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Local Science-based Recommendations and Monitoring for Climate Change Mitigation in the Context of the Sustainable Development Goals - European Municipal Perspectives and Key Indicators

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The author reserves this section to write in the Galician language, one of his mother tongues.

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Disclaimer

The author, Matías García, first approached climate change as a topic and field of action in 2010. He has continuously deepened his insights since then. His scientific background in pharmaceutical studies has allowed him to contribute to climate action through science communication and advocacy on both local and national levels. He collaborated with diverse associations and entities, coordinating and implementing climate-related campaigns in countries such as Spain, France, Australia, Indonesia, and Portugal. Working with local communities in different cultural contexts allowed him to develop a broader vision of the challenge of climate change, to identify common obstacles and opportunities, and to engage in practical approaches in local communities across a wide spectrum of cultural contexts and circumstances.

In September 2018, the author had the opportunity to be a part of the coordination team of the BEACON project in Portugal. Since then, he facilitates coaching, advisory services and prepares workshops addressed to EU municipalities to foster local climate change mitigation. This thesis results from the imperative need to support EU municipalities in planning and monitoring their climate change mitigation actions. It integrates current literature, the author's perspective, and the municipal experience in order to propose a distinguished contribution to climate change research and foster practical action.

Abstract

Climate change is one of the major challenges that humanity faces nowadays. Increases in extreme weather events, sea level rise, massive biodiversity loss and a decrease in food security are only a few of many consequences of global warming that threaten our current civilization. Organizations and governments around the world have noticed the urgent need to address the climate change challenge. As a result, the United Nations Framework Convention on Climate Change has developed a declaration for countries around the world to limit global warming below 1.5ºC relative to pre-industrial levels, the Paris Agreement (2015), which has 185 signatory countries. The Agenda 2030 has dedicated a specific Sustainable Development Goal (SDG) to climate action (SDG 13) that encompasses both mitigation and adaptation. The European Green Deal aims to achieve carbon neutrality by 2050, and billions of euros are destinated to that end. Despite all the positive intentions in addressing climate change, the nationally determined contributions of many regions, including the EU, are insufficient for limiting global warming below 2ºC. Global greenhouse gas (GHG) emissions are still increasing.

The United Nations Development Program, UN-Habitat, and the Global Taskforce of Local and Regional Governments highlight the importance and benefits of localization in supporting climate change mitigation (CCM) and sustainable development actions. Local governments can exploit context-specific measures that are key to enhancing co-benefits and reducing trade-offs between climate and sustainable development (SD) actions. Nonetheless, this bottom-up approach requires energy from local governments, who often suffer from a lack of capacity and resources, especially regarding the multifaceted climate change challenge. In this context of scarcity, municipalities could easily fail to properly integrate a CCM perspective into their agendas, including a failure to monitor their measures to reduce GHG emissions.

Monitoring and evaluation are highlighted as fundamental components for increasing the effectiveness and efficiency of local CCM and SD actions. In light of this reality and based on participatory-action research, this dissertation explores and recommends effective science-based actions (Chapter A) and relevant indicators (Chapter B) for local CCM for the European municipal context.

Recommendations are derived from the literature, especially the latest report from the Intergovernmental Panel on Climate Change regarding CCM (Working Group III, 2014). In order to identify a list of appropriate indicators, 17 EU municipalities from six European countries participated in an online survey to validate a number of indicators compilated, adapted and created based on the literature review. Further from the data analysis, the author proposed a methodology for interpreting and classifying the proposed indicators. The results concern the interviewed municipalities level of agreement regarding the suitability of the indicators for the municipal context. These results support the development of a common methodology for monitoring local CCM actions.

Keywords: Climate Action, Indicators, Localizing, Sustainable Energy and Climate Action Plan, Participatory-Action Research

Resumo

As alterações climáticas (AC) presentam-se como um dos maiores desafios que a humanidade confronta atualmente. O aumento dos eventos climáticos extremos, a elevação do nível médio do mar, a perda massiva da biodiversidade e a diminuição da segurança alimentar são apenas algumas das muitas consequências do aquecimento global que ameaçam nossa civilização. Organizações e governos de todo o mundo compreenderam a necessidade urgente de confrontar este desafio. Como resultado, a Convenção-Quadro das Nações Unidas sobre as Alterações Climáticas (UNFCCC) elaborou uma declaração de intenções internacional para limitar o aquecimento global abaixo dos 1,5ºC relativamente aos níveis pré-industriais, o acordo de Paris (2015), integrando 185 países signatários. A Agenda 2030 dedicou um SDG específico à Ação Climática (SDG 13) que abrange tanto a mitigação quanto a adaptação das AC. O Pacto Verde Europeu visa atingir a neutralidade carbónica até 2050 e vários milhares de milhões de euros serão destinados para este fim. Apesar de todas as intenções positivas para confrontar este desafio, as atuais Contribuições Nacionais Determinadas (NDC) de muitas regiões, incluindo a UE, são insuficientes para limitar o aquecimento global abaixo de 2ºC. A tendência global das emissões de gases de efeito estufa (GEE) ainda está a aumentar.

O UNDP, a UN-Habitat e a Global Taskforce of Local and Regional Governments destacam a importância e os benefícios de localizar, com o fim de apoiar as ações para mitigação das AC e para o desenvolvimento sustentável (SD). Os governos locais têm a possibilidade de proceder com medidas contextuais que são fundamentais para potencializar os benefícios e reduzir os efeitos adversos das medidas adotadas, tanto para a ação climática quanto para o desenvolvimento sustentável. No entanto, o apelo para esta abordagem *bottom-up* (de abaixo para cima no nível hierárquico ou espacial) requer certa energia por parte dos governos locais, sendo que normalmente sofrem da falta de capacidade e recursos, especialmente para abordar desafios multidisciplinares como é o caso das AC. Neste contexto de escassez, facilmente os municípios correm o risco de não realizar uma integração adequada da perspetiva da mitigação das AC nas suas agendas, incluindo a falta de monitorização das suas medidas para reduzir as emissões de GEE.

A monitorização e a avaliação são destacadas como componentes fundamentais para aumentar a eficácia e eficiência em todas as ações locais de mitigação das AC e do DS, aumentando o seu sucesso. Com base nesta premissa e na investigação-ação participativa, esta dissertação tem como objetivo explorar e recomendar ações locais efetivas baseadas na ciência (capítulo A) e indicadores relevantes (capítulo B) para a mitigação das AC dentro do contexto municipal europeu.

As recomendações foram propostas a partir da revisão bibliográfica, com o principal foco no último relatório do IPPC sobre mitigação das AC (Grupo de Trabalho III, 2014). Para conseguir uma lista de indicadores apropriados, o autor envolveu 17 municípios de 6 países europeus para participar numa serie de inquéritos on-line com a finalidade de validar um conjunto de indicadores compilados, adaptados e criados com base na revisão bibliográfica. Além da análise dos dados, o autor propõe uma metodologia para a sua interpretação, permitindo a classificação dos indicadores propostos. Os resultados apresentam o nível de concordância sobre quais indicadores são adequados para o contexto municipal, avançando e apoiando assim para o estabelecimento de uma metodologia comum para monitorar as ações locais de mitigação das AC.

Palavras Chave: Ação Climática, Indicadores, Localização, Plano de Ação para a Sustentabilidade Energética e Climática, Investigação-Ação Participativa

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Acronyms

AFOLU – Agriculture, Forestry and Other Land Use

BEACON – Bridging European and Local Climate Action

CCM – Climate Change Mitigation

CAT – Climate Action Tracker

CESOP – Centro de Estudos e Sondagens de Opinião (*Center of Opinion and Polling Studies)*

CO_2eq – Carbon Dioxide Equivalent

COP – Convention of the Parties

E/NBS – Ecosystem/Nature-Based Solutions

EMAS – Eco-Management and Audit Scheme

EDS – Education for Sustainable Development

EU – European Union

FAO – Food and Agriculture Organization of the United Nations

FOLU – Forestry and Other Land Use

GDP – Gross Domestic Product

GHG – Greenhouse Gases

GPC – Global Protocol for Community-scale greenhouse gas emission inventories

GI – Green Infrastructure

ICLEI – Local Governments for Sustainability

IPCC – Intergovernmental Panel on Climate Change

IUCN – International Union for Conservation of Nature

LCC – Life-Cycle Costing

LCA – Life-Cycle Assessment

LDVs – Light-Duty Vehicles

MDGs – Millennium Development Goals

NDC – Nationally Determined Contributions

NBS – Nature-Based Solutions

NGO – Non-Governmental Organization

NMT – Non-Motorized Transportation

OECD – Organization for Economic Co-operation and Development

PNEC – Plano Nacional Energia-Clima (*Energy and Climate National Plan*)

RE – Renewable Energy

REC – Renewable Energy Community

RECO - Recommendation

SDG – Sustainable Development Goal

SECAP – Sustainable Energy and Climate Action Plan

SD – Sustainable Development

UN – United Nations

UNEP – United Nations Environment Programme

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNFCCC - United Nations Framework Convention on Climate Change

VKT – Vehicle-Kilometer Travelled

WTO – World Trade Organization

1 General Introduction

1.1 Climate change: Current situation and general impacts

Nowadays, humanity can fully affirm that climate change is a reality. Up to this moment, human activities have contributed to an increase of about 1ºC in the global temperature relative to pre-industrial levels, and the temperature continues to rise [1, p. 6].

The increased global temperature is leading and worsening global environmental, social, and economic issues that could lead to the collapse of our civilization. As a consequence of climate change, is expected an increased risk of extreme weather events (e.g., drought, heat waves, floods, heavy precipitation, etc.) [2, p. 72], massive losses in biodiversity[3], [4, p. 24], [5, p. 5], ecosystem degradation (including the depletion of ecosystems' production services) [3], [5], [6], water scarcity [2], decreased food security [2, p. 69], an exacerbation of human health problems [2, p. 69] (and thereby an increase in public health crises), increased poverty [2, p. 73], decreased economic growth [2, p. 73], an increase in displaced people [2, p. 73], and economic losses [2, p. 73]. An increased risk of violent human conflicts is also expected to be indirectly caused by the temperature increase [2, p. 73].

The effects of climate change are all interlinked, with feedback loops within them that affect different world regions in different ways, increasing the consequences for the most vulnerable in particular [2, pp. 50, 69]. In the hypothetical case of a region with an increased risk of heavy precipitation driven by climate change, ecosystem degradation would occur, and many species would be unable to adapt to that change [3], driving them to extinction. Ecosystems degradation would also lead to their services' deployment, which would create decreases in food security, leading to economic losses and degrowth and increasing global poverty. As a result, social conflicts and forced migration would be exacerbated.

As an example, migration is remarkable in Bangladesh, because of the floods produced by increasing monsoon precipitation that is exacerbated by the climate change [7]. Droughts related to climate change in the African Horn, in addition to several economic crises, have also increased migration flows in recent years [7].

The systemic climate issue could be perceived as highly complex, but we could simplify it by focusing on the root of the problem, the increasing concentration of greenhouse gases in the atmosphere.

Greenhouse gases (GHG) are responsible for the greenhouse effect [8, Ch. 5], an effect that prevents the planet from cooling and keeping the earth's surface temperature around 15ºC instead of -18ºC. This effect has enabled life to develop and has become the basis for the current climate definition [8, Ch. 4]. This effect depends directly on the concentration of the greenhouse gases in the atmosphere. These gases have the capacity to absorb infrared radiation coming from the sun, heating the planet [8, Ch. 4, 5].

After the pre-industrial period, the concentration of greenhouse gases has increased exponentially, leading to the climate disruption led by the global rise in temperature that we are suffering today [8, Ch. 5]. In 2017, anthropogenic GHG emissions reached the unprecedent amount of 53.5 $GtCO_2eq$, an increase of 0.7 $GtCO_2eq$ compared with 2016 [9, p. 15].

There are several greenhouse gases identified with different potentials and sources, but it is the CO_2 that is most concerning because of its wide distribution in the atmosphere [2, p. 3]. The most important drivers of the increased CO_2 emissions are economic and population growth that depend on fossil fuel combustion [2, p. 4]. Figure 1 shows how global CO_2 concentrations have not stopped rising since the

pre-industrial period. In the 2002–2011 period, the concentration increased at an alarming speed [2, p. 44] (2.0 ± 0.1 ppm/year) [2].

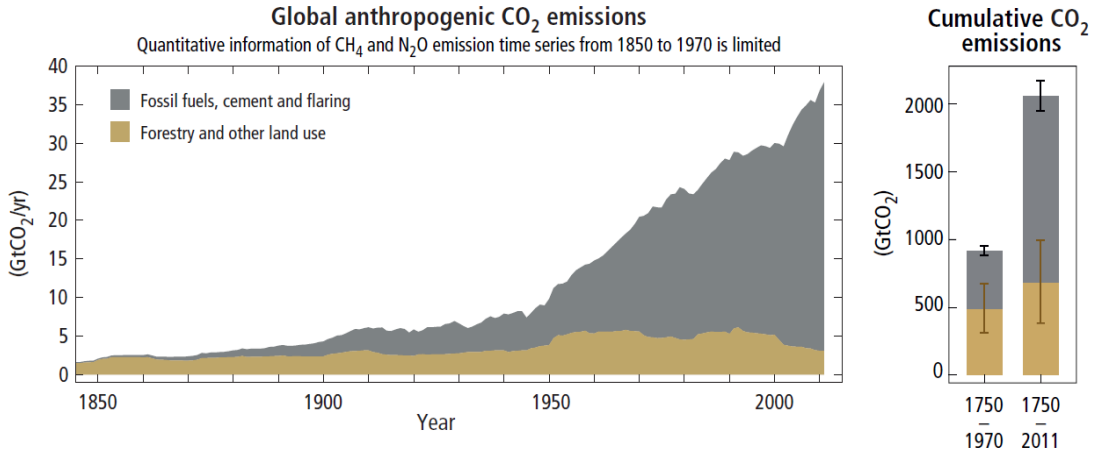

Figure 1 – Annual global anthropogenic carbon dioxide (CO_2) emissions (gigatons of CO_2-equivalent per year, $GtCO_2/yr$) from fossil fuel combustion, cement production flaring, and forestry and other land use (FOLU), 1750–2011. Cumulative emissions and their uncertainties are shown as bars and whiskers, respectively, on the right-hand side [2, p. 45].

As of today, the problem of the increasing concentration of CO_2 seems is still unsolved. Moreover, there are no signs that the maximum atmospheric level of CO_2 has been reached [9, Ch. 2]. Even the industrial and energy sectors have seen their CO_2 emissions increase as of 2017, after three years of stabilization [9, p. 15]. Despite this situation, the planetary challenges have not gone unnoticed among the highest representatives of the predominant world nations, who, under the umbrella of the United Nations (UN), have slowly been seeking solutions to the climate crisis [10].

1.2 Actions undertaken thus far: Political frameworks

The UN developed the first environmental convention in Stockholm in 1972 called The Conference of Human Environment, where 113 states participated with the aim to find a common solution to preserve the human environment [11]. As a result, it was recognized the evidence of man-made harm in some regions of the planet and the duty of all governments to deal with these challenges. Thereby, it was enhanced the importance of environmental protection and the environment's relation to human well-being and economic development [11].

