or more of the following programs: the European Local Energy Assistance (ELENA), the Joint European Support for Sustainable Investment in City Areas (JESSICA), the European Energy Efficiency Fund (EEEF) and other European initiatives such as INTERREG, LIFE, etc. Moreover, the National Strategic Reference Framework for Greece will ensure that the assistance from the Funds is consistent with the Community strategic guidelines on cohesion identifying different programs such as: Energy Saving in Municipalities, Energy upgrading of school buildings program, Bioclimatic upgrade of public open spaces, Green Roofs in Public Buildings, Pilot projects as Green Neighborhood and Green Rural and Island Communities, Financing schemes like ESCOs, Public-Private partnerships, etc.

The Budapest District 18th aims to apply for investment opportunities on energy efficiency and renewable energy through local, regional, national and European funds. With reference to local financial resources, two public companies are in charge of the realization of the waste management and energy efficiency programs. National financial resources are linked to the national energy saving strategies, plans and programs, such as: New Széchenyi Plan, Energy Service Companies (ESCO), Environmental Protection and Energy Efficiency Fund (Hungary). On the other hand, EU financial resources could be provided by the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD), and venture capital. In order to reach the above mentioned national and international financial sources and to investigate further new sources, the District Authority would seek professional service providers through public procurement. Application for these funds would be based on the local action plans developed in compliance with the local policy established during the project.

City of Nitra belongs to the first towns in Slovakia which joined the Covenant of Mayors (2008) and all the activities of the City management will be aimed at the achievement of the goals and the fulfillment

of the obligations stated in the Covenant of Mayors. After the acceptance of the upgraded version of the SEAP it is expected to have a two-year interval for assessing the fulfillment of the accepted actions, including possibilities of their financing. The total costs of the particular project solutions will be known only after the first meetings when possible solutions and detailed proposals of the most suitable technologies for future solutions will be specified.

Miercurea Ciuc at the time of the project had just signed the Covenant of Mayors. The city has already invested in renewable energies, funded energy efficiency programs and supported selective waste collection. Thus, the information gathered and the strategy elaborated within the project will be used also for the SEAP development process, assuring a full consistency with the city's future investments and related tendering documents. The financial sustainability of the strategy is granted by the forthcoming financing programs. In particular, also in this case great attention is paid to the Regional Operative Program (2014-2020) with regard to renewable energies, energy efficiency and sustainability.

In Skopje, the measures from the local strategic documents that will be produced during the implementation of the project (RE-SEEties) are expected to be implemented mainly after the end of the project. That's why it is important for the results of this project to have short and long term sustainability. To this end, local strategies and plans will be strictly linked to the national and regional strategy documents and action plans especially as concerns the financial possibilities for implementing the proposed measures. Skopje has several budget lines to fund the proposed measures and activities, but it is important to highlight that they depend on outside sources of funding in the form of grants through various programs such as the European Union, international funds and granting schemes. EU funding is expected to increase significantly when Macedonia will become a full member of the Union.

In the Municipality of Potenza, all the activities developed under RE-SEEties will be capitalized under the current urban planning activities and, in particular, in the monitoring phase of the local Sustainable Energy Action Plan in order to review priorities and targets. In this case the proposed actions will be financed through the Regional Operational Programme (ROP) of Basilicata (NUTS II Region) and, in particular, the Regional Development Fund (ERDF) and the European Social Fund (ESF).

Also in the case of the Municipality of Ptuj potential financial resources, which might be available after the project lifetime, will include National and regional funds, European Territorial Cooperation programs (ETC) and Horizon 2020, etc.

4. Discussion

A critical comparison of the technical measures proposed by the eight cities partners of RE-SEEties allows to derive interesting conclusions in terms of peculiarities, similarities and differences on several key aspects.

Fig. 2 provides an overview of the number of technological measures proposed by each partner in their Local Strategies and Action Plans which are the most significant both in terms of economic effort and expected benefits in terms of CO_2 emissions reduction.

