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SUSTAINABLE ENERGY PLANNING IN SLOVENIAN MUNICIPALITIES

TRAJNOSTNO ENERGETSKO NAČRTOVANJE V SLOVENSKIH OBČINAH

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Keywords: energy efficiency, energy management, Covenant of Mayors, sustainable energy action plan, Slovenia.

Abstract

One of the European initiatives responding to the global challenges of climate change, on the local level, is the Covenant of Mayors (CoM), a voluntary agreement of cities and municipalities to improve energy efficiency, the usage of renewable resources, and carbon dioxide (CO2) reduction by 2020. Our study represents a process of sustainable energy planning and analyses two Sustainable energy action plans (SEAPs) in Slovenia, offering an in-depth view of the improvements, which are composed of technological measures and "soft" measures, such as education and awareness raising. Further recommendations are made regarding the SEAP preparation, implementation, and monitoring, considering a systematic and holistic approach towards more sustainable local communities.

Povzetek

Ena izmed evropskih iniciativ, ki uresničuje skupne globalne izzive na lokalnem nivoju je t.i. Zaveza županov. Predstavlja prostovoljni dogovor mest in lokalnih skupnosti, z namenom povečati energetsko učinkovitost, uporabo obnovljivih virov in zmanjšanje izpustov ogljikovega dioksida do leta 2020. V našem prispevku predstavljamo proces trajnstnega energetskega načrtovanja in analizo dveh trajnostnih energetskih akcijskih načrtov v Sloveniji. Podrobna analiza ukrepov za izboljšanje prikazuje, da so le-ti sestavljeni iz tehnoloških izboljašav, kot tudi t.i. »mehkih vsebin«, med katere sodita izobraževanje in ozaveščanje.

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V zaključkih smo pripravili priporočila za pripravo, implementacijo in spremljanje trajnostnega energetskega načrtovanja, z upoštevanjem sistematičnega in celostnega pristopa k bolj trajnostnim lokalnim skupnstim.

1 INTRODUCTION

The European Union (EU) committed itself to becoming an energy-efficient and low carbon economy, by adopting the Climate and Energy Package in 2008, *[1]*. The Energy Efficiency Directive (EED), *[2]*, was approved in 2012 as the most comprehensive directive on energy efficiency. By 2014 all EU member states (MS) had transposed the EED into their national laws. The EED represents the following targets: a) a 20% energy increase regarding the consumption of the EU by 2020; b) MS shall ensure that from 2014 onward, 3% of the total floor area of public buildings owned or occupied by government be renovated each year; c) achieving new savings each year from 2014 to 2020 of 1.5% of the annual energy sales to final customers of all energy distributors, *[3]*. By reviewing the progress, the European Commission has prepared an agreement on new energy efficiency targets for 2030, including 27% of savings compared to the business-as-usual scenario, *[4]*.

To support the implementation of climate and energy policies at the local level, the European Commission has launched a Covenant of Mayors (CoM), representing a voluntary agreement towards increasing energy efficiency and usage of renewable resources at the local level, where local governments play a crucial role. The CoM represents a significant commitment to reach the EU sustainability goals, focusing on a 20% reduction of the EU greenhouse gas (GHG) emissions from the 1990 baseline year, raising the share of renewables by 20% in the energy consumed, and a 20% increase in energy efficiency, *[5]*. The CoM commitment covers the geographical area of the local authority, referring to a town, city, municipality or region, *[6]*.

By September 2016, 6201 mayors had become signatories. As argued by Christoforidis et al., *[7]*, the high number of signatories does not necessarily imply that the goals of CoM will be reached, because the commitment is required by the local authorities and their financial capabilities for investments.

Regarding the CoM initiative in Slovenia, there have been 29 signatures of commitment, and 29 Action Plans submitted to the CoM. Within them, there are 29 commitments to the 2020 targets, one commitment to the 2030 targets, and two adaptations (Idrija and Odranci) of the Action Plans.

