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The role of the municipalities in achieving the EU's sustainable energy transition

Greenhouse gas emissions are clearly responsible for the intensification of climate change, the largest share of which can be attributed to energy production and use. The European Union aims to reduce its greenhouse gas emissions to net zero by 2050. This energy transition by 2050 is called the energy transition. One of the European Union's best-known energy and climate organisations is the Covenant of Mayors for Climate and Energy (CoM). This publication evaluates the role of municipalities in the energy transition with the help of the analysis of the Sustainable Energy and Climate Action Plans (SECAP) document prepared by the Hungarian municipalities joining the alliance, especially from 16 submitted cities point of view. When planning the area-by-area reductions formulated in their mitigation action plans, they realistically perceive the extent of their direct intervention opportunities, they expect a greater proportion of the planned measures from local actors, so they can help achieve the goals by their exemplary operation, organizing awareness-raising events and finding sources of funding. Through their indirect role in local energy management, municipalities are important actors in achieving the EU's energy transition.

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Introduction

The European Union and its Member States are world leaders in promoting sustainable development and energy transition. In curbing global climate change and making social and economic development sustainable, special attention should be paid to the scale of energy consumption, energy mix and related greenhouse gas (GHG) emissions. The European Union is making significant efforts to reduce energy use and carbon dioxide emissions compared to the rest of the world¹⁶. Adaptation of the Sustainable Development Goal 7 (ensuring access to affordable, reliable, sustainable, and modern energy for all) and the goals of the Paris Climate Agreement (the increase in the global average temperature to well below 2°C above pre-industrial levels) is crucial to reach a liveable, cleaner, and affordable future. (Bertoldi ed. 2018a, IRENA 2017).

Without local participants, without knowing local characteristics and needs this tremendous task cannot be a success (Fuhr et al. 2018, Mészáros 2007). That is why among the five dimensions of the Energy Union, finalised in 2019, there is already a priority attributed to local actors: energy efficiency measures to reduce demand. (COM/2015/80) The 2021 review of the European Green Deal made more significant commitments than ever to achieve energy efficiency, use of renewable energies and a sustainable welfare society (COM/2019/640). The European Union highlights that access to clean, affordable, and secure energy must be fair and inclusive, funded by the European Union's Just Transition Fund (EU/2021/1056). The Member

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¹⁶ The share of world final energy consumption in 2020: Asia without China (25.8%), China (23.1%), USA (15.3%), EU (10.1%) – (European Commission 2023, 14)

The share of world carbon dioxide emission in 2020: China (33%), Asia without China (27%), USA (14%), EU (8%) – (European Commission 2023, 18)

States of the European Union are legally obliged under the Fit for 55% package to reduce the EU's net greenhouse gas emissions (GHG) by at least 55% by 2030 compared to 1990 levels and to reach climate neutrality by 2050. (European Council 2023).

EU policies, including sustainability efforts, are supported by several organisations and initiatives, such as the Covenant of Mayors for Climate and Energy (CoM), which, for the first time, helps municipalities by showcasing and disseminating good practices, providing free advice and methodologies by reaching out to cities. (Bertoldi et al. 2018c., Martire et al. 2018, Reckien et al. 2019, Salvia et al. 2021). A list of members joining the Covenant of Mayors is maintained on the association's website.¹⁷ Following the 2014 application cycle, the desire to join Hungary grew at an increasing pace. As of 1 January 2023, 34.21% of Hungarian settlements have joined the Covenant of Mayors for Climate and Energy (CoM), representing 34.25% of the country's territory, 50.19% of its residential population and 51.71% of the housing stock, meaning that in the future the benefits of accession will be felt in a significant part of Hungary. In terms of the legal status of settlements, 96% of cities with county rights, 56.52% of metropolitan districts, 34.78% of cities, 33.51% of villages, 32.28% of large villages, i.e. 34.2% of Hungarian settlements are signatories of the CoM (Takácsné Papp 2023).