The Stockholm convention was the trigger for the establishment of continuous leader's conferences urging for stronger international action regarding the environment [10]. The Earth Summit celebrated at Rio de Janeiro in 1992 went one step further than its predecessor by integrating 172 heads of state with the focus to enhance cooperation among states and ensure nations' commitments in facing climate change, the loss of biological diversity, deforestation, and desertification [12]. This conference was also known as Rio92, and it made a difference by creating new international treaties such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Agenda 21 [12].

The UNFCCC was created with the aim of limiting average temperature increases worldwide. As of today, this framework has been ratified by 197 parties [13], and it has the support of the Intergovernmental Panel on Climate Change (IPCC), the UN body for assessing the science related to climate change [14]. Since its creation, the UNFCCC has initiated several efforts to enhance parties' climate action, and these efforts have resulted in global agreements such as the Kyoto Protocol, adopted in 1997 [15].

This international agreement was an important starting point for establishing an emissions reduction regime because it set binding emissions reduction targets and used mechanisms such as international emission trading (a carbon market created for the parties to trade their assigned amount of CO_2 emissions like any other commodity) [15]. In practice, the agreement came into force in 2005 and was in effect until 2020 [15]. In 2012, some amendments were made [15]. Parties were asked for a reduction in their emissions by at least 18% below 1990 for the period 2013–2020 [15]. Unfortunately, this amendment did not integrate countries that contribute the most to GHG emissions, such as the United States or Canada [16, Ch. Technical Summary], who did not accept the amendment and have stayed out of the agreement since 2012 [15], [17].
The last recognized global effort happened during the 21st Convention of The Parties (COP) of the UNFCCC in Paris in 2015, resulting in the Paris Agreement [18]. This agreement sets the new global boundary at a maximum of 2ºC for this century in comparison with pre-industrial levels [19], [20]. It also aims to strengthen the global response to limiting temperature increases to 1.5ºC [19], [20]. To achieve this challenge, parties are encouraged to work on mitigation and adaptation strategies that aim to reach the CO_2 peak as soon as possible, and special support has been created for developing countries [19]. In terms of obligations, this agreement is a treaty as defined by the Vienna Convention on the Law of Treaties, where not every provision of an agreement is legally binding [21]. This flexibility and transparency is potentially the reason why many parties accepted the agreement: 185 parties have signed it, and only 12 of them have yet to ratify it (March, 2019) [22].

In order to achieve the 1.5ºC target of the Paris Agreement, the global peak of CO_2 concentration should occur by 2030 [1, p. 14]. A limit of 450 ppm CO_2eq should be expected if we are to have a good chance of limiting the global temperature below 2ºC by 2100 [2, p. 20]. This goal requires a reduction of emissions from 40% to 70% by 2050 compared with 2010 [2, p. 20]. Therewith, mitigation of climate change should be an important global assignment in combating the climate crisis.
Climate change mitigation (CCM) can be described as human intervention intended to reduce the

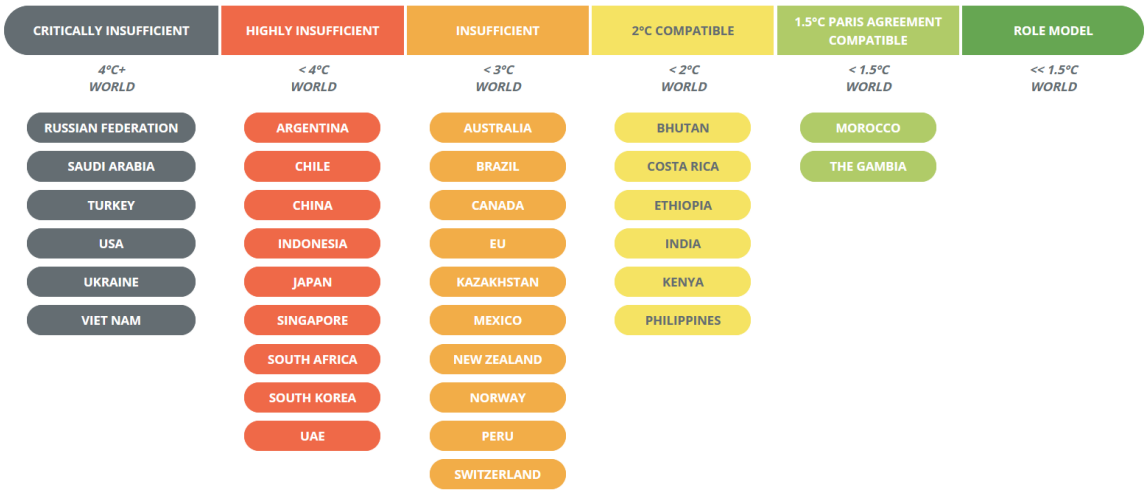

Figure 2 – Climate Action Tracker's country rating on "how sufficient" the NDCs are for achieving the Paris Agreement targets (July, 2020) [23].

sources of or to enhance the sinks of greenhouse gases [16, p. 4]. It is through mitigation that climate-related risks could be reduced in the next few decades [2, p. 17]. In 2015, the Paris Agreement parties agreed to strengthen their efforts to mitigate climate change and expressed their nationally determined contributions (NDC) to limit global warming below 2ºC [9, Ch. 2], [19]. Unfortunately, the NDCs of the parties are insufficient for achieving the goal of the Paris Agreement [9, p. 15]. Figure 2 summarizes the grade of sufficiency of the NDCs in accomplishing the Paris Agreement objectives per country [23].

The Climate Action Tracker (CAT) estimates the total warming that will occur following the aggregate effects of the Paris Agreement commitments. It affirms that, if all governments achieved their Paris Agreement commitments, the world would likely warm by 3ºC by 2100 (Figure 3), worsening the expected global effects from the temperature increase [24].

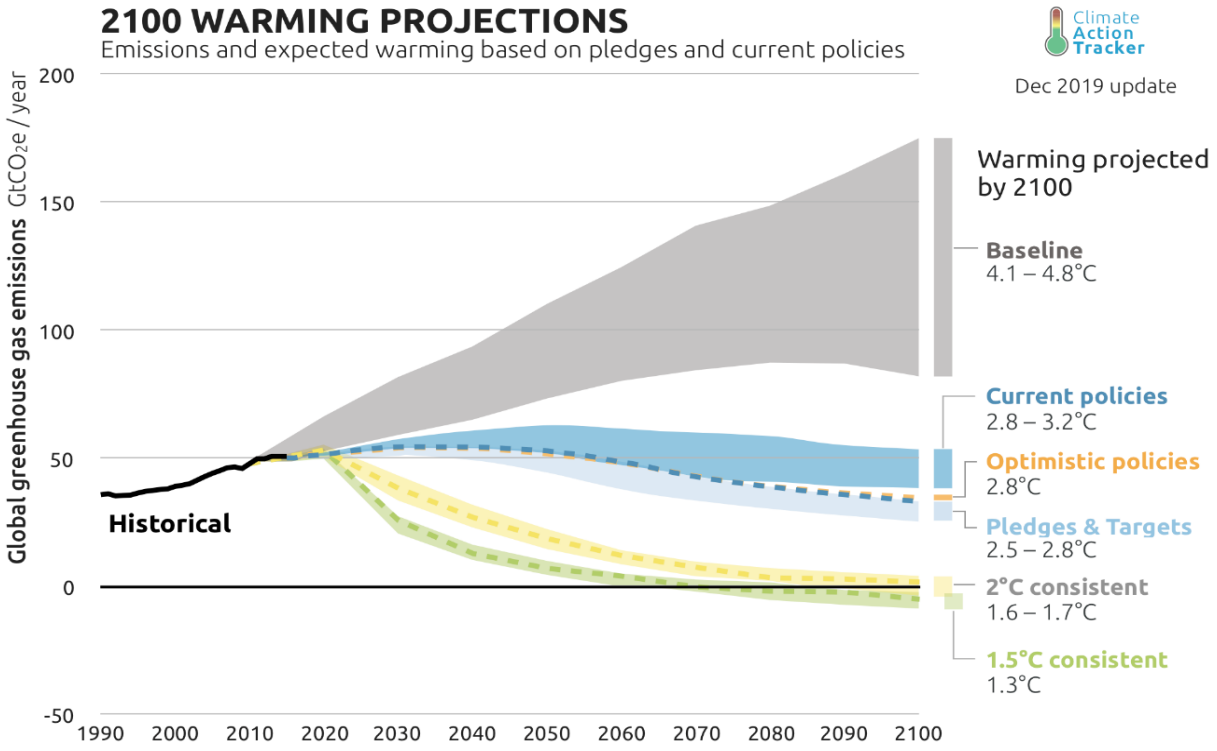

Figure 3 – Expected global temperature increase by the end of the century compared to pre-industrial levels implied by global emissions pathways in six scenarios: baseline emissions, emissions compatible with warming of 1.5°C, and 2°C, respectively, and the three scenarios related to our aggregation of 32 country assessments: pledges and targets, current policies, and an optimistic scenario. Ranges indicate uncertainty in emissions projections; dotted lines indicate median (50%) levels within these ranges [24].

As an example, the European Union (EU) established three main objectives in its climate and energy framework for the period 2020–2030: reduce GHG emissions from 1990 levels by 20% and 40% by 2020 and 2030, respectively, improve energy efficiency by 32.5%, and increase the total renewable energy (RE) share to 32% [25]. These last two objectives have been updated since the release of the framework in 2014 [26], whereby they have become more ambitiousness, perhaps because the EU had already foreseen in 2014 that the objective of improving energy efficiency would not be reached [26, pp. 8–9].

The EU has also released the European Green Deal Communication in 2019, [27] which is a roadmap for achieving carbon neutrality by 2050 [27], [28]. Nevertheless, the CAT categorizes EU NDCs as insufficient for accomplishing the goal of limiting global warming below 2ºC, as of July, 2020 (Figure 2) [29].

For that reason, under the Talanoa Dialogue, Paris Agreement parties shall submit their new or updated NDCs by 2020 in order to achieve the objectives [9].

1.3 Sustainable development and its relationship with climate change mitigation

With this urgency to accomplish the Paris Agreement objectives, the broader climate-action challenge is integrated into another global political agenda, the Sustainable Development Goals (SDGs), the Agenda 2030.

Sustainable development (SD) was first defined in 1987 in *Our Common Future*, also known as the Brundtland Report, as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [30, p. 16]. This report was a result of the imperative need for sustaining the planet's resources and governments' and peoples' desires for building a more prosperous, just, and secure world [30]. In addition, they concluded that environmental issues could not be separated from social and economic issues, and brought together these three essential components with respect to the pursuit of sustainability [30].

Following the Brundtland Report, the implementation of SD had its own evolution through the next decades as with the evolution of climate action. Into an increased global concern about poverty, environmental decay, resources deployment, and increased pollution [30], the global national representatives during the Earth Summit in 1992 prepared the Agenda 21, a framework for integrating SD into the global agenda [12]. This framework followed the paths laid out in the Brundtland Report by addressing the three dimensions of SD (environmental, social, and economic), identifying key areas of responsibility, and offering cost estimates for success [31].

In 2000, the UN General Assembly entered the new millennium and continued in the same line of the Agenda 21 by adopting the Millennium Declaration, which reaffirmed the global commitment and responsibility to achieving a more prosperous, peaceful, and just world and to enhancing freedom, equality, solidarity, tolerance, respect for nature, and shared responsibility [32]. To facilitate SD, in 2002 the UN create eight time-bound targets that lasted until 2015, the Millennium Development Goals (MDGs; Figure 4). These were the result of the Millennium Declaration being translated into more concrete actions to face the world's challenges [33].

Figure 12 – Millennium Development Goals (MDGs) [33].

After implementing the MDGs globally, the UN produced a final report in 2015 that summarized important improvements [34]. For example, the global poverty rate decreased from 47% in 1990 to 14% in 2015; global access to drinkable water increased from 76% in 1990 to 91% in 2015 [34, p. 4]. Despite these successes, progress was uneven, with the poorest and most vulnerable people being left behind, especially in Africa, least developed countries, landlocked developing countries, and small island developing states [35]. Regarding climate change, the situation worsened. By 2015, CO_2 emissions had increased 50% since 1990 [34, p. 53].

To learn from past experiences and to prove that global action works [34, p. 9], the UN used the MDGs as the starting point for a new global agenda in 2015 that continued working on SD. The UN established 17 new goals and 169 targets to pursue until 2030. These are the SDGs of the 2030 Agenda (Figure 5)

[35]. The complete list of targets can be found in Annex 1.
The SDGs try to reflect 15 years of experience from the MDGs' implementation process, modifying and amending what proceeded and what needed to be improved [36].

Figure 13 – Sustainable Development Goals (United Nations) [36].

In comparison with the SDGs, the MDGs were focused disproportionally on developing countries and even within these countries, the application of the MDGs was unequal, as they did not reach the most vulnerable populations [36, p. 30]. The SDGs are designed to have a holistic vision of the current crises, leaving no one behind.[35] This new approach is intended to better integrate the efforts of governments, civil society, and the private sector from countries of the global north, who contribute most to the climate crises [16, Ch. 4], [37].

One of the strongest improvements of the new agenda is its inclusive approach. The three dimensions that initially defined SD (economic, social, and environmental) are balanced by the 17 goals, which are specific but also co-related [35]. It could be said that the SDGs represent different facets of the same diamond. The SDGs are linked to each other, which allows for simultaneous improvements across the different dimensions and for the impact of efforts to be multiplied [36, p. 60]. As a past example, the MDGs were more successful when trade-offs were minimized and the synergies between the goals were increased [36, p. 31].

Regarding the co-relation of multiple SD areas, climate action is integrated as part of the SDGs and is represented by Goal 13 [35]. Climate-related frameworks, such as the Paris Agreement, also mention the importance of considering SD and environmental integrity as ways for achieving their proposed objectives [19].