This paper represents research work within the Erasmus+ project, Innovative educational tools for Energy Planning, focusing on energy planning and energy efficiency in Slovenian municipalities as the case studies. The paper is organized as follows: Section 2: provides background information on Sustainable energy action plan (SEAP), followed by SEAPs in Slovenia as case studies (Section 3), in which an in-depth review of SEAPs for the Municipality of Velenje and the Municipality of Krško was carried out in order to define the municipalities energy consumption “hot spots” and their measures for improvement. Section 4 analyses sectoral measures of the SEAPs, followed by monitoring activities in Section 5. Section 6 focuses on the results of the emissions reductions needed and discusses the measures to achieve them. Finally, a discussion and conclusions are represented in Section 7.

2 SUSTAINABLE ENERGY ACTION PLAN

The Sustainable Energy Action Plan (SEAP) is the main policy act that local authorities should adopt to reach the EU sustainability goals and reach its CO_2 reduction by 2020, *[8,9]*, as well as a planning tool to promote the policy strategies, *[10]*. The SEAP illustrates the applicable procedures to achieve the targets in CO_2 emissions reductions, and it is the subject of approval by the CoM office, *[7]*. It defines concrete reduction measures, time frames, and responsibilities to achieve the settled long-term goals, focusing on the reduction of CO_2 emissions and final energy consumption by end users, *[6]*. The SEAP covers areas where local authorities have an influence, such as land use planning, green public procurement, and changes in consumption patterns. According to Corrado et al., *[11]*, the SEAP is a precise operational tool for defining sustainable development strategies, regulations and actions in line with the policy directions defined by the local authorities. It also includes a future vision of the involvement of citizens and other stakeholders.

The preliminary action towards designing an SEAP is to prepare the Baseline Emission Inventory (BEI) data to identify the best fields of action and opportunities to reach the CO_2 reduction targets, *[6, 7]*. The recommended baseline year is 1990, since the Covenant's goal is to reduce the emissions by 20% by 2020 in comparison to the 1990 levels. However, if the data from 1990 are insufficient or unavailable, then a subsequent year must be chosen, *[12]*. The BEI is divided into four parts: the final energy consumption data, the CO_2 emissions, local electricity production and local heat/cold production, *[12]*, and enables the identification of main CO_2 emission sources and their reduction potential, including a preparation of the action plan and describing the actions in a more detailed way, *[11]*. The BEI represents the initial activity for the SEAP, which consists of four phases: Initiation, Planning, Implementation, and Monitoring and Reporting, which described in greater detail in Fig. 1.

Figure 1: *The SEAP process*

Signing the CoM for a municipality means that after formulating a BEI, the municipality must submit the SEAP within one year of being signed, create an internal management structure for

implementing the process involving other stakeholders and citizens, carry out monitoring, and communicate and disseminate the activities, *[11]*.

3 SEAPs IN SLOVENIA

In Slovenia, there are currently 29 SEAPs. In our study, two SEAPs are selected, the Municipality of Velenje (VE), and Municipality of Krško (KK) in order to define their principal activities approaching more energy efficient municipalities. The municipalities of Krško and Velenje have joined the CoM, the committing mayors, and other decision-makers on their field to increase energy efficiency and the use of renewable energy sources, and are undertaking to reduce CO_2 emissions by 20% until 2020.

Following the recommendation of the European Commission and Joint Research Centre, *[12]*, the scope of the action plans encompasses energy use in:

a) Buildings
   - Municipal building
   - Tertiary buildings, the buildings of the service sector that are not owned or operated by local communities
   - Residential buildings

b) Transport
   - The municipal fleet
   - Public transport
   - Personal cars and trucks

c) Street lighting.

The SEAPs are dedicated exclusively to the public sector. However, local communities can, with their policies, role models and the sustainable planning, have a positive impact on energy efficiency and sustainable energy usage in other sectors. Industrial sectors are not covered by the SEAPs.

Both SEAPs have identified the main goals, which are in line with the policy directions of the European Commission, *[1]*:

- To reduce CO_2 emissions in all sectors, implementing energy efficiency (EE) measures with further exploitation of renewable energy sources (RES), effective management and energy control, education and other measures,
- To reduce energy consumption in the public sector (public buildings, transport, and public lighting,
- To ensure the security of energy supply and diversity of energy sources.