The Literature review summarises the current literature sources examining the relationship between local levels and sustainability and, therefore, how municipalities can take part in the fight against climate change and its negative effects. Results present the most considerable difficulties caused by climate change through the Sustainable Energy and Climate Action Plans (SECAP) of the 16 selected cities joining independently and the official data release of the CoM (Baldi et al. 2023), as well as the planned steps in the fight against climate change and their typical sources of funding. The 16 cities are Ajka, Balatonfüred, Budaörs, Kisvárd, Mátészalka, Pápa, Sajószentpéter, Sárvár, Szarvas, Szentes, Szigetszentmiklós, Tapolca, Tiszalök, Tiszaújváros, Várpalota and Vásárosnamény. In the Discussion, Hungarian examples are put in the context of international experiences. The Summary chapter summarises the main results and future research directions.

Literature review

For the first time, implementing climate and energy policy objectives supporting sustainable development goals was defined as a responsibility of the state-level institutions. (WEC, UNFCC) In the European Union, from 2018, the new renewable directive (2018/2001/EU) highlighted the increasing role of the stakeholders at subnational levels. Cities are responsible for the largest energy consumption and three-quarters of global carbon dioxide emissions, which is why they were the first participants of the Covenant of Mayors for Climate and Energy (Kona et al. 2018, Salvia et al. 2021, Hritonenko and Yatsenko 2022). The objectives of Sustainability Development Goal 7 and the Paris Climate Agreement will not be achievable without effective intervention by cities, as is typical. *"Cities, accounting for more than 3/4 of global final energy consumption, are equipping themselves with governance tools to improve energy efficiency."* (Nastasi and Di Matteo 2016, 1064) Therefore, *"the most effective level of intervention and action is clearly the local level"* (Ács et al. 2019, 278), the main organizing principle of which is self-government. More and more municipalities respond to the slogan think globally, act locally, i.e. glocalization, and thanks to this, several sustainable measures are implemented, which are the basic conditions not only for local, sustainable prosperity but also for the achievement of European Union's 2030 and 2050 objectives, thus addressing global problems. The main advantage of local value creation is that *"municipalities are well aware of their environment, settlement, what climatic challenges they face, how frequent and what type of climate events they experience, and what is the extent of the damage caused by extreme weather"* (Ács et al. 2019, 278, Cinocca et al. 2018) In addition, local authorities have the capacity to address their

¹⁷ Covenant of Mayors for Climate and Energy: <https://eu-mayors.ec.europa.eu/en/home>

stakeholders at local level in addition to successfully identifying problems. (Ács et al., 2019) The two tools used to combat climate change are mitigation and adaptation. In urban terms, mitigation targets mean the reduction of GHG emissions related to buildings, industrial activity, infrastructure use and transport, and adaptation increases the resilience of cities to climate change. (Hritonenko and Yatsenko 2022, Bertoldi ed. 2018b) In this process, the role of municipalities not only as a coordinator but also as an integrator, i.e.,” *Municipalities can significantly contribute to increasing resilience to climate change, not only by coordinating but also by integrating.*”. (Ács et al. 2019, 278.)

Niemets et al. (2021), more developed world cities can become sustainable more efficiently than their less developed counterparts thanks to increased financial resources. Networks formed by cities acting in favour of climate protection not only provide methodological assistance to municipalities but also enable the formalization, monitoring, and evaluation of these commitments, forming a common platform, such as the Covenant of Mayors for Climate and Energy (Crocí et al. 2017). In their article, Dolge and Blumberga (2021) emphasize the role of the transport, industrial, service, agricultural and household sectors in achieving climate goals. According to the results of Crocí et al. (2017), the largest emitting sectors are buildings and transport, including public transport, municipal fleet, municipal buildings, and street lighting. Therefore, municipalities expect the greatest results from those areas whose operation they have a direct influence. Geels (2011), referring to the publication of Smith et al. in 2005, draws attention to the fact that “*the sustainability transition, of which energy issues are a key pillar, is goal-oriented, sustainability transitions are goal-oriented or ‘purposive’ in the sense of addressing persistent environmental problems, whereas many historical transitions were ‘emergent’ (e.g., entrepreneurs exploring commercial opportunities related to new technologies)*”. (Geels 2011, 25.)