A sector analysis shows that most of the proposed measures (23%) aims to green current transport systems improving public transportation accessibility and performance, encouraging walking and cycling usage so as to reduce travel by private vehicles. A great number of measures (21%) are aimed to increase the use of locally available renewable energy sources, mainly solar, biomass but also geothermal. Significant attention is provided to *waste management* (16%), where measures are aimed at increasing the amount of separately collected and recycled materials and reducing the amounts of landfilled waste. Buildings represent a significant opportunity for carbon abatement in all the partner cities: 15% of the proposed measures are devoted to improve energy efficiency in municipal and public buildings and 8% in domestic buildings (Residential) mainly upgrading insulation, reducing losses and installing building controls. Lighting is also considered of high importance (7%), introducing measures aimed at renewing public street lighting systems (lamps substitution and smart metering of lighting needs) and installing energy saving lamps also in domestic and commercial buildings. Bringing up the rear, only 2% of the specific intervention are proposed for the Commercial and Service which is a

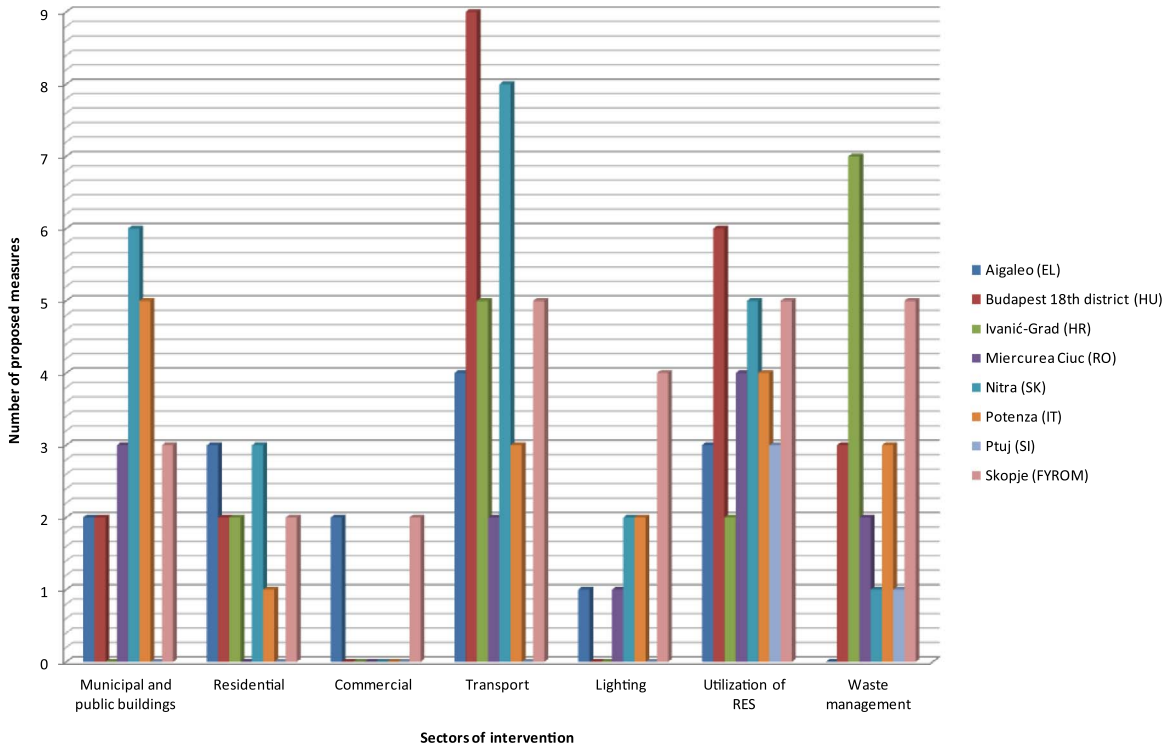

Fig. 2. : Number of technological measures proposed by partners in their Local Strategy and Action Plans.

sector characterized by high complexity.