The process of developing the SEAPs was divided into six steps, which were similar to the proposed methodology (see SEAP process, Fig. 1):

1) Preparation process of the SEAP: political will, coordination, and the scope,
2) Elaboration of the SEAP,
3) Approval of the SEAP as an official document for the municipality,
4) Implementation of the SEAP,
5) Monitoring and control of the implementation of the SEAP,
6) Reporting on the implementation of the SEAP.

Both municipalities (Velenje and Krško) identified the most significant activity in the preparation of the SEAP, which was achieving the political will for its successful implementation, and necessary consensus and support from the mayor and municipal council. Furthermore, the municipalities have identified the tasks of the municipal administration in the implementation of the SEAP:

- To ensure the budget for the implementation of activities and measures,
- To integrate the SEAP objectives in the development strategy of the municipality,
- To support the implementation of measures and activities of the SEAP,
- To ensure tracking and reporting on the implementation of the SEAP,
- To communicate with the general and professional public on the implementation of the SEAP,
- To provide and encourage citizens for the realization of the SEAP.

3.1 Analyses of energy use

In the SEAP for Krško, the reference year was 2005, while it was 2003 for Velenje. For both cases, the CO_2 inventory was based on overall energy consumption, using the standard method from the Intergovernmental Panel on Climate Change (IPCC) for GHG emissions, based on the end-use of energy, and have been classified into several categories (see Table 1), not including industry, and long-distance transport.

Table 1: *Analysis of energy use in the municipalities of Krško (KK) and Velenje (VE), with the reference years 2003 and 2005. Source: SEAP Krško and SEAP Velenje*

Category	VELENJE (VE) Energy used [MW h]	Total CO_2 emissions [t/a] in VE	KRŠKO (KK) Energy used [MW h]	Total CO_2 emissions [t/a] in KK
Buildings	400,302.2	147,488.3	18,935.3	39,045.1
- Public buildings	54,786.3	23,000.7	6,619.3	1,875.1
- Residential buildings	319,113.9	116,303.0	176,316.0	37,170.0
- Other non-residential buildings	26,402.0	8,184.6	n.a.	n.a.
Mobility/Traffic	61,159.0	13,081.0	95,407.2	23,387.2
Public lighting	1,694.5	943.8	3,534.0	1,968.4
TOTAL	463,155.7	161,513.1	281,876.5	64,400.7

Table 1 shows that the higher energy consumption belongs to the building category, which represents more than 86% of consumption in Velenje and 60% in Krško. According to Table 1, buildings present the most energy-consuming sector; thus, most of the attention in the SEAP

will be given to energy efficient and sustainable buildings, including energy efficient renovation of public buildings and exploitation of RES. Regarding the traffic sector, use of public transport is to be fostered, including a purchase of environmentally friendly vehicles. Public lighting represents a relatively low proportion of the contribution of the CO_2 emissions to the total balance. However, the measures to improve public lighting will focus on the replacement of the current lamps with more efficient ones.

3.2 Sustainable energy action planning

The results of the BEI are followed by the identification of the categories consuming the most energy and thus producing more CO_2 emissions, and where the improvements should be made. The Joint Research Centre, *[12]*, argues that the improvement measures must be defined with various criteria (quality and quantity), cover objectives, expected savings, and emission reduction, including timetables, deadlines, budget and risk analyses. Both municipalities plan on achieving 20% CO_2 emissions reduction by 2020 according to their baseline years. The SEAPs considered in the case studies were prepared by the local energy agencies (e.g. Local energy Agency Dolenjska and Energy Agency for Savinjska, Šaleška, and Koroška) in collaboration with the municipalities. Several experts from the agencies and municipalities have been included in the preparation of the SEAP from various fields, such as economic mechanical engineering, chemical engineering, etc.

Table 2 shows that the intention of both municipalities is to reduce the CO_2 emissions by more than 20%, as suggested. Thus, SEAPs for Velenje and Krško define several key actions to achieve their goals in three different sectors.