Methods

Covenant of Mayors for Climate and Energy is one of the well-known climate organisations that help settlements fight against climate change and join the European Union's climate goals. The leaders of these processes are the municipalities. (CoM). The CoM had 343 signatories on its official website, but the real number of its members was only 134 in 1. January 2023. The 343 signatories include 19 joined and 324 individual signatories. Joined signatory means that a settlement joins CoM; for example, as a member of LEADER¹⁸ Action Group, individual signatory means that a settlement joins CoM alone. However, the 324 individual members include 212 settlements registered as individuals even though they are members of a joint group, so the real number of individual members is only 89. Five of the 19 joint members were so-called collector groups. A specific feature of a collector group is that it includes several otherwise independent (e.g., Budapest and its districts) or joint signatories (e.g., the counties of Bács-Kiskun, Borsod-Abaúj-Zemplén, Szabolcs-Szatmár-Bereg and Veszprém and their LEADER Action Groups). The five collector groups included 19 joint members. In total, 19+5+19, 33 real joint members can be counted on the official list of the CoM. In addition, a further 12 signatories (3 individuals, 9 joint members) became known due to a free-word search on the internet. Although they are not officially or not yet members of CoM at the time of data collection, these municipalities or groups have a SECAP document prepared according to the CoM methodology. Based on these data, 98 (89+9) individuals and 36 (33+3) joint members can be found in Hungary (Takácsné Papp 2023).

The climate and energy commitments of these settlements led by municipalities are incorporated in the so-called Sustainable Energy and Climate Action Plans (SECAP), which, in

¹⁸ „LEADER is a European programme, with the aim to involve local actors in rural areas in the development of their own regions by forming Local Actions Groups (LAGs) and designing and implementing strategies.” (<http://elard.eu/leader-clld/>)

addition to the geographical, demographic and economic characteristics of the given jurisdictions, cover the energy consumption and GHG emissions of key Covenant sectors (municipal buildings, residential buildings, service buildings and transport), as well as the risks caused by climate change and the mitigation and adaptation strategic responses to them. Mitigation action measures (e.g., energy efficiency and clean energy production) can help reduce carbon dioxide or greenhouse gas emissions. In contrast, adaptation measures (e.g., flood protection) increase resilience to the adverse effects of climate change (Bertoldi ed. 2018a).

The strategic plans created in the SECAP documents are complemented by an Excel annex containing detailed data on the settlements and their plans. In many cases, these annexes are not available. The CoM updates its database annually, summarising each municipality's commitments (Baldi et al. 2023). The latter database is not always complete or contains redundancies. However, together with the textual SECAP documents, it fills in the information gaps nicely, thus enabling the analysis of the steps taken by municipalities towards sustainability and their specificities.

The publication is based on secondary research. It focuses on the 16 Hungarian cities that joined the Covenant of Mayors for Climate and Energy and has made commitments for 2030 on its official website. The other aspect was that the data from the research point of view was available. Cities were defined according to the Nomenclature of localities in Hungary on 1 January 2022 (KSH 2023). The chosen method is document analysis. It examines the climate risk, the greenhouse gas emissions, the typical measures to reduce them and the typical financial background of the 16 cities. The 16 cities are Ajka, Balatonfüred, Budaörs, Kiszvárd, Mátészalka, Pápa, Sajószentpéter, Sárvár, Szarvas, Szentes, Szigetszentmiklós, Tapolca, Tiszalök, Tiszaújváros, Várpalota and Vásárosnamény.

The research's limitation is that the examined cities measured their emission situation in different years and formulated their planned measures accordingly. Thus, there could be a minimum of two years and a maximum of 10 years between the base year and the target year of 2030, which could significantly impact the municipalities' room for manoeuvre. The results must be interpreted taking these into account.