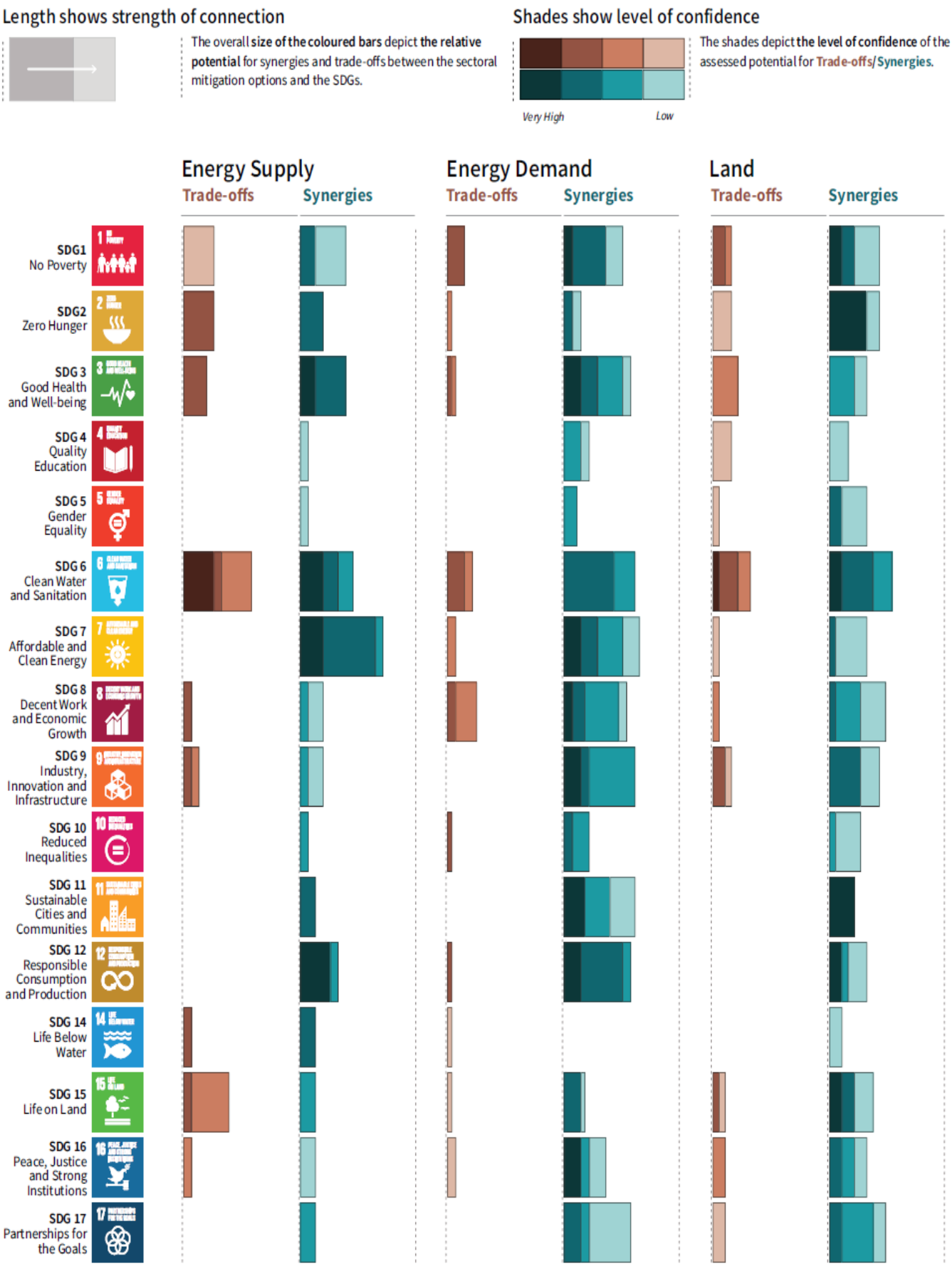

Figure 14 – Potential synergies and trade-offs between the sectoral portfolio of climate change mitigation options and the Sustainable Development Goals (SDGs) [1, p. 22].

Climate change mitigation and SD are mediums for tackling major global transversal issues. They are different concepts with several points in common and the same final objective, enabling sustainable life on earth. Consequently, multiple benefits arising from CCM policies, when properly designed, may also support SD. [16, p. 116]
Conversely, possible SD trade-offs may arise when tackling CCM. Nonetheless, they can be avoided with the adoption of complementary policies [16, p. 63] aimed at the many facets of SD, such as those that aim to reduce GHG emissions with an inclusive resilience perspective that leaves no one behind [16, p. 5,116]. As shown in Figure 6, the IPCC highlights the different synergies and trade-offs between CCM and the SDGs [1, p. 22]. For example, concerns about the interaction between the water cycle and land use should be approached carefully to avoid trade-offs [1, p. 22].

In conclusion, pursuing SD and combating climate change are related endeavors [16, p. 116]. This relation should be exploited to increase the efficiency and effectiveness of CCM action.

1.4 Localizing: The role of municipalities as key actors in mitigating climate change

The local perspective and contextualization of CCM and SD actions could be crucial for ensuring appropriate measures are taken in each context, where potential co-benefits are enabled and possible trade-offs are reduced. Despite the importance of general, top-down guidelines, different authors and organizations have defended the importance of bottom-up approaches in ensuring the effectiveness of actions taken for local communities. Castán Broto (2017) claims that "cities are so different, so contingent, that it does not make sense to build cities on a common global objective or shared recipes for best practice."[38] In terms of the governance perspective, Broto (2017) suggests "invest[ing] in recognizing the local history, the way social and material relations have been produced, and the trajectories that shape people's lives as essential components of any process of urban governance, including climate change mitigation."[38]

Governance is not the only important dimension that requires contextualization regarding effective CCM measures. Spatial planning processes, energy production, transportation and mobility, and land use are examples of relevant dimensions where contextualization is needed to ensure the effectiveness of CCM [16], [39].

Learning from past experiences, UN-Habitat has cited local action as a key for achieving the 2030 Agenda, including CCM [40, p. 7]. The UN has noticed that progress was more robust when governments addressed the processes inclusively, translating and adapting the global sustainability agenda into concrete and relevant initiatives at the local level [36, Ch. 3.1]. The UN affirms that localizing allows this agenda to be better adapted to local circumstances and helps reduce the inequality seen in implementing SD [36, p. 53]. The UN concluded that subnational governments bridge the gap between central government and communities and that they should play a strong role in fostering the involvement of civil society, organizations, the private sector (micro, small, and medium enterprises), academia, and other community-based organizations in SD actions [40, p. 7]. With the aim of amplifying the voices of local and regional actors and increasing joint-advocacy work relating to SDG implementation, climate change, and the urban agenda, UN-Habitat created the global task force of local and regional governments in 2013 [41].

UN-Habitat is not the only organization that supports local CCM and SD endeavors. Local Governments for Sustainability (ICLEI) is another example of a global network that creates connections among local, regional, national, and global governments to incorporate sustainability into day-to-day operations [42].

They influence sustainability policy and drive local action toward low-emission, nature-based, equitable, resilient, and circular development [42].

In the European context, the Covenant of Mayors is the relevant organization for enhancing local climate change action. This covenant has brought together thousands of local governments voluntarily committed to implementing EU climate and energy objectives since 2008 [43]. Its aim is to introduce a bottom-up approach for multi-level cooperation and to create a context framework for action [43]. As the EU dictates, within the EU countries, municipalities need to reduce their emissions by 40% by 2030 [26]. Country policies started to be developed. For instance, Portugal has integrated the EU Climate and Energy framework into their Energy and Climate Energy National Plan (PNEC) [44]. Despite the implemented emission-reduction measures at the national level, few are adapted to local contexts. The PNEC enhances the important role of municipalities with respect to climate action, enhancing their contribution in terms of awareness-raising campaigns [44]. However, they do not describe concrete measures to be adopted by the municipalities other than the obligation to elaborate local energy and/or mobility plans [44].

With the aim of supporting local climate action, the Bridging European and Local Climate Action (BEACON) Project, produced by the European Climate Initiative, tries to fulfil the gap between the different levels of governance, supporting municipal actors, policy makers, and educators in developing, refining, and implementing measures for reducing GHG through joint learning, networking, and developing tailored advisory services [45]. Working with participants from Bulgaria, Czech Republic, Romania, Greece, Poland, Portugal, and Germany, this project also aims to connect the different local actors participating and to disseminate good local-level practices for CCM [45].

1.5 The importance of monitoring local climate change mitigation actions

Monitoring was highlighted as important for achieving SD and therefore CCM [36, Ch. 2]. In addressing the CCM challenge, efficiency and effectiveness are crucial and require measuring climate impacts and identifying priorities for reducing carbon. These come along with an appropriate planning and monitoring system [38]. The UN suggests implementing a solid, efficient, inclusive, and transparent reporting and follow-up system at every level in order to better achieve climate- and sustainability-related goals [36, Ch. 2].

Regarding the local context, Boehnke et al. (2019) mentioned deficiencies in both data collection and action planning, which have led to inadequate practices [46]. The IPCC has also noted that municipalities often highlight progress on the implementation of mitigation projects, but the impacts of these initiatives are not often evaluated [16, p. 974].

The monitoring process seems to not be a priority, especially at the local level. As claimed in the last Global Environmental Outlook of the United Nations Environmental Program, the current monitoring process is severely inadequate and significant improvement is needed to be more effective in the decision-making process and to increase the credibility of local actors [47, Ch. 6].
The UN has already prepared indicators for monitoring the SDGs' implementation, with every goal and target having at least one associated indicator [48]. Unfortunately, few of these indicators could be addressed to the subnational level [48], where it seems to be more complicated to find a single recipe that suits every local context.
Despite the challenge of localizing, different organizations are committed to strengthening local capacity building and local monitoring processes. For example, UN-Habitat created the City Profiling Tool, which introduces different indicators for climate action in cities to facilitate city resilience assessments by local governments [49]. Local Governments for Sustainability has developed the global protocol for

community-scale greenhouse gas emission inventories (GPC), which follows the guidelines of the IPCC and aims to support the implementation of local emissions' inventories [50]. The Covenant of Mayors also created general guidelines for municipalities to prepare a Sustainable Energy and Climate Action Plan (SECAP), which includes in general terms how to develop the monitoring aspects associated with the designed plan [51]. In their guidelines called "How to develop a Sustainable Energy and Climate Action Plan," the Covenant of Mayors indicates that municipalities should identify data and indicators to monitor progress and results of each action undertaken [52, p. 56].

With all this available information, some municipalities have begun integrating climate action and the SDGs into their local agendas, including monitoring processes. This is the case of the Cascais municipality in Portugal. They have started to localize the SDGs by trying to integrate indicators for each goal, including climate action [53]. Unfortunately, as they affirm, their local adaptation of the SDGs into the municipal agenda is just an experimental process where the indicators, good practices, and the index used are indicative and do not accurately represent the reality of the municipality [53].

There is no concrete guidance to follow from municipalities with respect to SD monitoring within their territories. With this in mind, research projects were initiated in Portugal to facilitate this process. For example, the Center of Opinion and Polling Studies (CESOP) of the Catholic University in Lisbon, Portugal started developing indices to assess local sustainability in 2018 [54]. They are trying to adapt global SDG indicators to the local level by localizing the data that is already available at the Portuguese National Statistical Institute (INE) and PORDATA and by proposing new indicators when relevant data is unprocessed [54].
Another example of a local monitoring initiative is the ODSLocal project, an online tool that allows for the monitoring, visualization, and communication of municipal progress towards implementing the SDGs [55]. This website, developed by 2adapt, was launched on November 12th, 2020 [56].

This research intends to tackle the current lack of concrete guidance for municipalities regarding mitigating climate change by integrating all the arguments raised above and following the UN's and EU's current guidelines. It intends to contribute an answer regarding how to achieve SD and a facilitation tool for improving local CCM planning and monitoring processes.

2 Thesis Question and Objectives

This thesis results from the urgent need to address climate change, the importance of implementing related local actions, and the imperativeness of improving the planning and monitoring processes for CCM. It intends to explore and co-create a local CCM index within the municipal context and uses the municipalities participating in the BEACON project (Annex 2) to do so.

2.1 Context

- The author seeks for a solution to a current need in order to unlock local CCM activities.
- The scope should be as broad as possible so no one is left behind while also being specific as possible to facilitate CCM actions in EU municipalities without losing sight of common goals.
- The approach proposed should be compatible with different current frameworks that encompass climate action, such as the Covenant of Mayors and the SDGs.
- The developed index should not serve to compare municipalities but to acknowledge the evolution of a single municipality across time.

2.2 Thesis question

The thesis question is, “What indicators do European municipalities find most adequate for monitoring local CCM, using European municipalities as case study approach?”

2.3 General objective

The object of the thesis is to propose structured pathways that EU municipalities should integrate to pursue CCM and to analyze the most appropriate indicators for monitoring their progress on CCM.

2.4 Specific objectives

Chapter A objective:

- Propose a structured CCM action-oriented framework by domain for EU municipalities based on key scientific publications.

Chapter B objective:

- Identify and assess appropriate and suitable indicators for the local level that are structured according to the potential domains resulting from Chapter A that can be used by a wide variety of European municipalities for monitoring CCM.

3 General Methodology

Understanding the perception of local administration with respect to which indicators are most suitable for local-level CCM monitoring required several steps from the author. First, the author investigated what actions a municipality can implement to mitigate climate change (Chapter A) and translated them into recommendations organized by different domains linked to the SDGs. Secondly, the author proposed a set of indicators associated with the different recommendations. These proposed, collected, and adapted indicators from recent literature were then approved or disapproved by local administrations through online surveys (Chapter B).

In order to propose a common framework to support CCM planning and monitoring across all European municipalities, the author considers the European municipalities as similar units of local governance, thereby dismissing potential country or regional difference and enhancing their similarities in terms of purpose and structure, and affirming their common objective of reducing GHG emissions [26]. This approach is similar to the one proposed by the Covenant of Mayors, which recognizes the multiple contexts from all EU municipalities but focuses on what municipalities have in common: the objective to reduce their GHG emissions by 40% by 2030 [43].

4 Chapter A: Science-based Recommendations for Municipal-level Climate Change Mitigation

4.1 Introduction

In this chapter, the author compiles and proposes suitable recommendations for EU municipalities in order to establish a common ground to take action and for supporting local CCM.

4.2 Methodology

The author of this research reviewed the current literature to identify the field and context this research is situated within (see the introduction). The objective of the literature review was to understand what

others have done in the same field to ensure previous work is not duplicated and to identify key authors, organizations, and information for this research [57, pp. 42–43]. The author adopted the snowball technique during the literature review. Explained by Ridley (2012) and cited by Ssekamatte (2018), the snowball technique is one where, as you read articles or literature, you begin to recognize familiar authors and cited texts in the bibliographies and books that you are reading, following up on references from references and text you read [57, p. 56], [58].

Relying on the snowball technique, the base for proposing a structured CCM action-oriented framework started with the IPCC reports, especially the third part of the Fifth Assessment Report on CCM (AR5) by the Working Group III (2014). This report provides a comprehensive assessment of the technical and behavioral mitigation options available in domains such as energy, transport, buildings, industry, and land-use sectors and evaluates policy options across governance levels, from a local to an international scale [16, p. vii].
The author analyzed other relevant reports, books, articles, and grey literature to acquire more updated information and to delve deeper into topics relevant for municipalities. Three search engines were used to complement the snowball technique according to the following order of preference: Web of Science, B-on.pt, and Google Scholar. The author prioritized reviews before individual articles to have a general overview of the research theme. In addition, the author also prioritized articles from 2010 onwards but did not exclude other time periods. Depending on the domain, the author used different keywords related to the researched topic (Table 1). When clarification was necessary, the author also read similar articles cited in the initial articles analyzed. All the science-based information gathered was complemented with reports from global organizations and the author's personal experience of participating in different European CCM projects, related conferences, and workshops. The most relevant organizations consulted were the IPCC, the Food and Agriculture Organization (FAO), UN-Habitat, the United Nations Environment Program (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Union for Conservation of Nature (IUCN), the United Nations Convention to Combat Desertification (UNCCD), the EU, and the Organization for Economic Co-operation and Development (OECD).

Table 1 - Key words used to complement the main research topics organized by domain.

Domain	Key Words
Governance	governance climate change mitigation/climate change citizen assembly/good practice climate change mitigation local
Education and Communication	SDG 4 education for sustainable development goals/social cause advertisement effectiveness
Land Use	ecosystem-based solutions land management climate/nature-based solutions sustainable urbanization
Consumption Patterns	urban greenhouse gas footprints/EU public procurement climate change/food's environmental impacts
Waste Management	recovery organic solid waste fertilizer/composting food waste/policies single-use plastic
Energy	distributed energy generation sustainable development/energy decentralization prosumers /distributed generation review
Transportation and Mobility	sustainable urban mobility plan
Spatial Planning	nature-based solutions spatial planning

After gaining a general overview of the research topic, the author suggested different domains of interest for European municipalities in their approach to local CCM. For the categories, the author considered two criteria: where the municipality has the competence to address CCM and which are the most problematic global GHG emission sources, acknowledging that global GHG trends result from the sum of local trends.