Fig. 2 shows also that Skopje (FYROM), Nitra (SK) and Budapest 18th district (HU) are the most ambitious cities accounting, respectively, for 19%, 18% and 16% of the total number of proposed measures mainly in the field of transport systems and exploitation of renewable energy sources. Among these, Skopje (FYROM) is the only city with a LSAP covering all the analyzed sectors. The other cities are also quite ambitious on the same themes with some peculiarities: Aigaleo (EL) acknowledges the importance of increasing the energy efficiency of commercial buildings, Ivanić-Grad (HR) takes a leading role in waste recycling, Miercurea Ciuc (RO) and Potenza (IT) focus their efforts on public buildings and renewable energy sources. Ptuj (SI) accounts for 3% of the total measures dealing only with the utilization of renewable energy sources and waste management (issues on which they gathered great experience during the MED ZERO WASTE project [40]). This analysis should also take into account that, among the partnership, three cities were in the process to develop their first SEAP (Ivanić-Grad – HR, Miercurea Ciuc – RO, and Ptuj – SI) while the other five cities were updating their existing SEAPs.

A deeper analysis shows that not all the proposed measures are accompanied by detailed information in terms of costs assessment, estimates on energy savings and development of renewable energy sources (RES) as well as avoided CO_2 emissions through the implementation of the proposed measures. Evidence of this is provided by Fig. 3 which compares the *level of ambition* of partner cities, in terms of total number of the proposed measures, with the *level of maturity* of their Local Strategies and Action Plans, distinguishing among cities which have only introduced a "wish list" and those that have carefully assessed pros and cons of each measure. It can be seen that among the 138 proposed measures, less than half are accompanied with an assessment of investment/implementation costs (46%) or well identified targets on energy efficiency and renewable energy sources (40%) while 61% of these measures were completed with an assessment of CO_2 emission savings. This gap is quite evident in Miercurea Ciuc (RO) and Ptuj (SI) and partially in Aigaleo (EL) and Potenza (IT) as concerns the estimation of energy savings due to the implementation of the proposed measures. Skopje (FYROM), Nitra (SK) and Ivanić-Grad (HR) were very careful in assessing pros and cons of the proposed measures within their Local Strategies and Action Plans.

Similar considerations can be done as concerns the identification of *funding sources* for assuring the implementation of the proposed measures, aspect of extreme importance especially for South East European cities. As shown in Fig. 4, four out of eight partner cities did not specify the funding sources for the proposed measures (Budapest 18th district – HU, Miercurea Ciuc – RO, Nitra – SK, Potenza – IT, and Ptuj – SI), whereas the remaining four cities planned to finance them through municipal funding sources (22%), extra municipal funding (9% among regional, national, EU, private donors and investors, banks and ESCOs) or through a mixtures of financing instruments, consisting of municipal and extra-municipal funding sources (21%). In particular Aigaleo – (EL) and Ivanić-Grad (HR) showed to have a clear idea of the funding sources to be used case by case, whereas Skopje (FYROM) and Nitra (SK) proposed some measures (respectively 1 and 8), characterized by undefined funding sources. Besides, these two cities indicate that at least 50% of the proposed measures will be financed with municipal funds.

In order to evaluate the effectiveness of the measures proposed in the Local Strategy and Action Plans (LSAPs), starting from a common evaluation grid partner cities selected a set of indicators best suited to the local characteristics, identifying their trends and quantifying the targets to be reached (Table 11).