Results

The impact of climate change is no longer only a noticeable problem for warm climate regions but also a phenomenon negatively affecting the favourable climate of the Carpathian Basin. In contrast to the previous Sustainable Energy Action Plans (SEAP) developed by municipalities between 2008 and 2015, the new methodology applied after 2018 was adapted to the changing EU goals because the Paris Climate Agreement includes a second significant pillar: adaptation. Adaptation is a strategic response to the adverse effects of climate change. Nowadays, former SEAPs have been converted into SECAPs. In the new framework, municipalities assess the factors that pose the greatest threat to local stakeholders (municipalities themselves, citizens, and companies).

Based on the Sustainable Energy and Climate Action Plans (SECAP) of the 16 municipalities examined, I seek to investigate which consequences of climate change these settlements considered critical for themselves (Figure 1.). We can identify 151 areas at risk from climate change. The analyses classified the identified risks into eight umbrella groups. Figure 1. shows their share. Extreme storms, floods and resulting landslides (44.37%), extreme heat and fires (30.46%), extreme cold (9.27%), and other unnamed events with a weight of 6.62% are the biggest identified threats. The spread of diseases, biological hazards and groundwater floods have a much lower weight among the risk factors than the previous ones. The cities' stakeholders (municipalities, residents, representatives of industry, service sector, and agriculture) cannot combat these risks without financial investments. However, these adaptation investments do not address the cause of climate change.

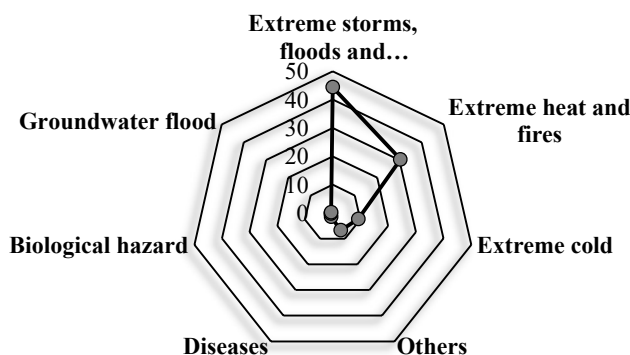


Figure 1. Frequency of climate risk identified by 16 cities examined

Source: Own calculation based on Baldi et. al. 2023

Mitigation measures formulate actions (requiring and not requiring investment) to reduce greenhouse gas emissions into the atmosphere, which is the root cause of climate change. The SECAP methodology identifies key Covenant sectors such as residential, service, municipal buildings, and transport, which are mandatory parts of a SECAP survey. The reason is that the municipalities, which are the leaders of these commitments, could mainly impact the energy consumption and emission of these sectors, in contrast to other sectors, for example, activities of industry and agriculture. Some signatories do not collect data from service buildings, so this sector's information is missing. Hence, Figures 2 illustrates the share of greenhouse gas emissions among three key areas (residential, municipal buildings, and transport) in their baseline year.

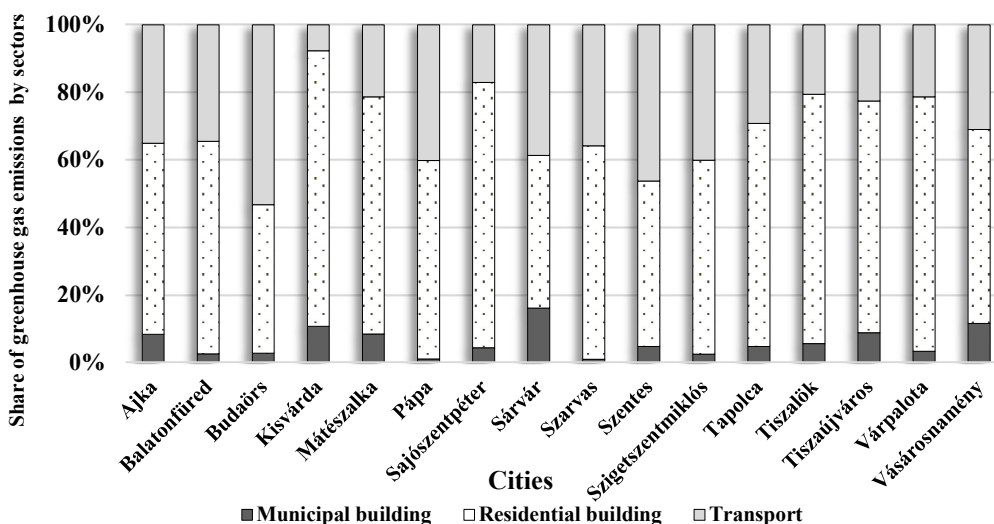


Figure 2. Share of greenhouse gas emissions of the three key areas

Source: Own elaboration based on the cities' SECAP documents and Baldi et. al. 2023