Table 2: *Expected CO_2 emissions reduction for various sectors. Source: SEAP Velenje and SEAP Krško*

Category	CO_2 reduction target per sector (VE) (in tons)	Contribution of action to the overall emissions reduction target (%) for VE	CO_2 reduction target per sector (KK) (in tons)	Contribution of action to the overall emissions reduction target (%) for KK
Buildings	31,392.0	19.4	11,177.8	17.4
Mobility/Traffic	5,444.4	3.4	4,700.6	7.3
Public lighting	505.0	0.3	1,004.1	1.6
TOTAL	37,341.4	23.1	16,882.5	26.2

4 SECTORAL ANALYSES OF MEASURES FOR VELENJE'S AND KRŠKO'S SEAPs

Within the sectors of buildings, traffic/mobility and public lighting Velenje proposed 31 and Krško 24 measures.

4.1 Buildings

The BEIs for both municipalities show that the building category (public buildings, residential buildings, and other non-residential buildings) is very energy consuming and consequently producing over 90% of the total CO_2 emissions in Velenje and nearly 65% of the emissions in Krško.

In the case of Velenje, 57 buildings of different typologies were considered for the analysis, including kindergartens, schools, dormitories, sport facilities and buildings of local communities). The majority of buildings are heated with the Šaleška Valley district heating system, which is the second largest district heating system in Slovenia, *[14]*, providing energy from a thermal plant, which is a non-renewable energy source. The Krško municipality included 32 buildings in their analysis, mostly primary schools and kindergartens. The analysis shows that the public buildings are mostly heated with natural gas (57%), heating oil (30%), and district heating (13%), while residential buildings use solid fuels (54%) and heating oil (27%). The reasons for low energy efficiency under the building category are not defined in the SEAPs. Corrado et al., *[11]*, argue that factors influencing high energy consumption in the building sector are construction and the limited use of insulating materials for outer walls, one-family heating plants (often oversized and inefficient), and cooling systems.

In Velenje's SEAP*, [14]*, 18 measures for public and residential buildings are identified, which consist of 14 “technology/equipment” measures and four “soft” measures. Under the “technology/equipment” measures, such as thermal solar collector systems, the optimization of district heating, the co-financing of energy efficient appliances for households, updating the boiler technology, installation of micro-photovoltaic systems on private buildings, etc., see Table 3. “Soft” measures cover awareness raising.

***Table 3**: Measures, costs, estimated CO_2 reduction and assessment of energy savings for Municipality of Velenje, [14]*

No.	Measure	Sector	Costs [in EUR]	Estimated CO_2 reduction [t/a]	Assessment of energy savings [MWh/a]
1	Educational events, awareness raising about EE and RES in public buildings	Public buildings	4,000/a	93	300
2	PV power plants on public buildings	Public buildings	2,500,000	55.7	100
3	5 thermal solar collector systems for public buildings	Public buildings	60,000	27.1	49
4	Optimization of district heating	Public buildings	1,000,000	7,579	24,447

5	Utilization of district cooling absorption system	Public buildings	1,000,000	848	1,523
6	Optimization of lighting in public buildings	Public buildings	500,000	1,628	2,923
7	Change of electric appliances with more efficient ones	Public buildings	500,000	678	1,218
8	Updating technology in boiler rooms of public buildings	Public buildings	1,000,000	283	913
9	Replacement of building doors, windows, etc.	Public buildings	696,486	287	927
10	Supporting the energy /passive construction	Public buildings	5,000		
11	Educational events, awareness raising about EE and RES in residential buildings	Residential buildings	2,000,000	3,856	12,438
12	Installation of heat dividers	Residential buildings	1,000,000	8,328	29,851
13	Change of non-energy efficient home appliances	Residential buildings	11,697,000	2,646	4,752
14	Installation of systems for the exploitation of thermal solar energy for private houses	Residential buildings	1,000,000	87	280
15	Change of lighting (bulbs) in residential buildings	Residential buildings	300,000	1,959	3,518
16	Replacement of doors, windows and improving the facade	Residential buildings	2,500,000	2,313	7,463
17	Installation of micro PV systems on private buildings	Residential buildings	1,200,000	223	400
18	Supporting the low energy /passive construction – private houses	Residential buildings	5,000		
19	Change of bulbs to more efficient ones	Public lighting	14,000	126	226.3
20	Change of lamps	Public lighting	73,000	126	226.3
21	Change of lamps with power of 200-500 W	Public lighting	201,240	113	203
22	Change of lamps with power of 100-199 W	Public lighting	569,908	125	225
23	Change of lamps with power of 1-99 W	Public lighting	338,576	64	115
24	Regulation for public lighting	Public lighting	221,416	216	388
25	Self-sufficient street lighting	Public lighting	250,000	0.2	0.4
26	Increasing biofuels (7,5 % until 2020)	Traffic		981.1	