Table 11 shows that almost all indicators (65) are related to energy measures and only 3 indicators refer to waste measures. In particular, Budapest 18th district (HU) selected "General waste produced" indicators to quantify Waste reduction targets whereas Nitra (SK) utilized "Energy produced by waste" and "Avoided level of CO_2 " indicators to characterize the effects of Waste to Energy measures. Skopje (FYROM) and Nitra (SK) indicated a consistent number of indicators, respectively 20 and 19, whereas Aigaleo (EL), Potenza (IT) and Ptuj (SI) have not specified any quantitative indicator in their LSAPs. As concerns the sectors under focus, partner cities identified the largest number of indicators in the buildings sector (20), followed

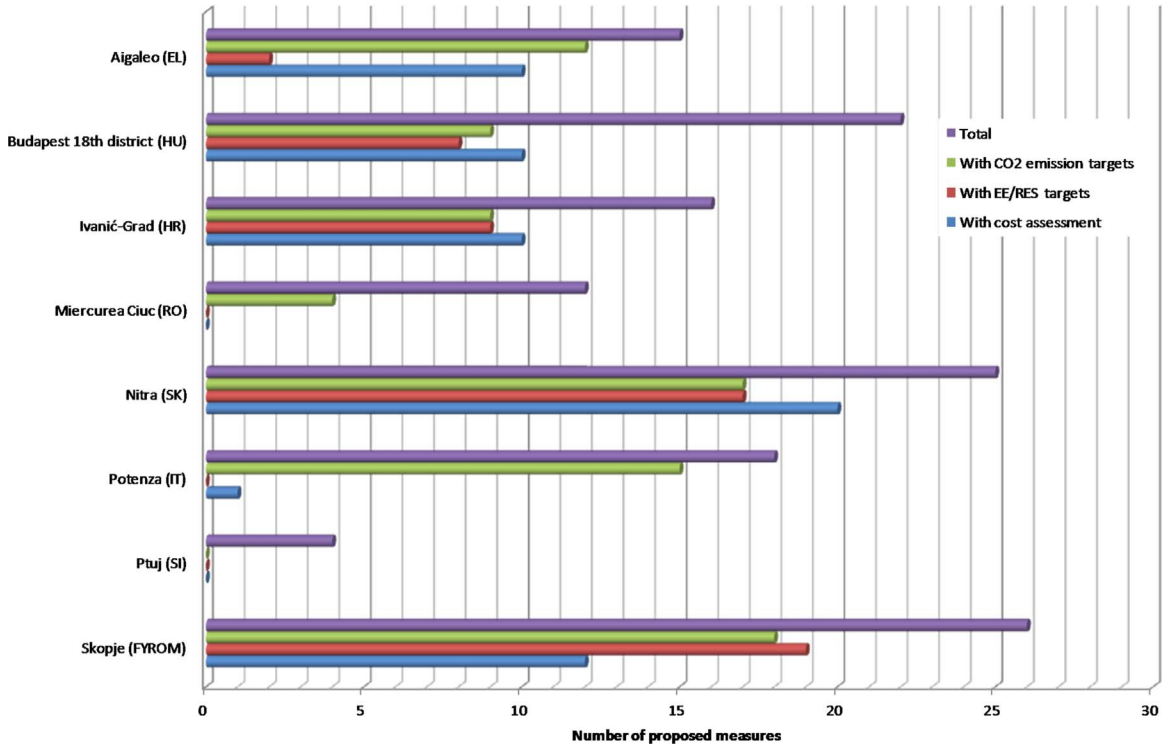

Fig. 3. : Focus on the proposed measures in terms of targets and cost assessment.