Among the 16 observed cities, municipal buildings have the lowest greenhouse gas emissions (average 6.6%); transportation takes an average of 29.78%; residential buildings (average 64.15%), except Budaörs, have the highest emissions. These and individual ratios depend on the size of the city, the number of residential and municipality buildings, their characteristics, whether they have public transport services, and many other specific factors. This publication does not detail these; it just gives a global picture.

Greenhouse gas emission depends on the amount of a given energy type and its emission factor. Energy consumption (MWh) of a given energy type multiplied by its emission factor (tCO₂eq/MWh) equals the greenhouse gas emission (tCO₂eq). (Bertoldi ed 2018b.). Residential buildings had a significant share of the energy consumption, averaging 64.45%, while transport was the second most significant energy consumption sector (average 29.09%), except Budaörs. Municipal buildings had less share, average 5.45%. Fossil fuels dominate the energy mix of the 16 cities examined; the second most abundant was electricity and, where relevant, district heating. Nevertheless, 81.25% of the observed cities used renewable energy. In municipal buildings this ratio was just 6.25%, but in the residential buildings it is favourable because solar and geothermal energy have zero emission factors. In transport, the use of gasoline and diesel is still clearly predominant, but 6 out of the 16 cities (37.5%) use renewable energy. (SECAP document of 16 cities)

To reduce the GHG emissions of the cities' successfully, targeted interventions are necessary. Together, the examined cities have planned 320 measures to reduce GHG emissions in their jurisdictions by at least 40% by 2030. One of the cities measures its emission in tonnes of carbon dioxide (tCO₂) and 15 in tonnes of carbon dioxide equivalent (tCO₂eq), the unit of measure of greenhouse gas emission. This fact does not limit the analysis because 1 tonne of carbon dioxide (tCO₂) equals 1 tonne of GHG emission (tCO₂eq) (Bertoldi ed 2018b.). Emission reductions can be achieved through tasks requiring investment (e.g. building insulation) and tasks requiring no investment (e.g. behavioural changes). (Bertoldi ed. 2018b.) 45% of the total actions belong to municipal buildings, 29% to residential buildings, and 26% to the transport sector. 84% of the total measures need smaller greater financial investments, and only 16% do not. (Baldi et. al. 2023, SECAP document of 16 cities). Table 1 presents the types of measures and their share breakdown by the three key Covenant sectors.

Table 1. Mitigation measures of the 16 cities

Key-covenant sectors	Share of a given measure within the total number sector's measures (%)
Municipal buildings	100
Integrated action	47.23
Energy efficient lighting systems	17.36
Building insulation	14.58
Renewable energy for space heating and hot water	6.94
Behavioural changes	4.86
Energy efficiency in space heating and hot water	4.86
Information and communication technologies	4.17
Residential buildings	100
Integrated action	60.46
Renewable energy for space heating and hot water	15.96
Energy efficient electrical appliances	7.45
Behavioural changes	6.38
Building insulation	3.19
Energy efficiency in space heating and hot water	3.19
Information and communication technologies	2.13
Energy efficient lighting systems	1.06
Transport	100

Key-covenant sectors	Share of a given measure within the total number sector's measures (%)
Cleaner efficient vehicles and eco driving	41.46
Modal shift to walking and cycling	25.61
Integrated action	17.07
Car sharing pooling	6.10
Modal shift to public transport	6.10
Improvement of logistics and urban freight transport	3.66