Following the IPCC remarks [1, Ch. D] regarding the potential synergies between CCM and SD and with the aim of producing a common framework that could serve both, the author suggested a link between the SDGs and the recommendations from Chapter A. To make this link, the author analyzed all the different SDG targets (Annex 1) [35] and associated them with each proposed CCM recommendation. In addition, the author considered the potential synergies and trade-offs inherent to the relationship between SD and CCM [1, p. 22] in order to consider local CCM actions that are also relevant to SD [16, pp. 5, 116].

4.3 Results and discussion

In this section, the author presents the results of the literature review in order to illustrate and suggest practical recommendations regarding municipal CCM action. Annex 3 contains the associated, complementary publication "Roadmap for local climate change mitigation," a science-policy brief resulting from this research that supports municipalities in planning for climate action.

4.3.1 Domains of relevance for European municipal-level climate change mitigation

4.3.1.1 *G*lobal *trendiest* sources of greenhouse gas emissions by sector

Globally, the increase in anthropogenic GHG emissions between 2000 and 2010 were directly produced by the following sectors: energy (47%), industry (30%), transport (11%), and construction (3%) [59, p. 46]. The agricultural, forest, and other land use sector (AFOLU) has not increased its impact during this period, but it is an important contributor to GHG emissions: in 2010, it was responsible for 24% of net emissions [59, p. 46]. The IPCC has also stated that the following are key drivers of CCM: consumption and behavioral changes, production and trade patterns, waste, infrastructure choices and their related lock-in effects, among others [16, Ch. 5]. As noted, every municipality has its own challenges and context. Nonetheless, the author assumes that the global drivers of GHG emissions result from the sum of local parts. For instance, the sustainable energy action plan of the municipality of Setúbal, Portugal identified their three most problematic GHG emission sectors, ranked as follows: production and transportation of energy, industry, and transportation. These sectors are also the most problematic at the global level, as noted by the IPCC [60].

4.3.1.2 The role of European municipalities

A municipality is defined as a legally determined region with a local government administration [61]. Although the definition may differ from country to country, all municipalities have the same purpose: local governance [61].

Competences also differ from country to country depending on their legislation. In the context of Portuguese law, for example, municipalities are tasked with safeguarding and promoting their populations' interests in the following sectors: rural and urban equipment, energy, transport and communications, education, heritage, culture and science, sports and leisure, health, social action, housing, civil protection, environment and basic sanitation, consumer defense, development promotion, land use and urban planning, municipal police, and external cooperation [62].

Despite differences, EU municipalities have the same goal of reducing their GHG emissions by 40% by

2030 [52, p. 25]. In order to reduce or increase the efficiency of municipal energy fluxes, global European organizations for municipal CCM, such as the Covenant of Mayors, have highlighted local CCM efforts in the energy sector, and now considering also crucial domains such as land-use planning, mobility and transportation, and consumption patterns [52, pp. 13–14] The Covenant of Mayors expects local authorities to play an exemplary role by taking outstanding measures related to their own context [52]. Thus, the Covenant is also enhancing the importance of stakeholder engagement, where communication is fundamental [52, p. 44].
In analyzing specific European projects fostering municipal CCM, the BEACON project has suggested the following categories of focus for participant municipalities: governance, power and heating and cooling, transport, urban planning, communication and sensibilization, natural resources, consumption patterns, and waste management [45].

4.3.1.3 Proposed domains for EU municipal climate change mitigation

Based on the analyzed literature, the author proposes the following eight domains for structuring CCM in every European municipality: governance, education and communication, land use, consumption patterns, waste management, energy (production and end use), transportation and mobility, and spatial planning.

4.3.2 Proposed recommendations for local climate change mitigation by domain

4.3.2.1 Governance

Governance refers to a process of setting, applying, and enforcing rules by both governmental and non-governmental actors in a network setting [63]. Within the context of climate action at the local level, the capacity for governance is highly related to the effectiveness of climate policy [16, p. 41]. As the IPCC has remarked, CCM is a technically feasible exercise, but institutional arrangements, governance mechanisms, and financial resources must be aligned with the goal of reducing GHG emissions [16, p. 92].

Each locality has its own characteristics (different size, national legislation, and international networks) [46]. Thus, each of them has their own way of proceeding with climate action. Nevertheless, the author analyzed their approach to governing and their internal aspects as they relate to achieving mitigation goals.
Starting with governance style, Boehnke et al. (2019) [46] denote four types of local governing styles for climate action: governing by authority, self-governing, governing by provision, and governing by enabling [46]. A study of 627 climate experiments in 100 global cities by Broto and Bulkeley [64] affirms the prevalence of the provision style, which enhances the importance of the "governing by enabling" mode as a complement to achieving the desired climate action [64]. As Boehnke et al. explain, governing by provision entails that the municipality is the provider of sustainable services (water, electricity, public housing, transport, etc.) [46]. In the case of governing by enabling, Boehnke et al. state that the role of the municipality is as a facilitator that implements subsidies and loan schemes, distributes information, coordinates climate action among actors, and establishes public-private partnerships [46]. The author of this research assumes that the city-level focus of Boehnke et al. (2019) and Broto and Bulkeley (2013) could be replicable at the municipal level.

Analyzing the importance of the public-private partnerships, as mentioned by Boehnke et al. [46], local authorities could integrate local stakeholder into their CCM processes. Establishing stakeholder partnerships could be seen as a way to distribute responsibilities that seeks cooperation on municipal-level climate action. Although evidence is limited, case-study results indicate that engaging institutions in

stakeholder engagement is important to successfully implement mitigation policies [16, p. 1184]. Partnerships are important for local government because they extend the operation of the state through other actors [64].
For example, the IPCC remarks the institutions' responsibilities on stakeholder engagement, via creating spaces for stakeholder participation, considering the organizational resources of the stakeholders themselves and the general policy environment [16, p. 1184]. Given the complexity of climate change, the range of stakeholders is immense [16]. The author of this research suggests classifying local stakeholders into the following groups: business and industry (private sector), non-governmental organizations (NGOs) and non-profit associations, and civil society and other related public institutions. For example, NGOs could have an important role in connecting "knowledge with responsibility" and promoting norms of accountability [16, p. 1184], which would help ensure successful CCM policies. Some of the major roles of NGOs might include raising public awareness, lobbying, influencing investment decisions, and monitoring and implementing agreements [16, p. 1184]. Collaboration among municipalities, regional agencies and other public institutions may also be necessary for successful CCM. For example, the Covenant of Mayors suggests presenting joint SECAPs among municipalities in case a municipality faces a lack of human and financial resources required to achieve covenant-related commitments on its own [43]. The author acknowledges that the acceptance of civil society is also needed for successful climate action. Citizens' assemblies are an example of civil society engagement that leads to more inclusive, co-designed, and collaborative governance [65]. In the right context, citizens' assemblies can facilitate societal buy-in with respect to policy decisions, thereby increasing the legitimacy of decisions [65].

In terms of institutional policies and instruments, the IPCC classifies them by economic instruments (taxes, subsidies, subsidy removals, and emissions trading schemes), regulatory approaches (rules and objectives with penalties in cases of non-compliance), information policies (good information quality is essential to raise public awareness and concern about climate change, to identify environmental challenges, to better design of environmental policies, to monitor their impacts, and to provide relevant information to inform consumption and production decisions), government provisions of public goods and services and procurement, and voluntary actions (actions taken beyond regulatory requirements) [16, p. 94]. As local governments' authority differs from country to country, some instruments are not suitable for every municipality. Thus, the author focuses on three instruments that may be universally accessible and encourages the use of regulatory and economic policies when possible. In terms of voluntary actions, as an example, the author highlights the importance of engaging the Covenant of Mayors initiative by local authorities not only for the support and guidelines that this initiative provides for climate action but also for the opportunity to publicize municipal climate actions [43]. Integrating the Covenant of Mayors also requires the creation of a baseline emissions inventory that contributes to municipal information policies by providing information about the current emissions situation of the municipality. This information can enable appropriate, effective, and targeted measures in the sectors contributing the most to GHG emissions [43].

Municipal-owned and managed services could be essential in provisioning sustainable services. The author uses the term (re)municipalization in reference to the process of bringing previously private or privatized services under local public control and management, including services that have always been in private hands or services that previously did not exist [66]. The Transnational Institute collected 835 cases of (re)municipalization across 45 countries. The institute defends publicly managed services because these services generally focus more on quality, are universally accessible and affordable, and deliver on broader social and environmental objectives [66, p. 158]. Thus, (re)municipalization could be the key to achieving local CCM goals depending on the local conditions and the different motivations for (re)municipalizing [66, p. 161], [67]. This fact is particularly obvious in the energy sector, where

new local public companies and co-operatives have been pioneering an energy transition based in renewables, but also in other sectors such as transportation and waste management. As an example, it is nearly impossible for a private waste company to engage in a genuine "zero-waste" policy because their whole business model is predicated on maximizing volumes of collected waste [66, p. 162].

The internal organization of the municipality plays a key role in fostering local climate action. Effective climate policy involves building institutions and capacity for governance [16, p. 41]. Most climate policies intersect with other societal goals, either positively or negatively [16, p. 39]. Due to the multidisciplinary character of CCM, fostering internal collaboration, cooperation, and information sharing among local administrative divisions could play an important role in enhancing potential policy co-benefits and reducing the risk of adverse side effects [16, p. 40].
For example, in the Syros Workshop of the BEACON project "Engaging with colleagues for ambitious climate action," 27 participants of local administrations from Germany, Greece, and Portugal discussed which internal structures are necessary to implement successful, ambitious climate action [68]. In their report, they identified three internal structuring options: a centralized climate structure (climate unit), a decentralized climate structure (expert team), and a decentralized expert team led by one coordinator (hybrid).
The author recommends the hybrid structure because of the advantages of having a decentralized expert team lead by a coordinator. The increased need of human resources embedded in the hybrid structure may not feasible for every municipality. Nonetheless, the final aim is the cooperation between departments to not only avoid potential double efforts but also to share relevant information for developing appropriate climate action plans.

In relation to cooperation-based internal structures, the IPCC highlights the importance of capacity building and institutional education for CCM. Decision makers often have insufficient or imperfect knowledge about climate risks. This knowledge deficit could be addressed through better data communication and public education [16, p. 160]. Understanding climate change is crucial for mitigating it. Several articles from UNFCCC acknowledge the role of capacity building in promoting collective action on climate change [16, Ch. 13]. The author of this research extrapolates this knowledge to local institutions.

Table 2 – Recommendations for local climate change mitigation (CCM) related to the governance domain.

Governance-related Recommendations	SDG Targets
A - Provisioning Sustainable Services/Green Public Procurement	13.2 & 17.14
B - Promote Information Policies	13.2 & 17.14
C - Undertake Voluntary Actions	13.2 & 17.14
D - (Re)municipalize Local Services to Foster Institutional Capacity for Climate Change Mitigation	13.2 & 17.14
E - Establish Stakeholder Partnerships	17.16 & 17.17
F - Rearrange the Internal Structure of the Local Administration	17.16 & 17.17
G - Capacity Building for Local Administration Climate Action	13.3

In Table 2, the author suggests recommendations for municipalities to pursue local CCM linked to appropriate SDG targets.

When connecting the proposed recommendations to the SDG targets resulted the Goal 13 (Climate action) and Goal 17 (Partnerships for the goals). The author acknowledges that the targets proposed in Goal 13 could be modified from a national context to a municipal context and, regarding the Goal 17, that CCM is a medium for pursuing SD, thus, acknowledging partnerships for the goals, partnerships for CCM.

4.3.2.2 Education and communication

Human values and behavior may result from multiple factors such as, for example, cultural, religious, and other beliefs systems [16, p. 299]. Despite their complexity, substantial changes in human values in the long term and inducing behavioral changes in the short term could be important for CCM [16, p. 300]. However, the link between values and ecologically conscious behavior is often vague because of the wide range of factors involved [16, p. 300]. Nonetheless, these values and behavioral changes could be induced through learning and socialization [16, p. 299]. Thus, education and communication could be crucial in fostering CCM at the local level, and local administrations could take the lead on the matters.

The United Nations Educational, Scientific and Cultural Organization defines education for sustainable development (ESD) as the education that empowers learners to make informed, responsible decisions for environmental integrity, economic viability, and a just society for present and future generations, while also respecting cultural diversity. Education for sustainable development is about lifelong learning and is an integral part of quality education. It is also holistic and transformational education that addresses learning content and outcomes, pedagogy, and the learning environment. It achieves its purpose by transforming society [69]. Education for climate action could empower learners to make informed decisions about CCM and thereby transforming society.

The IPCC states that the aim of an educational program in CCM and climate change adaptation is to represent a collective global problem as individual and collective knowledge and experiences [16, p. 256]. Such an education program would require strategies for disseminating scientific information and would have to advertise practical implications in ways that are understandable to diverse populations [16, p. 256]. For example, institutions could promote strategies for education or communication to different target groups (scholars and non-scholars).

Some European municipalities have noticed the importance of schools in promoting personal values and inducing behavioral changes aligned with climate goals and actions. Supported by different projects, such as BEACON [45] or Three for Climate [70], municipalities from Czech Republic, Germany, Greece, Portugal, Slovenia, Romania, and Bulgaria are closely collaborating with some of their local schools to raise awareness about the climate change challenge.

As a complement to education, communication can also induce behavioral changes. Municipalities may have an important role in communicating local information related to climate action (information policies) and also through non-commercial advertising campaigns. Advertising is used to shape consumer purchasing behavior [71]. Local authorities may use a similar strategy to induce behavioral changes in support of climate action. However, it is difficult to determine the effectiveness of advertising campaigns [71], [72]. Nonetheless, some progress has been made in the field of neuroscience. Harris et al. (2019) showed that action- and emotion-based marketing communications that ask individuals to "act," "share," "pledge," or "challenge" are more effective than predominantly rational-based appeals for inducing changes in decision making [72].

Following from the above, the author suggests recommendations for municipalities to pursue CCM and links them to appropriate SDG targets (see Table 3).

Table 3 – Recommendations for local climate change mitigation (CCM) related to the education and communication domain.

Education- and Communication-Related Recommendations		**SDG Targets**
Education	A.1 - Promote climate change education in schools and other educational institutions A.2 - Promote climate change education for citizens not currently enrolled in an education	4.7 & 13.3
Communication	B.1 - Dissemination of general information on climate change and local environmental conditions B.2 - Dissemination of information on actions taken by the municipality to mitigate climate change B.3 - Invest in non-commercial advertising campaigns to increase citizen awareness about the climate change crisis and regenerative responses	

The education and communication dimension transverses every other domain, where specific communication strategies are crucial for achieving the proposed measures. For instance, communications campaigns intending to induce a reduction in consumerist behavior is related to the consumption patterns dimension; specific training such as eco-driving courses is related to the transportation and mobility dimension.

When connecting the proposed recommendations to the current SDG targets resulted the Goal 13 (Climate action) and Goal 4 (Quality education), acknowledging in that case, ESD as education for CCM.