27	Restriction of parking in the city centre	Traffic			
28	Education and awareness raising	Traffic	108,000		
29	Improvement of municipality fleet	Traffic	90,000		
30	Supporting car sharing	Traffic			
31	Free public transport	Traffic	4.500.000	2.500	

The SEAP of Krško *[13]* introduces 16 public and residential building measures, consisting of 13 technology/equipment measures, such as energy restoration of buildings, co-financing energy efficient appliances for households, installation of biomass boilers, co-generation in public schools, installation of PV power plants, and three soft measures, which are awareness raising, employment of energy manager, and promotion of low-energy construction; see Table 4.

***Table 4**: Measures, costs, estimated CO_2 reduction and assessment of energy savings for municipality of Krško, [13]*

No.	Measure	Sector	Costs [in EUR]	Estimated CO_2 reduction [t/a]	Assessment of energy savings [MWh/a]
1	Educational events, awareness raising about EE and RES in public buildings	Public buildings	24,000	98 [total]	331 [total]
2	Energy renovation of public buildings	Public buildings	3,598,534	218	1.088
3	Energy renovation of public buildings	Public buildings	5,766,120	46	109
4	Solar systems for hot water	Public buildings	200,000	46	82
5	Change of electric appliances with more efficient ones	Public buildings	50,000	34 [total]	61 [total]
6	Installation of biomass boilers (wood)	Public buildings	363,000	367	874
7	Co-generation in the public school	Public buildings	94,270	5,5	27
8	Supporting low energy, passive construction	Public buildings	5,000		
9	Installation of PV power plants	Public buildings	2,000,000	468	840
10	Installation of heat dividers	Residential buildings	5,000	153	759
11	Change of non energy efficient home appliances	Residential buildings	230,000	1,105 [total]	1,984 [total]
12	Replacement of doors, windows, etc.	Public buildings	2,990,700	452 [total]	1,888 [total]
13	Replacement of bulbs in households	Residential buildings	30,000	737	1,323
14	Employment of a manager of boilers in public buildings	Public buildings	90,000	53 [total]	236 [total]

15	Energy renovation of residential buildings	Residential buildings	131,555	5.2	10-15%
16	Energy renovation of PGE Krško	Public buildings	193,950	19	82
17	Renovation of public lighting	Public lighting	299,602	538 [total]	965 [total]
18	Exchange of bulbs with more efficient ones	Public lighting	14,000 + 73,000	126 [total]	226 [total]
19	Increasing biofuels (7.5% until 2020)	Traffic		483	
20	Parking restriction in the centre	Traffic			
21	Education, awareness raising – public transport and mobility	Traffic	12,000/a		
22	Improving the municipal fleet	Traffic	35,000/car	0.8	
23	5 stations for electric vehicles	Traffic	25,000		
24	New vehicle for fire-fighters	Traffic	25,000	0.2	

4.2 Public lighting and local transport/mobility

Regarding public lighting, the BEIs for both municipalities show that their public lighting is not efficient, consisting of mostly high-pressure mercury lamps, which could be replaced by highly efficient LED lamps. The improvement measures of the public lighting thus focus on technology/equipment, such as change of bulbs, and regulation and control of public lighting.