Source: Own elaboration based on Baldi et. al. 2023

The energy consumption and GHG emissions of municipal buildings can be considered negligible in contrast to the other two key Covenant sectors examined (SECAP document of 16 cities). However, they are responsible for most planned measures (144 actions, 45% of total actions). Integrated actions have the biggest share (47.23%) among interventions. It contains the different combinations of different measures (e.g., complex energetic renovations), which are listed below. Actions connected to municipal buildings are typically building insulation (14.58%), renewable energy for space heating and hot water (6.94%), behavioural changes (4.86%), energy efficiency in space heating and hot water (4.86%), information, and communication technologies (4.17%). The proportion of measures related to the modernization of public lighting is the second highest (17.36%). The SECAP database classifies the provision of local public lighting as a part of the municipal buildings (Bertoldi ed 2018b.). The provision of local public lighting services is a mandatory task for municipalities (Mötv.). Direct (renewable energy, energy-efficient luminaires) and indirect (transactive energy, energy storage systems, demand response) investments in modernizing public lighting have a cost-saving function. LED luminaires and smart lighting controllers not only achieve significant cost savings but also emission reductions of up to 85%¹⁹ (Sadeghian et al. 2021). However, the share of this reduction in the cities' total emissions (including residential buildings and transport) is not significant.

The second most interventions are related to residential buildings (94 actions, 29% of total actions). 60,46% of planned measures are classified in integrated actions. It contains the different combinations of different measures (e.g., complex energetic renovations), which are listed below. Renewable energy for space heating and hot water takes 15.96%. Energy efficient electrical appliances (7.45%), behavioural changes (6.38%), building insulation (3.19%), energy efficiency in space heating and hot water (3.19%), information and communication technologies (2.13%), energy efficient lighting systems (1.06%) are less mentioned areas. Despite the predominance of integrated measures, the municipality only develops the SECAP strategy; its implementation and financing are mainly the public sector's responsibility. Local authorities can only play a coordinating role. That is why it would be fruitful if municipalities paid more attention to awareness-raising actions because, thanks to these actions, residents could get information about their technical and financial opportunities. The population's lack of knowledge and financial resources could jeopardise the 2030 targets.

We can find local energy production possibilities among the municipal and residential measures, like renewable energy for space heating and hot water. It means the using of solar and solar thermal energy or geothermal energy production. The advantage of green energy production in this way is that the emission factor that determines the GHG emissions drastically decreases because the emission factors of these kinds of energy types are zero.

There are 82 actions (26% of total actions) relating to the transport sector. According to the SECAP methodology this sector includes municipal fleet, public, private, and commercial transport (Bertoldi ed. 2018b.) and is almost 100% based on fossil fuels (gasoline and diesel).

¹⁹ "Artificial light services account for 30% of the world's energy production. Nearly 55% of the costs associated with public lighting in a settlement are related to energy and 45% to operation." (Sadeghian et al. 2021, 3.)

However, Sátoraljaújhely, Szentes, Szarvas, Mátészalka, Vásárosnamény and Tiszalök used biofuels in their baseline years. (SECAP document of 16 cities) The use of electric vehicles is another key factor to cleaner transportation. With eco-driving customs and the modal shift to walking and cycling thus serve physical health, sustainability, and environmental protection. Eco-driving is a driving technology solution that means more consciously operating the car at lower revs and using the climate control system. These take the 41.46% of the interventions. (SECAPs of Sajószentpéter, Tiszalök, Vásárosnamény, Mátészalka, Szentes, Szarvas). In the plans of municipalities, electrification measures mean electric buses and the replacement of the fleet of vehicles of the municipality and its institutions. In the National Energy and Climate Plans, the greening of transport pays considerable attention. From 1 January 2022, only electric buses will be available for purchase with the support of the Green Bus Programme. (ITM 2020) Modal shift to walking and cycling, car share pooling, modal shift to public transport are the actions which do not exactly need financial investment. These take together 37.81% of the total transport measures. Integrated actions have less share, than it was in municipal and residential buildings. Improvement of logistics and urban freight transport (3.66%) has the less important role to reduce the emission caused by transport sector.

As seen from the above, GHG reduction measures are, to a large extent, investment-intensive. For municipal and residential buildings, integrated improvements play the leading role, while measures not requiring investment tend to predominate in the transport sector. However, through awareness-raising actions, municipalities can share knowledge with residents and increase their energy consciousness so they can easily reach the financial support offered.