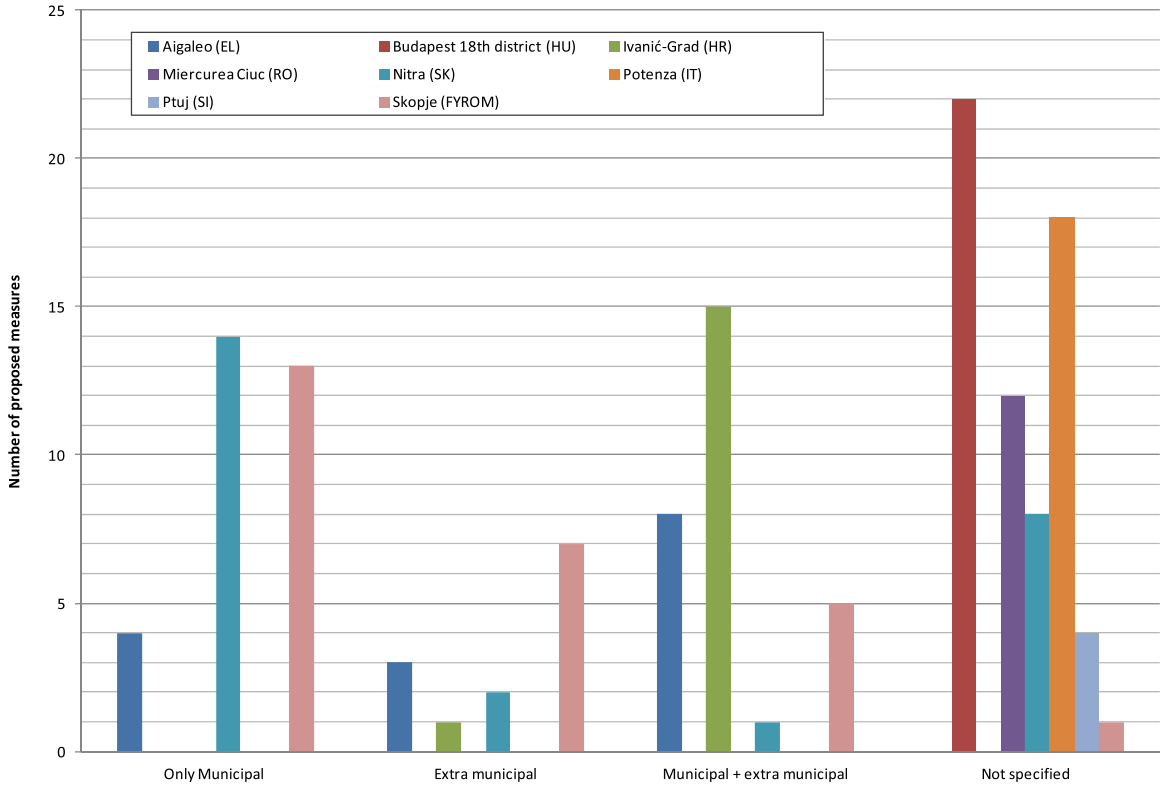

Fig. 4. : Focus on funding sources identified for implementing the proposed measures.

by transport (17), local energy production from RES (13), public lighting (7), citizens involvement (6) and green public procurement (2). It can be also noted that no indicator was proposed to monitor the local economic impact of the energy measures. Moreover, limited to eight indicators Budapest 18th district (HU) and Ivanić-Grad (HR) identified only a qualitative trend without fixing a quantitative target (reported in the table as N/A).

5. Conclusions

Resource efficiency is a common challenge for municipalities throughout Europe. This is particularly true in the South East Europe region, where local authorities need to develop and implement policies for enhancing the quality of life in urban areas while ensuring a reduction of resource extraction, energy consumption and waste generation.

Capacity building, technology and knowledge support are key factors to tackle resource efficiency in an integrated manner at urban level. A contribution in this direction was provided by the RE-SEEties project, in which city partners were helped to approach energy and waste management working simultaneously on different fronts: data and methodologies, available technologies, policy making tools, incentives, awareness raising initiatives.

The Local Strategies and Action Plans (LSAP) developed by RE-SEEties partners represent one of the main outcomes of such a complex process which laid its foundations on an intensive strategy building process with relevant stakeholders and a continuous peer review process by the project's expert partners. The process of quality control of the strategies developed within the project resulted in recommendations for improvement. According to a common methodology, each partner city identified a suited list of indicators to assess the local case study and the potential results of implementing the proposed local energy and waste strategies. In this framework, it was very useful to elaborate effective monitoring methods and observe trends of each specific indicator at municipal level. The identification of appropriate targets is an important feature, which must necessarily also take into account the possible sources of financing in order to avoid the implementation of local strategies and action plans characterized by unrealistic measures.