To reduce the urban GHG emissions from transport/mobility, all the parameters contributing to the emissions need to be examined and are related to the city (municipality) shape and settlement location, *[15]*. Regarding the CO_2 emissions, the municipality fleet, public transport, and personal vehicles have been considered. In both municipalities, personal vehicles represent over 95% of all the CO_2 emissions. Velenje's and Krško's SEAPs propose six transport-related measures, consisting of soft measures (e.g. awareness raising, car sharing, parking restriction in the city centre) and improving the municipal fleet (new, more efficient vehicles and usage of biofuels).

5 SEAP MONITORING

Continuous control of the implemented measures and reporting the results is an important part of the implementation process of the SEAP. At the beginning SEAP guidelines forecast biennial monitoring, assessing the implemented activities and propose goals. Furthermore, the BEI should be updated with the current CO_2 emissions. The four-year monitoring report is called the Monitoring Emission Inventory (MEI), which is a substantially updated version of BEI, not based on CO_2 emissions reduction, but on the re-calculation of the BEI, *[11]*. Regarding the monitoring

process of SEAPs in Velenje and Krško, it could be perceived that in 2016 Krško prepared an updated version of their SEAP, which could be in line with the MEI, while for Velenje, no information regarding the annual and/or biennial achievements was reported, based on the indicators settled.

6 RESULTS AND DISCUSSION

When municipalities committed to the voluntary agreement of the CoM, they agreed to reduce their CO_2 emissions by at least 20%. In our cases, Velenje suggested cutting their emissions by 23.1% and Krško even my 26.2%, compared to the BEI, see Fig. 2. Thus, Krško needs to reduce the CO_2 emissions by almost 17 k tonnes, while Velenje by around 37 k tonnes.

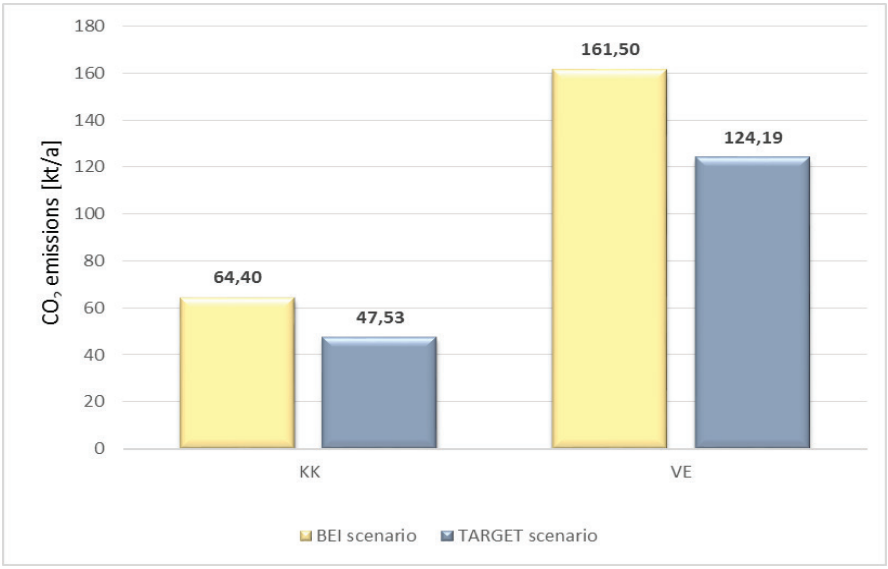

***Figure 2**: The 2020 Baseline Emissions Inventory (BEI) and targets*

Based on the data in the SEAPs of the municipalities Krško and Velenje, calculations have been made regarding the annual CO_2 emissions targets until 2020, see Table 5. The greatest CO_2 emissions reductions in both municipalities are expected in the building sector, followed by mobility, and public lighting.