4.3.2.3 Land use

Land is the main resource of ecosystem services, and its use directly affects human economies and quality of life [16, p. 818]. Land not only provides food and fodder to feed the earth's population; it also modulates the climate via regulation services that depend on how it is used [16, p. 818]. Changes in land conditions affect the global and regional climate, reduce or accentuate warming, and affect the intensity, frequency, and duration of extreme weather events [39, p. 11].

Data available from 1961 onwards show that global population growth and changes in per capita consumption have caused unprecedented rates of land and fresh-water use, leading to human-induced degradation of about a quarter of the earth's ice-free land area [39, p. 2]. Thus, for climate change, land use is highly relevant, and certain types of land use can increase GHG sinks (e.g., afforestation, management for soil carbon sequestration, etc.). Conversely, certain land uses increase GHG emissions (e.g., deforestation, rice cultivation, etc.) [16, Ch. 11].

An estimated 23% of total anthropogenic GHG emissions (2007–2016) derive from AFOLU, including 13% of carbon dioxide (CO_2), 44% of methane (CH_4), and 82% of nitrous oxide (N_2O) [39, p. 7]. The

IPCC reports further analyzes two AFOLU categories, "agriculture and forestry" and "other land use," to understand their contribution to GHG emissions and possibilities for mitigating them.
In terms of agriculture, emissions are mainly non-CO_2 emissions (CH_4 and N_2O) produced mainly by animals' enteric fermentation (23%–40% of total agricultural emissions), manure management (about 15%), use of synthetic fertilizers (12%), rice cultivation (9%–11%), and biomass burning (6%–12%) [16, p. 823], [39]. All of them are projected to increase [39, p. 11].
Emissions fluxes related to FOLU are mainly CO_2 emissions due to losses in carbon forest stocks via permanent forest loss or temporary forest loss where forest regrowth does not balance deforestation [16, p. 826]. As a specific example, 15% of the tropical rain forest net emissions are due to non-balanced removals [16, p. 826].

Moreover, other issues such as land degradation and desertification could accelerate GHG emissions, as growing vegetation in degraded areas will become difficult. Driven by unsustainable land management [39, p. 17], land degradation processes are also exacerbated by climate change through increases in rainfall intensity, flooding, drought frequency and severity, heat stress, dry spells, wind, rising sea levels and wave action [39, p. 6]. Thus, fighting land degradation is necessary to effectively address CCM in the land-use sector [39, Ch. C, D].
Food security is another issue linked directly to land degradation and climate change that is adversely affected by warming, changes in precipitation patterns, and more frequent extreme events [39, p. 7]. Beyond affecting food systems, climate change also creates additional stresses on land by exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, and infrastructure [39, p. 15].

Due to its enormous influence on different matters, land use's effect on climate change should be addressed through actions related to land degradation, desertification, food security, ecosystem conservation, and SD approaches, and these actions should be done together to take advantage of their complementary nature [39]. As the IPCC claims, techniques that have co-benefits in terms of climate action, land degradation and desertification are site and region specific [39]. It is therefore important to localize and involve local administrations in these actions. Municipalities are key actors in promoting and initiating appropriate land-use strategies that address CCM. Namely, they have key roles in engaging local stakeholders and contextualizing appropriate measures for the local territory.

Sustainable land management is presented as one of the main ways to mitigate climate change in the land-use sector [39] that also attends to other major issues to look for potential co-benefits. The UN defines sustainable land management as "the use of land resources, including soils, water, animals, and plants, for the production of goods to meet changing human needs, ensuring the long-term productive potential of these resources and the maintenance of their environmental functions" [73]. Processes that degrade land or cause permanent deforestation are opposed to this notion. Thus, it is important to not only consider sustainable land management but also to act in already degraded areas through restoration (e.g., forest restoration and soil restoration) aligned with biodiversity conservation goals and targets [39].

Forest management is relevant for CCM [16, Ch. 11]. In order to have a common framework regarding forest management, the definition of forest must be clarified. The author adopted the definition from the IUCN natural forest concept, and it is as follows: "areas where many of the principal characteristics and key elements of native ecosystems such as complexity, structure, and diversity are present, as defined by the Forest Stewardship Council (FSC) [74], approved national and regional standards of forest management" [75]. The author prioritizes IUCN's definition rather than the FAO's or IPCC's definitions because the IUCN does not consider monoculture plantations as forests [76]. The energy inputs needed to sustain a monoculture often lead to land degradation [77, p. 140].

The IPCC remarks with high confidence that changes in forest cover from, for example, afforestation, reforestation, and deforestation, directly affect regional surface temperature through exchanges of water and energy [39, p. 12]. Thus, improvements in the forestry dimension could lead to potential co-benefits not only with respect to CCM and climate-change adaptation but also in terms of ecosystems and land restoration [39].
Consequently, municipal forest areas should be increased or recovered and the already existent ones should be protected. Wildfires will increase in occurrence because of global warming [39, p. 16]. Thus, it is important to work toward preventing these fires, which increase carbon emissions and destroy existing carbon sinks [39]. Beyond preventing wildfires, the IPCC highlights other strategies for reducing deforestation like sustainable forest management (for the forestry industry) and preventing forest areas from being changed into croplands [39]. The author proposes extrapolate the forests' associated recommendations to other related ecosystems that also act as carbon sinks within the municipal territory.

Agriculture is one of the main drivers of AFOLU emissions [16, Ch. 11] and land degradation [78]. Since the "Green Revolution" started in the 1950s [77, p. 140], a food production model based on homogeneity has been implemented, where genetically uniform crop varieties are grown with high levels of complementary inputs including irrigation, fertilizer, and pesticides. Homogeneity often leads to depleted agroecological resilience and thus natural capital [77, p. 140]. This food production system, often cited as the "conventional" system [78] uses unsustainable agricultural practices such as the use of herbicides for weed control or not rotating crops [77, Ch. 10], leading to soil erosion [79]. These "conventional" agricultural systems also rely on synthetic fertilizers in place of soil quality management [77, p. 140], which directly increases GHG emissions [16, p. 824]. In terms of how food is produced, the IPCC and FAO note the importance of transitioning towards sustainable food production, as the green revolution model is not only aggravating climate change; it is also unlikely to achieve the zero hunger goal for the most vulnerable people [39, p. 16], [77, p. 141]. Therefore, sustainable food production is useful for CCM and also climate-change adaptation because it combats desertification and land degradation and promotes food security and SD in general [39, p. 19].
This research integrates the vision of the FAO regarding sustainable food production and agriculture: "A world in which food is nutritious and accessible for everyone and natural resources are managed in a way that maintains ecosystem functions to support current, as well as future human needs" [77, p. 143]. This definition considers the natural fluxes that help maintain ecosystem functions, soil organic carbon management, and other practices that the IPCC remarks, including soil erosion control, improved fertilizer management, and improved crop management [39, p. 25].
Different agricultural systems exist that include these guidelines for sustainable food production. These systems include permaculture, which is based on natural design approaches [80], and agroecology, which encompasses the economic, social, and environmental dimensions [77, p. 143]. Agroecology is defined by the IUCN as a land-use system in which woody perennials are grown for wood production with agricultural crops, with or without animal production [75]. Agroecology is highlighted as an example of mitigation-adaptation synergy in the agriculture and forestry sector [16, p. 847]. The author of this research refers to all sustainable food production systems as organic to simplify sustainable local food production measurement. This consideration follows the EU standards for organic food production [81].
Moreover, the IPCC recognizes the importance of indigenous and local knowledge in agricultural practices that contribute to overcoming the challenges of climate change, food security, biodiversity conservation, desertification, and land degradation [39, p. 31]. Improving local food production is another way to achieve CCM, and it avoids external dependencies and reduces transportation costs and associated emissions. Local food production could ensure food security. For instance, local food

production is a key element in the FAO's project "Brazil's Fome Zero" (Zero Hunger) [77].
Regarding where the food is produced, the global forest atlas from Yale university shows that industrial agriculture (along with subsistence agriculture) is the most significant driver of deforestation in tropical and subtropical countries, accounting for 80% of deforestation from 2000 to 2010 [82]. In following the IPCC guidelines for mitigation, it is important to avoid deforestation in giving space to agricultural fields [39]. Agroforestry may therefore have an important role to play because it avoids land-use competition [39]. Urban food production and peri-urban food production were also identified by the IPCC as methods for avoiding competition between land use for food production and urban expansion [39, p. 18].

Land competition and land conversion are major drivers of carbon-sink losses, especially when forests are replaced by agricultural fields [39]. Urban expansion can also lead to increased land-use competition, for instance, by croplands [39, p. 18]. Inappropriate urban expansion reduces soil permeability, which reduces groundwater infiltration [83, p. 12]. This reduction leads to a reduction in soil carbon sequestration and an intensification of the impacts from extreme rainfall events in cities or downwind urban areas [39, p. 12].
Improved land water harvesting and increased ground water infiltration from, for instance, limiting land impermeable areas, could create potential co-benefits. These co-benefits not only concern reductions in flood risks and the enhanced conservation of fresh groundwater reserves (increase of rainwater interception and infiltration) but also the prevention of further land degradation [16, p. 964], [84]. Reducing impermeable areas for water harvesting is mentioned as beneficial for soil organic carbon sequestration, which increases soil fertility [39, p. 22], [85]. It not only contributes to CCM and climate change adaptation but also to reverse desertification and land degradation [39, p. 20].

Ecosystem/nature-based solutions (E/NBS) are presented as ideal sustainable strategies that benefit different domains simultaneously. They are based on natural processes and cycles that use natural flows of matter and energy, take advantage of local solutions, and follow seasonal and temporal ecosystem changes [79]. They are also relevant in multiple areas, from spatial planning and urbanization [86] to the agricultural sector [79]. In addition, E/NBS are effective solutions to global issues like climate change in terms of adaptation and mitigation because they interact with natural fluxes, require less maintenance, are cost effective, and are probably more effective over a long time span when properly constructed [79].
As an example, more urban green spaces and infrastructure based on E/NBS that also integrate biodiversity values (e.g., green roofs, green walls, ground areas for water infiltration, etc.) could help CCM and biodiversity conservation. Moreover, these solutions could also contribute to reducing the climate risk associated with the exacerbated warming produced by conventional urbanization, especially during heat-related events [39, p. 12,18].

Table 4 presents the author's recommendations related to land use for municipalities' local CCM activities and links these activities to appropriate SDG targets.

Table 4 – Recommendations for local climate change mitigation (CCM) related to the land-use domain.

Land-Use-related Recommendations		SDG Targets
General	A - Promote Sustainable Land Management	15.1, 15.5 & 15.9
Sustainable Food Production	B.1 - Promote organic farming systems B.2 - Increase urban and peri-urban organic food production B.3 - Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge	2.4
Sustainable Forest Management	C.1 - Increase municipal forest areas C.2 - Reduce forest loss and degradation caused by forestry activity C.3 - Avoid conversion from forest land to other land use, particularly from switching into cropland or monocultures C.4 - Implement operational and effective wildfires management	15.2 & 15.b
Soil Carbon Sequestration	D - Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltration	6.6 & 15.3
Green Urban Infrastructure	E - Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	11.7& 15.9

4.3.2.4 Consumption patterns

The global consumption of goods and services has increased dramatically over the last decades, in both absolute and per-capita terms, and is a key driver of environmental degradation, including global warming [16, p. 288].

At a global level, food is the consumption category with the greatest climate impact, accounting for nearly 20% of GHG emissions, followed by housing, mobility, services, manufactured products, and construction [16, p. 305].

For GHG accounting, the IPCC basically relies on two different approaches in the consumption sector: the territorial-based approach and the consumption-based approach [16, Ch. 4.4]. The territorial-based approach allocates those emissions that are physically produced within the territorial boundaries of a nation (or jurisdiction) [16]. The consumption-based approach assigns emissions through the whole supply chain of goods and services consumed within a nation irrespective of their territorial origin [16, p. 306]. This second approach relies on a product's carbon footprint. A product's carbon footprint includes all emissions generated during the lifecycle of a good or service, from production and distribution to end use and disposal or recycling [16, p. 306].
Both approaches present advantages and disadvantages, and they were formulated according to certain conventions and purposes [16, Ch. 4.4.2]. For example, producers want the responsibility of GHG

emissions to be assigned to consumers (consumption-based approach), as do nations that are net-exporters of industrial goods [16, p. 307]. Conversely, net-importers might prefer that GHG emissions are the responsibility of producers (territorial-based approach), and expect that they will improve their production chain to reduce GHG emissions.
Regarding the territorial-based approach, the responsibility for the emissions associated with the goods' production only arises when this territory is framed within a normative or legal framework such as a climate agreement that specifies rights or obligations [16, p. 306]. For this approach to work, it is assumed that nations do not have a fragmentated climate policy [16, p. 306]. In practice, differences in climate legislation differ from country to country, and this could be an incentive for producers to move into countries with soft climate legislation to avoid responsibility for emissions generated. Countries with stringent climate legislation could suffer from their producers' exodus, which would increase their dependency on imported goods and increase the emissions associated to trade. It is important to mention that the territorial-based approach does not account for GHG emissions associated with trade [16, Ch. 4.4.2], which is an important gap in GHG emissions accounting.
In comparison, with the consumption-based approach, GHG emissions can be accounted for independently of a nation's climate policy, and this may help in cases when global climate policy is fragmented [16, p. 36]. Moreover, it does not allow current GHG inventories to be reduced by outsourcing production or by relying more on imports [16, p. 307].

Consumption-based accounting presents different challenges, as there is no accepted carbon footprint methodology or widely accepted definition [16, p. 306]. These challenges may be surpassed by using a standardized process. The consumption-based approach integrates trade emissions and therefore has the controversial risk associated related to the competitiveness in the trade system, increasing costs and reducing demand for products abroad [16, p. 306]. The IPCC also comments that the consumption-based approach may violate the rules of the World Trade Organization (WTO) [16, p. 306], but also, it implies a fairer illustration of who is responsible for current emissions [16, p. 307]. The author encourages prioritizing the framework that results in the greatest reduction of GHG emissions. In the European context, GHG emissions responsibilities should be allocated to consumers because the sum of the countries accounts for more imports than exports [87]. Thus, the consumption-based approach should be used, even if it implies violating the trade system's rules. Given the evidence that global consumption is a key driver of environmental degradation and global warming [16, p. 310], the author finds it illogical to continue defending a trade system that contributes to maintaining global GHG emissions at high levels. For that reason, the author highlights the consumption-based approach as a valid GHG accounting method in the EU context and suggests reviewing the trade system rules (such as the ones promoted by the WTO) and potentially adapting them to the current climate situation.

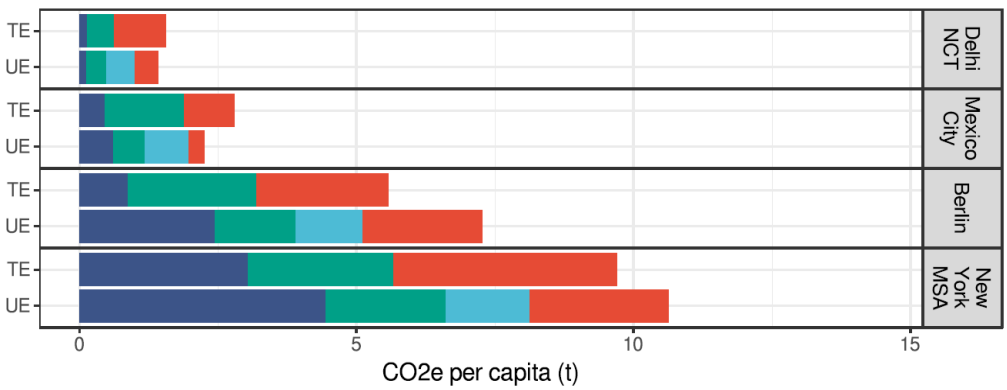

Figure 15 – Sectorial comparison of total territorial emissions (TE) and upstream emissions of households' consumption (UE) in four cities in CO2eq per capita per year [88].