Finally, besides estimating plans and expected impacts, the financing background of plans is also an essential factor that can determine success or failure. Planning practice should see the financing background of the planned measures. Figure 3 shows the planned funding sources for the measures planned by the 16 cities.

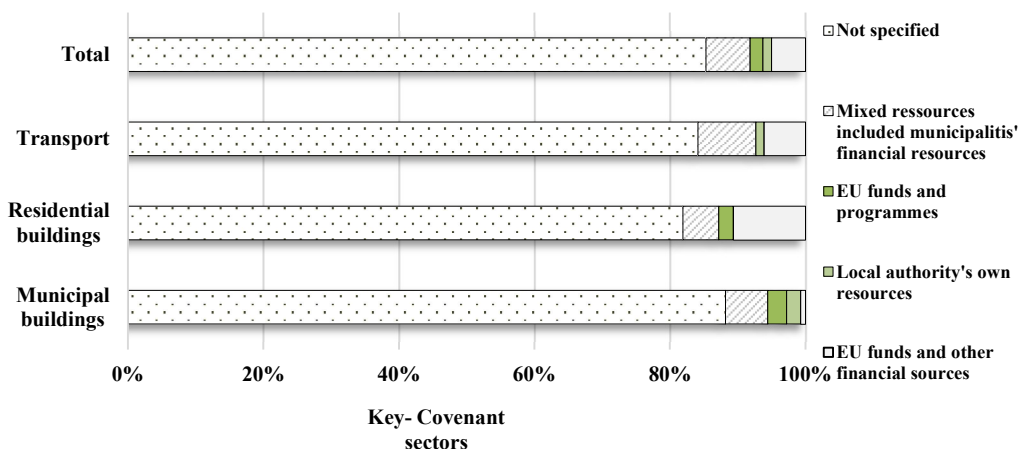


Figure 3. Financing source types among key-Covenant sectors

Source: Own calculation based on Baldi et. al. 2023

One of the shortcomings of the SECAP documents is that the financial sources of the planned actions in the three key areas are not defined (85%). Municipalities can be confident in planning their own resources, but even in the case of municipal buildings, local authority's own resources appear only in the case of planned measures 2.08%, in the case of transport development 1.22%, and in the case of residential buildings it does not appear at all. However, the financial resources of municipalities, complemented by national, EU or private partnership resources, can also reduce GHG in the three key areas. For municipal buildings, this proportion is 6.25%; for residential buildings, it is 5.32%; and for transport, it is 8.54%.

Overall, municipalities have a crucial role in situation assessment and planning on the path towards a sustainable, equitable and inclusive energy transition. However, their capacity to provide the financial means to achieve this is severely limited.

Discussion

The Paris Climate Agreement, concluded in 2015, was the first international agreement that brought together 196 countries worldwide to take effective action against global warming. (EU 2016 L 282) Greenhouse gas emissions are responsible for the intensification of climate change, the largest share of which can be attributed to energy production and use. The European Union aims to reduce greenhouse gas emissions to net zero by 2050. This energy transition by 2050 is called the energy transition. Cities are responsible for over 30% of global greenhouse gas emissions (Melica et al. 2018). 75% of the European Union's population lives in cities, a proportion expected to rise further by 2050 (Eurostat 2022). More and more mayors recognise the responsibility of municipalities in the fight for climate protection and commit their municipalities to the reduction targets of greenhouse gas emissions. Experience shows, however, that municipalities mostly do not have the financial and human resource capacity and information to support the development and implementation of strategic goals adequately (Bertoldi et al. 2018a, Martire et al. 2018, Reckien et al. 2019, Salvia et al. 2021).