***Table 5**: Annual average reduction of CO_2 emissions (in k tonnes) needed per category in VE and KK*

Year	Krško			Velenje		
	Buildings	Mobility	Public lighting	Buildings	Mobility	Public lighting
2003				147.5	13	0.9
2005	39	23.4	1.9			
2012				144.01	12.40	0.85
2013				140.52	11.80	0.79
2014	37.41	22.73	1.76	137.03	11.20	0.74
2015	35.81	22.06	1.62	133.54	10.60	0.69
2016	34.22	21.38	1.48	130.05	10.00	0.63
2017	32.63	20.71	1.35	126.56	9.39	0.58
2018	31.03	20.04	1.21	123.06	8.79	0.53
2019	29.44	19.37	1.07	119.57	8.19	0.47
2020	27.85	18.70	0.93	116.08	7.59	0.42

Considering the measures to achieve the 2020 SEAP targets, both municipalities will use a combination of technological improvements and "soft" measures; technological improvements are prevailing in all the measures introduced, and require substantial investments, see Section 4. Furthermore, the expected investment costs for technological improvements regarding the SEAP in Velenje are around 31 million euros and in Krško around 16 million euros. The annual municipality budgets include the investment costs (e.g. Velenje for the year 2015 around 15 million euros); however, the investment budget lines are not specified for the energy efficiency or activities related to the SEAPs. Therefore, the data for SEAPs investments from the municipalities' budgets and potential CO_2 reductions cannot be obtained.

Both municipalities have made public information regarding their energy efficiency projects, e.g. Velenje's energy renovation of the health centre or Krško's energy renovation of elementary schools, which nevertheless represent too little information in order to make a correlation between the investments made and annual achievements of the CO_2 emissions targets. Based on the public information obtained, CO_2 emissions reduction under the category of public lighting seems attainable, after the investments made, because LED lighting produces around 80% less CO_2 emissions than commonly used high-pressure sodium lamps do, *[16]*.

The building category requires huge investment costs, mostly depending on the municipalities' budget priorities, capabilities to attract investments, especially in the form of public-private partnership, and gaining EU funding. The municipalities are proposing some private-public partnerships and co-financing from EU funds, but unfortunately, information about how many measures were realized through these instruments or how many private investments have been made is not available. Even greater vagueness exists in the mobility category. Measures targeting this category are focusing on parking restrictions, supporting car sharing and public transport. According to the data obtained from the Statistical Office of the Republic of Slovenia, in both municipalities there is around 0.5 car per capita, meaning that on average every person above 18 owns a car, *[17, 18].* Thus, changes in mobility patterns will be needed, including the behaviour of inhabitants. As argued by Louf and Barthelemy, *[19]*, cities are not defined only by

spatial and functional issues (e.g. shops, hospitals, etc.), but also by the individuals commuting between places.

7 CONCLUSIONS

Urban areas represent a challenge regarding the reduction of CO_2 emissions; thus, the CoM represent a valuable and reasonable initiative towards more sustainable city living when implementing SEAPs in the local area. The cases in Slovenia have shown that room for improvement still exists in terms of preparation, implementation, and monitoring, such as considering social aspects, especially planning in a line of the economic situation of the particular local community, selecting measures in the SEAP that improve the condition of the local economy (indirect employment and green jobs). In terms of preparation, the SEAP needs to be designed based on the improvements and measures that are feasible to realize, and not as wish list of actions of the local community, since the planned of implemented measures are not corresponding with the municipalities' existing budgets.

Our study has shown that the municipalities are primarily focusing on the building category and its measures, which is the most extensive from the costs perspective but bringing the most positive impacts on the emissions reduction from the quantity perspective. SEAPs also need to be coherent with the priorities of the European Commission to obtain the funding (e.g. improving the public lighting is not a priority within the 2014–2020, but it was in a previous period). This survey also illustrates that, within the implementation phase, municipalities need to appoint an expert, an energy manager with the responsibility to carry out continuous monitoring. An educated energy manager should be a prerequisite and a good solution regarding SEAP implementation and follow-up. SEAPs are also lacking integrated and holistic approaches, and interdisciplinarity regarding the measures, e.g. sustainable urban mobility merges spatial, energy, environmental and social features of the urban area. Furthermore, the implementation needs to be followed by detailed reporting, where investments were made and emissions reduced should be correlated with the municipality budget, public-private partnerships and EU funding, preferably on an annual or biannual basis. Energy planning is an important instrument, although maybe all the emissions reductions of both municipalities would not be achieved until 2020, but with SEAPs municipalities have set goals and made commitments, including political and stakeholders' supports towards more competitive, secure and sustainable energy systems, and GHG reduction targets, representing long-term goals.

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