To better understand the value of the consumption-based approach, a recent study from Pichler et al. [88] analyzed GHG emissions accounted for by the territorial-based approach and by the consumption-based approach (product carbon footprint) in Berlin, the National Capital Territory of Delhi, Mexico City, and the New York metropolitan statistical area [88]. Their results show (Figure 7) how the upstream emissions from household consumption are substantial and highly significant, ranging between 81% (Mexico City) and 130% (Berlin) of territorial emissions, and in the two more affluent cities of Berlin and New York, they surpass territorial emissions [88].

The carbon footprint of products (and firms) could offer the appropriate information to enable a range of mitigation actions and can have essential co-benefits [16, p. 306]. It is conceivable to rely on climate policies that target the consumption and production sides of emissions, as is done in other policy areas [16, p. 307].

As part of the carbon footprint framework, it is essential to inform consumers about the climate impact of products or services, with the final aim of inducing more climate-friendly purchasing decisions [16, p. 306]. However, there is no single accepted carbon footprint methodology, which makes advocating for sustainable consumption more challenging. Nonetheless, it is possible to support consumers' purchasing choices through different criteria that could help them acknowledge the environmental performance and sustainability of a product or service. The author identifies the following:

- *Labels:*
  Environmental labels based on objective and transparent criteria awarded by independent third parties could play an important role in identifying sustainable products or services [89]. Third-party ecolabels and declarations have proven to be effective in transforming consumer sustainability attitudes into actual behavior in many cases [16, p. 308]. The EU identifies four type of useful labels:
  i. Multi-criteria labels: These are based on scientific information about the environmental impact of a product or service regarding production and distribution, the use phase, and final disposition [89]. Examples are EU Ecolabel, Nordic Swan, and the Blue Angel [89].
  ii. Single-use labels: These are based on one or more pass/fail criteria linked to a specific issue [89]. Examples are the EU Organic label or Energy Star.
  iii. Sector-specific labels: These are related to specific sectors, for instance, the forestry sector with the FSC or the Programme for the Endorsement of Forest Certification related labels [89].
  iv. Grade product labels: These labels assess products and services' environmental performance using grades rather than pass/fail criteria [89]. An example is the EU Energy Label, which grades energy-related products according to their energy efficiency [89].
- *Life-Cycle costing (LCC):*
  The LCC approach accounts for a purchased product as well as the costs incurred during its use and disposal [89]. This approach could be useful in procurement processes by accounting for costs of used resources, maintenance, and disposal not reflected in the purchase price, and it may include associated GHG emissions[89].
- *Environmental management systems and schemes certifications:*
  Environmental management systems are organization-related tools aimed at improving the overall environmental performance of organizations [89]. In the EU, there are Eco-management and audit schemes (EMAS) and the International Standard on Environmental Systems (EN/ISO 14001) [89].

- *Product Origin:*
  Another example that could support consumers in choosing low-carbon products is the origin location. Low trade emissions are associated with local products. Local consumption could increase and protect the local economy while saving GHG emissions associated with trade (for instance, by reducing transportation of goods) [90]. Local production also makes the impacts of the production and consumption visible, which can help adjust consumers' needs to ecological limits [91].
  Supply proximity products are highly relevant for climate change mitigation within the agricultural sector [92]. The IPCC has noted the need for the decentralization of agricultural production and has advocated for producing more food for local consumption as opposed to exportation [39, p. 31]. These changes will considerably save GHG emissions, especially methane and nitrous oxide [92].
  Municipalities can promote local currencies in their territory, as those currencies directly support local businesses, leading to an increase in local product consumption [93]. Local currencies not only boost local economies but additionally contribute to SD through community-building and through enabling different consumption patterns that reduce environmental impact [93]. France already has over 80 local currencies in circulation (March, 2020) [94].

All the criteria presented could guide local governments in their purchasing decisions, and they could be included in their local public procurement regulations. Public procurement regulations could have an important role in transforming the market [16, p. 718], and they could also contribute to sustainable consumption and other sustainability goals [89, Ch. Introduction]. The EU defined green procurement as a process whereby public authorities seek to produce goods, services, and works with a reduced environmental impact throughout their life-cycle compared to goods, services, and works with the same primary function that would otherwise be procured [89, p. 4]. The EU introduced sustainable public procurement terms that include both environmental and social criteria in purchasing decisions [89, p. 4].

The Paris Agreement is the internationally relevant framework for climate considerations in public procurement procedures [95]. At the EU level, Martinez Romera and Caranta [95] defined the extent of climate change features in EU procurement law [95]. They concluded that, although EU public procurement could still be more stringent with respect to climate considerations, EU procurement law mostly allows and occasionally mandates climate change considerations in public purchasing [95].

For achieving green public procurement, the EU released the "Buying green!" handbook, which explains how to integrate environmental criteria through the procurement process and how to articulate it within the current procurement framework [89]. Within this handbook, the EU provide green public procurement criteria for a number of product and service groups, which are regularly reviewed and updated [89].
Awarded contracts should be followed up with monitoring that ideally includes information about the environmental impact of purchasing decisions made [89, Ch. 1]. As a specific example, the city of Barcelona reviewed and developed, in a highly participatory way, new rules governing the inclusion of sustainability criteria in public contracts, where green requirements are now compulsory for all contract bodies in high-priority procurement categories [89, p. 18].

Beyond the municipal public procurement criteria, local authorities may have an important role in promoting sustainable consumption patterns in the population. Sustainable consumption requires formulating strategies that foster the highest quality of life, the efficient use of natural resources, and

the effective satisfaction of human needs while simultaneously promoting equitable social development, economic competitiveness, and technological innovation [16, p. 307].
Behavior is an underlying driver affecting sustainable consumption in the decomposition of anthropogenic GHG emissions [16, p. 387]. Consumption patterns are shaped not only by economic forces but also by technological, political, cultural, psychological, and environmental factors [16, pp. 387–388].
Despite complexity, it could be possible to induce behavioral changes without modifying pricing, thus facilitating the involvement of the local administration. From an economic perspective, Ayres et al. (2009) estimated that non-price, peer-comparison interventions can induce a consumption response equivalent to a 17%–29% price increase [16, p. 389]. Behavioral interventions can target voluntary behavioral change by focusing on individuals' perceptions, preferences, and abilities, or by changing the context in which decisions are made [16, p. 389].
The definition of sustainable consumption refers to the efficient use of natural resources [16, p. 307]. Therefore, reductions in consumption that do affect quality of life may be an adequate starting point for local authorities seeking to produce behavioral changes in consumption patterns. Sustainable consumption could overcome consumerism, which is defined as a cultural paradigm where "the possession and use of an increasing number and variety of goods and services is the principal aspiration and the surest perceived route to personal happiness, social status, and national success" [16, p. 304]. Assadourian (2010) also argues that increased material wealth above a certain threshold does not contribute to subjective well-being [16, p. 310]. Accordingly, different studies of emotional wellbeing (Kahneman and Deaton 2010, Deaton 2008, and Sacks et al. 2010) found a weak relationship between income and well-being at higher income levels [16, p. 310]. Consequently, local authorities could promote sustainable consumption, reducing citizens consumerist culture insofar as it does not affect their personal wellbeing.

In conjunction with deterring consumerism, local authorities could promote the consumption of goods and services with the lowest carbon footprints. The OECD has proposed some ways for promoting sustainable consumption that are addressed to governments [96]. For example, they recommend increasing awareness among the population through communication campaigns, education, and advertising for sustainable consumption [96]. In addition, labels could help disseminate information of the products' sustainability and encourage consumers to choose the most sustainable options. The OECD argues that standards and mandatory labels are the most direct policy instruments for eliminating unsustainable products from the market [96, p. 9], in addition to the use of subsidies and incentives, and the importance of the public procurement in influencing the market towards sustainability [96]. The OECD affirms that combining different approaches will increase the effectiveness of sustainable consumption campaigns [96, p. 49].

Targeting products with higher climate impacts such as food could be a starting point for pursuing mitigation in the consumption patterns domain.
Globally, food is the consumption category with the greatest climate impact, accounting for 20% of GHG emissions [16, p. 305]. Moreover, food consumption has a high potential for mitigation because it is closely linked with land use, where consumption could influence production and vice versa.
Diet choices are the first challenge to address. In the last IPCC special report on land use, the IPCC confirm that balanced diets, featuring plant-based foods such as those based on coarse grains, legumes, fruits, vegetables, nuts, seeds, and animal-sourced food produced in resilient, sustainable, and low-GHG emission systems, constitute major adaptation and mitigation opportunities while generating significant co-benefits related to human health [39, Ch. B].
Poore and Nemeck (2018), in their study on the GHG emissions associated with 40 major foods,

conclude that moving from current diets to a diet that excludes animal products has transformative potential. Using 2010 as a reference year, such a diet will reduce food's land use by 3.1 billion ha (a 76% reduction), food's GHG emissions by 6.6 billion Mg of CO_2eq (a 49% reduction), acidification by 50%, eutrophication by 49%, and scarcity-weight freshwater withdrawals by 19% [97].
Therefore, diets with no animal products should be promoted to reduce GHG emissions, and they have potential co-benefits in other areas like land use and natural resource conservation.
To increase this diet's mitigation potential, one must also consider how food is produced. Consumers should be encouraged to purchase food produced using sustainable techniques [39, Ch. B]. The EU label for organic farming could be useful for identifying the most sustainable products. As a complement, seasonal and local food should also be considered as a way to reduce consumers' carbon footprints because less energy is used to produce and/or supply these products [39, p. 31], [92]. Based on the governing by enabling model, municipalities could target consumers to promote sustainable food consumption and target producers to facilitate the consumption of locally produced goods, leading to co-benefits like boosting the local economy.

Table 5 presents the author's recommendations related to consumption patterns for municipalities' local CCM activities and links these activities to appropriate SDG targets.

Table 5 – Recommendations for local climate change mitigation (CCM) related to the consumption patterns domain.

Consumption-related Recommendation	SDG Targets
A - Promote the Consumption-Based Accounting Methodology for GHG: The Carbon Footprint	12.6
B - Adopt Green Public Procurement	12.6 & 12.7
C - Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products	12.2 & 12.8
D - Promote a Reduction in Consumerist Behavior	12.2, 12.5, & 12.8
E - Promote Sustainable Consumption	12.2 & 12.8
F - Facilitate Locally Produced Product Consumption	12.2 & 12.8

These recommendations are linked to SDG 12 (Responsible consumption and production). The author acknowledges that reducing consumerist behavior is a means for preventing waste generation. Sustainable Development Goal 8 (Decent work and economic growth) could be linked to the consumption patterns domain, especially target 8.4, which defends decoupling economic growth from environmental degradation. Ward et al. (2016) concludes that growth in gross domestic product (GDP) cannot plausibly be decoupled from growth in material and energy use [98]. Thus, the author of this research wholly excludes SDG 8 in relation to CCM.

4.3.2.5 Waste management

The Collins dictionary defines waste as "material which has been used and is no longer wanted" [99]. The EU defines waste as "an object the holder discards, intends to discard, or is require to discard" [100].

The quantity of municipal waste per capita in the period 1980 and 2005 increased by 29% in North America, 35% in OECD countries, and 54% in the EU15 [16, p. 385]. The total amount of municipal solid waste generated globally has been estimated at about 1.5 Gt per year and is expected to increase to approximately 2.2 Gt by 2025 [16, p. 786]. Of the current amount, 300 Mt are recycled, 200 Mt are treated with energy recovery, 200 Mt are disposed in sanitary landfills, and the remaining 800 Mt are discarded in non-sanitary landfills or dumps [16, p. 786].
In 2010, GHG emissions from waste represented 3% of total GHG emissions from all sources and mainly consisted of solid waste disposal on land and wastewater handling [16, p. 385]. However, emissions related to waste management are not only related to the direct emissions from waste management. The emissions from the production of materials to replace discarded materials should also be considered [16, p. 786].

Accordingly, appropriate waste management has considerable potential in CCM and transitioning toward a circular economy [101], [102].
The IPCC suggests the following as important options for mitigation in waste management: waste prevention and reduction, followed by reuse, recycling, and energy recovery [16, p. 744], in that order.

Waste prevention and reduction is foreseen as part of the circular economy strategy in the EU [103]. The EU guidelines for waste prevention include reducing the quantity of material used in the creation of products and increasing the efficiency with which products, once created, are used [100]. Strategies for zero-waste scenarios could be categorized according to the aim of behavioral change (promotional and informational strategies) or according to enforced limits on waste generation (regulatory strategies) [100]. As part of the process, the EU highlights the importance of avoiding unnecessary consumption and, as a complement, designing and consuming products that generate less waste [100]. Local authorities could approach “unnecessary consumption” as part of their plan for reducing consumerist behavior among the population and link it to the consumption patterns domain [16, p. 310], [96].
In terms of limiting waste generation, it could be useful to identify products that generate less waste from the moment of purchase through a lifecycle assessment (LCA) [100]. Nonetheless, even if a LCA is not possible, products with short lifespans could be targets for regulatory policies, as their use probably increases waste production. An example is single-use plastic products. The annual production of plastic is about 300 million tons (data from 2015), with roughly 50% disposed of after a single-use [104]. Single-use plastics could be targeted by implementing local bans, as is the case in 28% of municipal governments in California [104]. Other approaches could include using communication campaigns to promote local sustainable consumption among stakeholders [100].
As the EU highlights in its new circular economy plan, food is another important target for waste prevention [103]. Currently, 25%–30% of total food produced is lost or wasted [39, p. 26]. From 2010 to 2016, global food loss and waste contributed 8%–10% of all anthropogenic GHG emissions [39, p. 26]. Thus, reducing food loss can lower GHG emissions and contribute to adaptation through reduction in the land area needed for food production [39, p. 26].
As a good local practice example, in Portugal, the cooperative *Fruta Feia* seeks to reduce the waste of tons of good quality food that is thrown back to the land by farmers every year and also to prevent resource waste in food production [105]. Their initiative has already saved 1,834 tons of food [105].

Other important target groups for reducing food waste and specifically included in the new EU circular economy action plan are water and nutrients, electronics and information and communication technologies, batteries and vehicles, packaging, textiles, and construction and buildings [103].

If reducing waste cannot be achieved, reusing products, is the next possibility for reducing waste generation [16, p. 24].

The reparation of goods and the promotion of product exchanges could be included as part of the reusing dimension. The EU Commission, within the context of its circular economy action plan, is working to establish a new "right to repair" and considers new horizontal material rights for consumers, for instance, as regards the availability of spare parts or access to repair [103].
Following the recommendation of governing by enabling [46], local authorities could promote the re-use of goods by increasing people's awareness, organizing events, or developing infrastructure for the development of circular economic activities. For instance, municipalities could support the re-using endeavor by creating repairing offices, second-hand goods markets for citizens and any other activity that leads to a lifetime increase of a product.