The overall exercise allowed to derive common conclusions, recommendations and lessons learned. First, common analytical tools can be very useful to support strategic planning and the identification of comprehensive, sustainable strategies. During the project, municipal officials acquired technical competences on the use of different tools to support decision-making in energy planning and waste management. Because these tools are fed in with data, they experienced the complexity of data collection and estimation methodologies and how data quality plays an important role in the definition of a good strategy. Nevertheless, municipalities need to invest in knowledge and capacity building in order to increase the intellectual and institutional capital of public employees and managers to monitor grant opportunities, establish potential partnerships, prepare project documentation and reporting in order to be involved and fully active in international and local funding programs.

Second, although municipalities play the main role in the development of a Local Sustainable Energy Strategy and Action Plan, the RE-SEEties experience has further proved the key role of stakeholder engagement in the implementation of sustainable strategies. As a matter of fact, municipal facilities account for only a small percentage of the resource use and the associated emissions. Thus, a substantial reduction in energy consumption can be achieved only through an active participation of all the main local actors and stakeholders in the main steps of the strategy building process: development, adoption, implementation and monitoring.

Third, behavior change is of central importance in bringing about energy savings and waste reducionts. Although in most cases this issue is treated separately and is considered secondary to technological development, the mutual information-exchange will result in a better strategy whereas the transparent, democratic planning process will increase the willingness to cooperate and implement the strategy.

Table 11
Energy and waste indicators selected from the partner cities.

City	Sector	Indicator	Monitoring method/Source	Trend/Effect	Quantification
Budapest 18th district (HU)	Transport	Number of electric, eco and hybrid vehicles procured by the city	City administration data.	Increase	1
		Number of new public electric charging stations	City administration data.	Increase	29
		Informed and educated citizens	Conducting surveys and number of drivers which went through ECO-driving course	Increase	N/A
	Buildings	Total energy consumption of public buildings	City administration.	Decrease	7413 MWh
		Capacity/awareness level of public building managers	City administration.	Increase	N/A
		Total energy consumption of households	Public utility companies, selected areas door- to-door surveys	Decrease	40-55% of the renovated buildings + 172352 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Increase	38741 tCO_2
	Local Energy Production from RES	Electricity produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	18256 MWh
		Heat energy produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	21028 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	22611 tCO_2
	Green Public Procurement (GPP)	Number of public procurements using "green criteria"	City administration.	Increase	N/A
	Waste reduction	General waste produced	Muncipal waste management company	Decrease	0,5 kg/person/year
Ivanić-Grad (HR)	Transport	Fuel savings	Extract data from fuel supplier's bills. Convert to energy.	Decrease	14187 MWh
		Total energy consumption of renewable fuels in public fleets	Extract data from biofuels suppliers' bills. Convert to energy. Sum this indicator with the previous one and compare values.	Increase	5275 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Increase	5014 tCO_2
		Informed and educated citizens	Conducting surveys and number of drivers which went through ECO-driving course	Increase	N/A
	Buildings	Total energy consumption of households	Public utility companies, selected areas door- to-door surveys	Decrease	29843 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Increase	11187 tCO_2
		Total energy consumption of non-residential buildings	Public utility companies, selected areas door- to-door surveys	Decrease	6183 MWh
		Quality and comfort of living	Carry out surveys in selected areas of the municipality.	Increase	N/A
	Local Energy Production from RES	Heat energy produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	10909 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	4400 tCO_2
	Citizens involvement	Number of citizens attending energy efficiency/renewable energy events	Attendance lists, city administration stats.	Increase	N/A
		Energy saving because energy efficiency/renewable energy events	Survey	Increase	N/A
		Number of Environmental and energy NGOs actively participating in local events and policy making activities	Attendance lists, city administration stats.	Increase	N/A
Miercurea Ciuc (RO)	Transport	Quality of air (NOx, PM)	Carry out surveys in selected areas of the municipality.	Decrease	1584 tCO_2
	Buildings	Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	807 tCO_2
	Public lighting	Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	15 tCO_2
	Local Energy Production from RES	Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	21250 tCO_2
Nitra (SK)	Transport	Number of public transport passengers	Agreement with a public transport company.	Increase	10000000
		Fuel savings	Extract data from fuel supplier's bills. Convert to energy.	Decreasel	103645 MWh/yr
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Increase	26604 tCO_2
		Informed and educated citizens and municipal workers	Conducting surveys and number of drivers which went through ECO-driving course	Increase	100
	Buildings	Total energy consumption of public buildings	City administration.	Decrease	12847 MWh/yr
		Capacity/awareness level of public building managers	City administration.	Increase	100 people
		Total energy consumption of households - reduction	Public utility companies, selected areas door- to-door surveys	Decrease	49235 MWh/yr
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	20725 tCO_2
		Number of buildings with an energy certificate	City administration, national/regional energy agency	Increase	12
		Total energy consumption of non-residential buildings	Public utility companies, selected areas door- to-door surveys	Decrease	41018 MWh/yr
	Public lighting	Energy consumption	City administration.	Decrease	81.45 MWh