Sustainable Energy and Climate Action Plans (SECAPs) allow cities to assess the greenhouse gas emissions associated with their energy use and thus formulate measures to reduce them by 2030. (Bertoldi ed. 2018a.) In the future, cities and local organisations will have to make an increasing effort towards sustainable energy management. (Rivas et al. 2021, European Commission 2019) Numerous surveys and publications explore the sustainability and resilience of Hungarian municipalities (Ács et al. 2019, Nagy et al. 2018 a.-b., Nagy et al. 2021, Benedek 2021). However, evaluation of the SECAP documents is a research niche in Hungary. Based on the literature they reviewed, Eisenack and Roggero (2022) express uncertainty as to whether implementing mitigation plans impacts emission reductions and whether other factors may be behind the mitigation. Fuhr et al. published in 2018 Gouldson et al. (2016) and Bansard et al. al. (2016) state that the results achieved in GHG reduction cannot be attributed entirely to the involvement between local authorities and international organisations but instead to independent programmes already underway. The energy used and mix determines an area's greenhouse gas emissions. Buildings had the highest emissions of the areas studied, consistent with the literature. Cipriano et al. (2017) in their view, more accurate information could be obtained based on the floor area of buildings or net usable floor area, while it would also be easier to identify properties with poor energy characteristics. Cinocca et al. (2018) highlight that the methodology is constantly evolving thanks to monitoring reports, so municipalities can get an increasingly accurate picture of emissions related to their territory and the effectiveness of measures to reduce them. Fuhr et al. draw attention to an essential dilemma regarding the possibilities of municipalities (2018, 3). *"critics stress that cities largely operate in the shadow of hierarchy and have only limited capacities to tackle the problem of climate change independent of other levels of government. This implies that local decision-makers are dependent on regional, national, and international regulatory umbrellas that provide incentives and resources for cities to undertake large-scale climate action (...) Thus, the question arises whether, under which conditions, and how local governments can build enduring capacities to play their part in the global endeavour to achieve deep decarbonization."* Municipalities cannot act alone but can be influential actors in achieving climate protection goals embedded in regional, national and international cooperations. In the 2000s, it was observed that cities could take much more flexible steps to curb climate change than at the level of nation-states, and thanks to their international network, they can continue their work more effectively. (Fuhr et al. 2018) Several literary sources (Economidou et al. 2022, Melica et al. 2018, Salvia et al. 2021) deal with the role of municipalities, international networks, and international climate

organizations in achieving climate goals. Their research results prove that international climate organizations can effectively help settlements. The authors emphasize that the primary task of international climate organizations is to supplement the gaps in knowledge and practice at local levels, including municipalities, and to pass on the experience gained from good practices to help implement local measures towards climate goals as early and effectively as possible.

Conclusion

This publication first collected the consequences of climate change that the 16 cities examined with SECAP considered critical for themselves. The results show that these cities' most significant environmental threats are extreme storms, floods and resulting landslides, and extreme heat and fires. In addition, local authorities can also tackle the root cause of climate change by reducing GHG emissions in their jurisdictions. Among three key Covenant sectors (municipal and residential buildings as well as transport), municipal buildings have the lowest greenhouse gas emissions (average 6.6%); transportation takes an average of 29.78%; residential buildings (average 64.15%) have the highest emissions, except Budaörs. In contrast, the most significant share of mitigation actions belongs to municipal buildings, and the lowest share belongs to transportation. When municipalities plan the area-by-area reductions formulated in their mitigation action plans, they realistically perceive the extent of their direct intervention opportunities; they expect a more significant proportion of the planned measures from local actors.

The cumulative impact of the plans presented in the study will not be fully realized until 2030 the earliest. However, their benefits are increasingly felt as the pace of implementation increases. While climate change is a global problem, these small-scale actions at the local level are increasingly important in addressing the problem and achieving a just and sustainable energy transition.

As seen from the above, GHG reduction measures are, to a large extent, investment-intensive. For municipal and residential buildings, integrated improvements play the leading role, while measures not requiring investment tend to predominate in the transport sector. However, through awareness-raising actions, municipalities can share knowledge with residents and increase their energy consciousness to reach the financial support offered easily.

Municipalities are crucial in assessing the initial situation of their settlement and planning for a sustainable, equitable, and inclusive energy transition. However, their capacity to provide the financial means to achieve this must be improved. A future research direction could be to assess the municipal motivations behind planning through interviews.

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