Recycling would be the next step after waste prevention and reduction and reusing goods. Globally, only about 20% of municipal solid waste (MSW) is recycled, and about 14% is treated with energy recovery, while the rest is deposited in open dump sites or landfills [16, p. 82]. It is expected to enable remanufacturing and high-quality recycling as part of the EU circular economy action plan [103].

Part of the success of the recycling process relies on the individual's responsibility, as normally individuals are responsible for correctly separating waste. Local authorities could facilitate the recycling process by ensuring access to waste collection points and increasing people's awareness of the importance of the recycling process.

Right before waste disposal, there are different treatments available as part of the reusing dimension. Depending on the nature of the waste, it could be used to increase soil fertility or produce heat and energy [16, p. 789], [106].

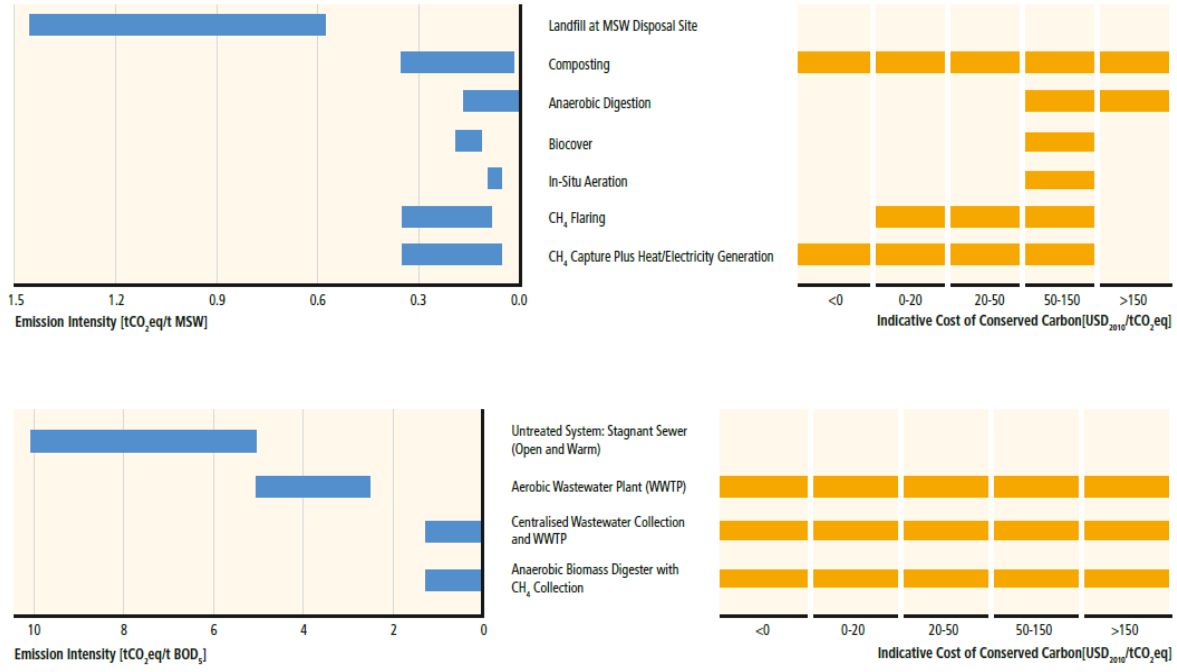

Figure 16 – Indicative CO_2eq emission intensities and levelized costs of conserved carbon of municipal solid waste practices/technologies (upper figure) and wastewater treatments (lower figure) [16, p. 791].

The IPCC studied the costs and possibilities for selected mitigation options with respect to reducing the GHG emissions of the two waste sectors that represent 90% of waste-related emissions: solid waste disposal and domestic wastewater [16, p. 791]. The IPCC observes that the costs and possibilities vary

widely across regions and treatment methodologies [16, p. 791]. Consequently, local authorities could have a crucial role in enabling appropriate waste treatment procedures in local contexts. Nonetheless, regardless of the local context, as shown in Figure 8, solid waste disposal in landfills and non-treatment for wastewater are the options to avoid because of their related emissions intensity [16, p. 791].

The author suggests composting as the preferential option for food and green waste because its provides co-benefits. It not only to reduces landfill GHG emissions but also improves soil properties through compost application [106]. Accordingly, improving soil properties increases soil fertility [107] and thereby avoids desertification and increases soil carbon sequestration [39, p. 20], [108]. Moreover, the assessment of gaseous emissions of the compost production ensures the sustainability of the process [106].
There are multiple techniques for composting, and two important factors are waste heterogeneity and the presence of oxygen (or lack thereof).
The aerobic process requires prior source separation to ensure a correct compost process [16, p. 789]. As an advantage, the aerobic process could be suitable for decentralized and small-scale situations, where the separation responsibility could be given to consumers, and they can create compost themselves. As a local example, the Lisbon municipality launched the Lisboa a Compostar project to promote domestic food waste compost treatment [109]. The project has an important component of citizen awareness raising and capacity building, and encourages people to reduce their waste and also to substitute their synthetic fertilizers with their own compost [109].
Anaerobic composting techniques allow for the inclusion of meat and other substances, but the included elements needs to be digested in closed biochemical reactors [16, p. 789], complicating its application at a small scale. Nonetheless, the methane generated in anaerobic digestion (biogas) could be used in gas engines to produce energy [16, p. 789].
This biogas production (considered as part of bioenergy processes) has important co-benefits. It reduces fossil-fuel dependencies, reduces GHG emissions from waste disposal, produces energy, and can even make use of the residues of the process as crop fertilizer [110].

Table 6 – Recommendations for local climate change mitigation (CCM) related to the waste management domain.

Waste Management-related Recommendations		**SDG Targets**
Waste Prevention and Reduction	A - Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Products with Short Lifespans	12.3 & 12.5
Re-use	B – Enable the “right to repair”, promote the exchange of second-hand goods and increase awareness about re-using	12.5
Recycle	C – Promote Recycling	12.5
Waste Treatments	D.1 - Produce compost, particularly from food or green waste D.2 - Biogas production: Capture methane from waste management or wastewater management D.3 - Reduce landfill waste disposal D.4 - Reduce the amount of untreated wastewater	11.6

Methane could also be recovered through wastewater treatment. As displayed in Figure 8, both centralized wastewater collection and anaerobic biomass digestion with methane capture could be the most interesting options for pursuing local CCM [16, pp. 788–789].

Table 6 presents the author's recommendations related to waste management for municipalities' local CCM activities and links these activities to appropriate SDG targets.

4.3.2.6 Energy

Energy is a significant domain. To explore how to localize CCM action in this sector for municipalities, the author suggests focusing on two main energy areas: the energy production and supply sector and the energy end-use sector and energy efficiency (which includes the building sector).

The energy supply sector comprises all energy extraction, conversion, storage, transmission, and distribution processes with the exception of those that use final energy to provide energy services in end-use sectors [16, p. 516]. The energy supply sector is the largest contributor to global GHG emissions; it was responsible for approximately 35% of total anthropogenic GHG emissions in 2010, and its share was expected to increase [16, p. 516]. In the baseline scenarios assessed by the IPCC, the energy supply sector increased emissions from 14.4 $GtCO_2$/yr in 2010 to between 24 and 33 $GtCO_2$/yr in 2050 [16, p. 516].

The pathway for mitigation suggested by the IPCC as concerns the energy supply is to initiate a deep transformation of the energy system towards decarbonization of electricity generation (decarbonization is the process for reducing carbon and fossil-fuel dependency in energy production) [16, p. 516].

To achieve energy decarbonization, the IPCC states that Renewable Energy (RE) needs to be prioritized as the main energy source and explains that the possible adverse side effects (location and technological) associated with RE can be reduced through appropriate technology selection, operational adjustments, and siting of facilities [16, p. 516]. In this paper, RE is understood as energy derived from natural, unlimited, and replenishable sources [111]. The IPCC admits that nuclear energy could play an important role in contributing to a low-carbon energy supply, but it is not recommended due to the associated risk (operational risks, safety concerns, uranium mining risks, financial and regulatory risks, unresolved waste management issues, nuclear weapon proliferation, and adverse public opinion) [16, p. 517]. This research does not consider nuclear energy as renewable because of its adverse side effects. This research recognizes bioenergy, direct solar energy, geothermal energy, hydropower, ocean energy, and wind energy as RE sources [16, p. 525]. The IPCC also notes the importance of bioenergy combined with carbon dioxide capture and storage systems, which play an important role in low-stabilization scenarios. Nonetheless, the production and use of biomass for bioenergy has context-specific impacts on land use, including adverse side effects and risks regarding land degradation and food insecurity [39, p. 22]. Hydropower is included as a source of RE. Nevertheless, lifecycle emissions from fossil fuel combustion and cement production related to the construction and operation of hydropower stations falls in a range of up 40 gCO_2eq /kWh [16, p. 540], far higher than other renewable technologies' lifecycle emissions [16, p. 541].

Despite the different approaches for mitigation, it is important to avoid any energy production based on fossil fuels (carbon-based fuels from fossil hydrocarbon deposits, including coal, peat, oil, and natural gas) [16, p. 1262]. The current fossil-fuel reserves contain sufficient carbon to yield radioactive forcing above that required to limit the global mean temperature increase to less than 2ºC [16, p. 525]. The IPCC also highlights the importance of analyzing site- and context-specific factors, such as the use of resources or public perceptions, to ensure RE projects are viable for CCM [16, p. 569].

In addition, approximately 25% of all losses in Europe and 40% of distribution losses are due to distribution transformers, and roughly a further 25% of losses are due to distribution systems'

conductors and cables [16, p. 528]. More distributed generation systems can reduce these losses since generation typically takes place closer to loads than with central generation, and thus electricity does not have to travel as far [16, p. 528].
An integral solution for SD is energy supply decentralization. Alanne and Saari describe "distributed energy systems" as sustainable because they are cost-efficient, reliable, and environmentally friendly [112]. Khetrapal (2020) reviewed the potential technical, economic, and environmental benefits of distributed energy generation [113]. Regarding the environmental benefits, the author highlights the reduction of fossil-fuel consumption and the resulting reduction in GHG emissions [113]. In addition, Khetrapal (2020) further notes the significance of optimally selecting, sizing, and positioning distributed generation systems since an inappropriate location can negatively impact system performance (increased losses and degraded voltage profile) [113]. The appropriate and diverse use of local resources is presented as an important benefit from energy supply decentralization [112].
Municipalities should support distributed models of energy production because they have multiple co-benefits when adapted to local contexts. Energy decentralization could be addressed differently depending on its technical and social dimensions [114].

Decentralization also implies improving citizen participation in designing and operating power systems, whether individually or collectively [114]. Consumers could even become prosumers (both energy consumers and producers), providing flexibility to the energy market [114]. People's increased participation promotes a bottom-up approach that opens the possibility for consumers to participate in the development of renewables [114].
To promote decentralized energy production and to standardize the meaning of self-energy producers, this research uses the EU definition of renewable energy communities (REC). According to Directive (EU) 2018/2001, a REC is a legal entity

(a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity;

(b) the shareholders or members of which are natural persons, SMEs, or local authorities, including municipalities;

(c) the primary purpose of which is to provide environmental, economic, or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits.

Renewable energy communities are entitled to produce, consume, store, and sell RE, including through renewables power purchase agreements, to share RE within the community, and to access all suitable markets [115], [116]. Energy communities can be instrumental for facilitating the energy transition at the citizen and local levels [117]. As was exposed with the governance dimension, (re)municipalization of the energy sector (for instance, the energy distribution grid) may support the energy transition by facilitating energy decentralization [66, Ch. 8]. As a municipal example, the Barcelona municipality has become an REC in 2019 through their public energy supplier Barcelona Energía [118].

Regarding end-use energy, different sectors are contributing to GHG emissions: transport contributes 27%, building 32%, and industry 28% (all data are direct emissions accounted for in 2010) [16, Ch. SPM]. This section only focusses on the end-use energy of the building sector, which includes residential, commercial, public, and service sectors [16, p. 22]. Most of the GHG emissions in the building sector are indirect CO_2 emissions from electricity used in buildings, and the OECD countries contribute the most GHG in this sector, with moderate GHG growth between 1970 and 2010 [16, p. 678].

To achieve mitigation in this sector at the local level, the last IPCC report suggested two different dimensions to focus on that are related to energy efficiency and human lifestyles, cultures, and behavior

[16, p. 23]. In terms of energy efficiency, the IPCC cites existing knowledge, advanced technologies, and policies for stabilizing emissions related to this sector as opportunities [16, p. 23]. As examples, the IPCC highlights the advances achieved through the adoption of very low energy codes for new buildings and from reducing heating and cooling energy use. Along with building codes, appliance standards (if well designed and implemented) have been among the most environmentally and cost-effective instruments for reducing emissions [16, p. 23].
Regarding the social aspect, awareness raising that encourages people to reduce their energy use could be essential. In Europe, scenarios indicate that behavioral changes could reduce energy demand by up to 20% in the short term [16, p. 23]. European municipalities already have the EU commission's guidelines for increasing energy efficiency in buildings, and these could be supported by engaging local stakeholders to pursue the same goal. Reducing energy consumption is the final aim of increasing energy efficiency; nonetheless, reducing energy consumption could also be fomented directly in the municipal territory from out the energy efficiency umbrella.

Table 7 presents the author's recommendations related to energy for municipalities' local CCM activities and links these activities to appropriate SDG targets.

Table 7 – Recommendations for local climate change mitigation (CCM) related to the energy domain.

Energy-related Recommendations		**SDG Targets**
Energy Production and Supply	A - Promote Appropriate Renewable Energy (RE) Production	7.2
	B – Decentralize Energy Production (Both Social and Technological Aspects)	
	C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	
Energy Efficiency and End Use	D - Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure	7.3
	E - Facilitate Citizen and Private Sector Involvement to Increase Energy Efficiency	
	F - Encourage Energy Consumption Reduction	

4.3.2.7 Transportation and mobility

The global transport sector accounted for 27% of final energy use (6.7 $GtCO_2$) in 2010, with OECD countries being the highest contributors in this sector [16, p. 21]. The emissions of this sector are expected to increase significantly, up to between 9.3 and 12 $GtCO_2$/yr by 2050 based on the IPCC scenarios [16, p. 72].

Turning to the details, Figure 9 presents the total emissions from 1970 to 2010. One can observe how transportation emissions have increased through time, with road transportation being the highest transportation contributor to global GHG emissions [16, p. 606]. It is with road transportation where local authorities can mitigate climate change, as mobility is one the local authorities' competences, especially as concerns light-duty vehicles (LDVs)**.** Light-duty vehicles includes passenger cars and commercial vans below 2.5–3.0 tons in net weight [16, p. 605]. Their number is expected to double in the next few decades from the current number of 1 billion vehicles globally [16, p. 611]. Thus, there is a high potential

for mitigation through shifting into different modes of low-carbon transportation or to non-motorized transportation (NMT), combined with an increase in LDVs' engine performance [16, pp. 603, 620]. Nowadays, exchanging conventional LDVs for electric vehicles will only save an insignificant amount of CO_2eq where electricity systems rely on high-carbon intensity (500–600 gCO_2eq/kWh), and the mitigation costs can be hundreds of dollars per ton [16, p. 624]. In addition, the material needed to proceed with transport decarbonization through new technologies may create adverse effects on local environments because of unsustainable mining of resources to supply low-carbon transport technologies [16, p. 632]. Mitigation pathways at the local level prioritize reducing the number of LDVs instead of completely replacing the current fleet for low-carbon LDVs. This measure can also be supported by other means of transportation (NMT, collective transportation, or other already existent low-carbon modes of transportation).