(continued on next page)

Table 11 *(continued)*

City	Sector	Indicator	Monitoring method/Source	Trend/Effect	Quantification
		Number of new energy efficient lighting sources (SSL and others)	City administration.	Increase	100
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	20.52 tCO_2
	Local Energy Production from RES	Electricity produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	150 MWh/yr
		Heat energy produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	17770 MWh/yr
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	3609 tCO_2
		Number of public procurements using "green criteria"	City administration.	Increase	2
	Waste to energy	Energy produced by waste	Regional/National Public Administrations	Increase	36040 MWh/yr
		Avoided level of CO_2	Regional/National Public Administrations	Increase	7320 tCO_2
Skopje (FYROM)	Transport	Fuel savings	Extract data from fuel supplier's bills. Convert to energy	Decrease	342934 MWh
		Number of electric, eco and hybrid vehicles procured by the city	City administration data.	Increase	5
		Number of new public electric charging stations	City administration data.	Increase	15
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	121 $ktCO_2$
		Informed and educated citizens	Conducting surveys and number of drivers which went through ECO-driving course	Increase	10000
	Buildings	Energy consumption of public buildings	City administration.	Decrease	71000 MWh
		Capacity/awareness level of public building managers	City administration.	Increase	100 people
		Energy consumption of households	Public utility companies, selected areas door- to door surveys	Decrease	88910 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	108 ktCO2
		Total energy consumption of nonresidential buildings	Public utility companies, selected areas door- to door surveys	Decrease	51700 MWh
	Public lighting	Energy consumption	City administration.	Decrease	288828 MWh
		Number of new energy efficient lighting sources (SSL and others)	City administration.	Increase	300+
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	259 $ktCO_2$
	Local Energy Production from RES	Electricity produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	9608 MWh
		Heat energy produced by local RES installations	Regional/National Public Administrations (feed-in tariffs of certificates)	Increase	50119 MWh
		Avoided level of CO_2	Carry out surveys in selected areas of the municipality.	Decrease	42 $ktCO_2$
	Citizens involvement	Number of citizens attending energy efficiency/renewable energy events	Attendance lists, city administration stats.	Increase	10000
		Energy saving because energy efficiency/renewable energy events	Survey	Increase	121092 MWh
		Avoided level of CO_2			71 $ktCO_2$
	Green Public Procurement (GPP)	Number of public procurements using "green criteria"	City administration.	Increase	1

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