Within this context, the concept of "sustainable transport" arises as a priority for CCM. It defends the accessibility of all in helping meet the basic daily mobility needs consistent with human and ecosystem health, but to constrain GHG emissions by [16, p. 609].

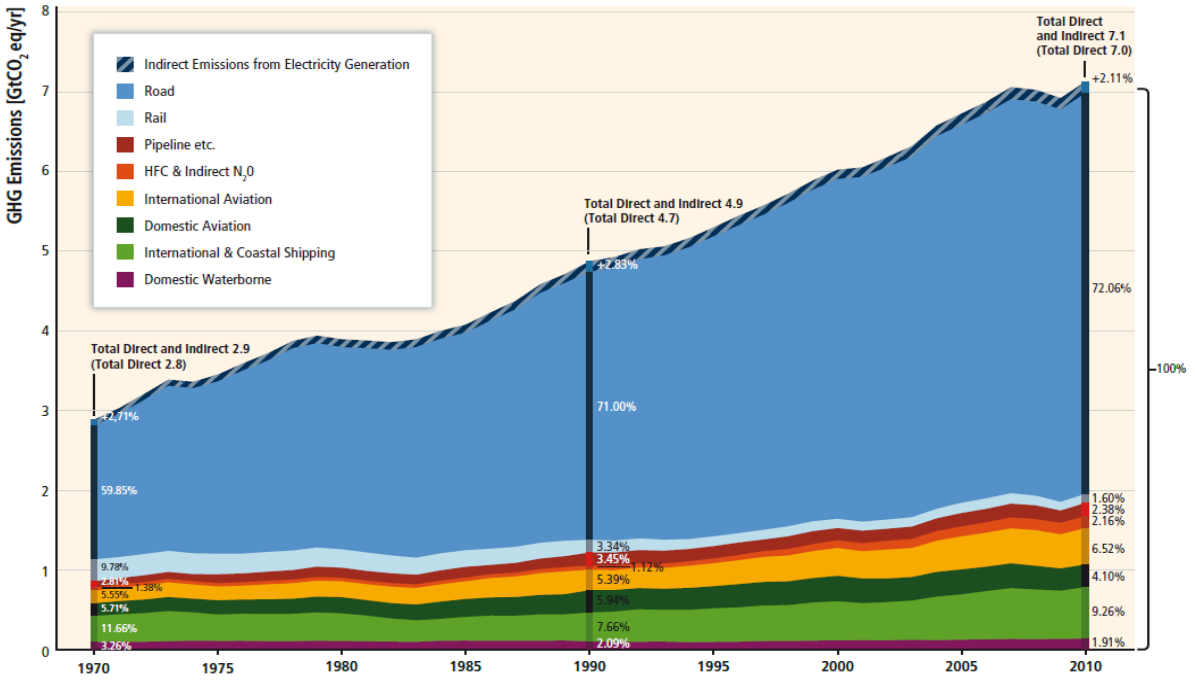

Figure 17 – Direct GHG emissions of the transportation sector (shown here by transport mode) rose 250%, from 2.8 Gt CO_2eq worldwide in 1970 to 7.0 Gt CO_2eq in 2010 [16, p. 606].

The IPCC reports clearly reaffirm the mitigation potential within this sector through different areas of actualization: changes in the built environment (urban and community redevelopment to increase accessibility), behavioral changes (avoiding long journeys where possible and shifting to lower-carbon transport systems and NMTs), investments in related infrastructure (public transportation, walking and cycling infrastructure, etc.), less energy-intensive modes of transportation (by enhancing vehicle and engine performance), and reductions in carbon-intensive fuels (biofuels, electricity or hydrogen produced from low GHG sources, etc.) [16, p. 603].
Changes in the built environment could be linked to the spatial planning domain, where the urban form and infrastructure could play important roles in reducing vehicle-kilometers travelled (VKT) [16, pp. 951, 958].

All these mitigation pathways could be integrated by municipalities in a sustainable urban mobility plan (SUMP), where local authorities could provide appropriate measures regarding their local context. The

Urban Mobility Observatory, which is under the European Commission's general directorate for mobility and transport, has created useful guidelines for developing and implementing a SUMP [119]. They reaffirm the following eight principles for correctly developing such a plan: (1) plan for sustainable mobility in the "functional urban area," (2) cooperate across institutional boundaries, (3) involve citizens and stakeholders, (4) assess current and future performances, (5) define a long-term vision and a clear implementation plan, (6) develop all transport modes in an integrated manner, (7) arrange for monitoring and evaluation, and (8) assure quality [120].

An example of a municipality that has appropriately designed, planned, and implemented sustainable mobility is the municipality of Pontevedra, Spain. Pontevedra was awarded with several international prizes regarding sustainable mobility and urban planning, such as the Smart Mobility Award (Hong-Kong 2015) and the first EU urban road safety award (2019) [121]. Among the measures that they have implemented, the following can be highlighted: speed limits up to 30km/h in all urban areas, the installation of 300 speedhumps, and the prioritization of pedestrians over LDVs, with spaces free from motorized transportation (except for those needed for residential or commercial activities) [122]. As a result, in 2014, Pontevedra has reduced its fossil-fuel consumption by 66% compared to 1999 levels [123]. There is a varied range of policies that could address sustainable transportation at the local level. Municipalities should play their role by contextualizing appropriate policies and measures according to their own local reality.

Following the model of governing by provisioning [46], providing reliable and efficient low-carbon collective transportation services is important for fostering sustainable transportation [16, Ch. 8]. Aside from municipal responsibilities, the (re)municipalization of transportation services could be the key to inducing the change needed for moving towards sustainable transportation systems due to their better alignment with local urban development policies, which could encourage the use of public transportation or non-polluting transport over LDVs [66, p. 31].

Table 8 – Recommendations for local climate change mitigation (CCM) related to the transportation and mobility domain.

Transportation- and Mobility-related Recommendations	**SDG Target**
A - Implement Local Policies for Sustainable Transportation	11.2
B - (Re)municipalization of Transportation Services	
C - Reduce Automobile Dependency, Especially Dependency on Light-Duty Vehicles	
D - Promote the Reduction of Fossil-Fuel Dependency in Transportation	
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne, and Low-Carbon Buses)	
F - Promote and Increase Accessibility and Safety for Non-Motorized Transportation (For Example, Cycling or Walking)	
G - Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	

By following the concept of "sustainable transport," this research suggests the following actions to be taken by local authorities to promote CCM: induce mobility behavioral changes through communication campaigns, promote alternative low-carbon or NMT transportation for long and short distances, prioritize collective transportation over individual transportation, and reduce the need for conventional LDVs.

Table 8 presents the author's recommendations related to transportation and mobility for municipalities' local CCM activities and links these activities to an appropriate SDG target.

4.3.2.8 Spatial planning

In 2006, urban areas accounted for between 71% and 76% of CO_2 emissions from global final energy use and between 67%–76% of global energy use [16, p. 927]. Urban form and infrastructure significantly affect direct (operational) and indirect (embodied) GHG emissions and are strongly linked to the throughput of material and energy in cities, the waste they generate, and their related system efficiencies [16, p. 927]. Mitigation options vary by urban type and development levels [16, p. 927]. The options available to rapidly developing cities include shaping their urbanization and infrastructure development trajectories [16, p. 928]. The main goal of pursuing CCM for this dimension for municipalities is to shape urban form and integrate and improve urban infrastructure by developing it toward low-carbon pathways [16, p. 928]. Thus, the author structures the local CCM approach according to three main areas: urban form, infrastructure, and the spatial planning process.

Urban form and structure are the patterns and spatial arrangements of land use, transportation systems, and urban design elements, including the physical urban extent, the layout of streets and buildings, and the internal configuration of settlements [16, p. 949].
Regarding urban form, the IPCC cites the importance of four key interrelated drivers to consider in reducing GHG emissions: urban density, land-use mix, connectivity, and accessibility [16, p. 952].

- Density: Density is the measure of an urban unit of interest (e.g., population, employment, and housing) per area unit [16, p. 952]. Density affects GHG emissions in two different ways. Low density of employment, commerce, and housing increases the average travel distances for both work and shopping trips (and thus increases VKT) [16, p. 952]. Low density of employment, commerce, and housing also brings more difficulties in switching to less energy-intensive and alternative modes of transportation [16, p. 952]. To achieve mitigation with respect to density, the IPCC suggests prioritizing medium-rise buildings (less than seven floors) over single-unit and high-rise buildings [16, p. 955]. They state that medium-rise buildings can increase urban density without the increased need of materials and embodied energy of high-rise buildings [16, p. 955].
- Land-Use Mix: Land-use mix refers to the diversity and integration of land uses at a given scale [16, p. 955]. Diverse and mixed land uses can reduce travel distances and enable both walking and the use of NMT, thereby reducing aggregate amounts of vehicular and associated GHG emissions [16, p. 955]. For service-economy cities with effective air pollution control, mixed land use can also benefit citizen health and wellbeing by promoting walking via more walkable distances [16, p. 955]. Increasing mixed land use would facilitate reductions in GHG emissions.
- Connectivity: Connectivity refers to street density and design [16, p. 956]. High urban connectivity is characterized by finer-grain systems, with smaller blocks that allow frequent changes in direction [16, p. 956]. When connectivity is high, there is typically a positive correlation with walking and thereby lower GHG emissions [16, p. 956].
- Accessibility: Accessibility can be defined as access to jobs, housing, services, shopping, and, in general, to people and places in cities [16, p. 956]. It can be viewed as a combination of proximity and travel time and is closely related to land-use mix [16, p. 956]. Highly accessible communities

are typically characterized by low commuting distances and travel times, which are enabled by multiple modes of transportation [16, p. 956]. Metanalyses show that VKT reduction is most strongly related to high accessibility to job destinations [16, p. 956].

These four dimensions should be approached simultaneously to be most effective in reducing annual VKT [16, p. 957].

Infrastructure affects GHG emissions primarily during three phases of its lifecycle: construction, use and operation, and end-of-life [16, p. 951]. Analyzing all emissions for each phase associated with new infrastructure, including transboundary emissions, is important for shaping its sustainability and resilience [16, p. 951]. Related energy should be accounted for from the use and operation phase and the end-of-life phase, including that from reuse, recycling, and primary and embodied energy from building materials used [16, p. 951]. For example, the manufacturing of steel and cement, two of the common infrastructure materials, contributed nearly 9% and 7% to global carbon emissions in 2006, respectively [16, p. 951]. Thus, at the planning stage when choices of materials are made, a forward-looking life-cycle assessment can help reduce undesired lock-in effects with respect to the construction and operation of large physical infrastructure [16, p. 391]. The placement of infrastructure could also modulate the GHG emissions associated with its use and operation phase. Infrastructure is linked to urban form, especially among transportation infrastructure, travel demand, and VKT [16, p. 951]. Municipalities should consider reducing direct and indirect GHG emissions related to municipal infrastructure and give special consideration to potential lock-in effects. Consequently and in accordance with SDG 9 (which focuses on developing quality, reliable, sustainable, and resilient infrastructure) [35], information about infrastructure-related GHG emissions could facilitate a better acknowledgement of its costs and benefits for CCM and its long term sustainability.

Spatial planning is a broad term that describes systematic and coordinated efforts to manage urban and regional growth in ways that promote well-defined societal objectives such as land conservation, economic development, carbon sequestration, and social justice [16, p. 958]. The framework for infrastructure and urban form could be the base for facilitating a CCM perspective in the municipal spatial planning process. There is no single recipe for approaching spatial planning from a CCM perspective. Nonetheless, based on case studies, the IPCC highlights the success and effectiveness of strategies that combine a spatial planning process with climate action. Doing so harmonizes and integrates each scale plan (regional, district, and neighborhood) and requires institutional capacity and political wherewithal to align the right policy instrument to specific strategies [16, p. 958].
Each municipality should choose a context-specific combination of policy instruments to accomplish CCM within the spatial planning dimension.

Green infrastructure (GI) plays an important role for CCM in the spatial planning process. The EU green infrastructure strategy defines GI as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services [124]. Green infrastructure can refer to rural, peri-urban, or urban settings covering terrestrial, coastal, and marine areas [124]. One of the key aims of the GI EU strategy is to foster the potential co-benefits of GI, namely CCM and climate-change adaptation, reduced energy use, disaster risk management, food provision, biodiversity conservation, health and wellbeing, recreation, increased land and property values, competitiveness and economic growth, and enhanced territorial cohesion [124]. Green infrastructure is linked closely with E/NBS, as both could potentially increase ecosystem services, leading to more carbon sinks and reduced GHG emissions. Recommendations for municipalities on that field comes through the integration of the ecosystem service approach (by GI, nature-based solutions, or both) into urban planning processes, maximizing the ecosystems' provision, adopting methods for

mapping, assessing, and measuring ecosystem services, promoting payments for ecosystem services, and calculations the (economic) cost of their use [124].
For bringing out co-benefits, GI can be seen as a connected network of green and blue spaces, either in the city or countryside, that are linked to the concept of ecological connectivity [124].
Funded by the European Commission, the EKLIPSE project has developed an evidence- and knowledge-based report that analyzes the different benefits and challenges of applying E/NBS; defined as "an impact evaluation framework to support planning and evaluation of nature-based solutions projects" [125]. They highlight the importance of NBS in increasing green spaces, which not only increase carbon storage and sequestration in vegetation and soil but also improve the local or regional micro-climate through cooling, shading, and shelter [125, p. 19,20]. The European Commission has provided a preliminary list of possible NBS interventions for urban areas, depending on the pursued goal (e.g., protect and increase urban green spaces, plant green roofs and walls, use phytoremediation and phytostabilization, encourage the planting of appropriate plants and caterpillar food plants, etc.) [126, pp. 40–51].
The process of integrating GI and/or NBS are site specific, adjusting different related designs and plans to each local context, where municipalities plays an important role. As a practical example, the city of Vienna has had an ongoing large-scale green infrastructure strategy for more than two decades [125]. It contributes to numerous national strategies (e.g., Biodiversity Strategy Austria, Netzwerk Natur, Natura 2000), is embedded in urban plans (e.g., the Urban Heat Island Strategy Plan, City Development Plan 2025), and covers existing, recovered, and new NBS such as small- to large-scale parks, trees, rivers and streams, green bridges, green roofs, green walls, and large-scale nature protection areas (e.g., Naturschutzgebiet Donauauen) [125].

Table 9 presents the author's recommendations related to spatial planning for municipalities' local CCM activities and links these activities to appropriate SDG targets.

Table 9 – Recommendations for local CCM related to the spatial planning domain.

Spatial Planning-related Recommendations		**SDG Targets**
Spatial Planning Processes	A.1- Enable the local administration in integrating climate change mitigation perspectives into municipal spatial planning processes	11.3
	A.2 - Integrate nature/ecosystem-based solutions into the spatial planning process A.3 - Implement adequate spatial planning policies and instruments to support low-carbon fluxes in the municipality	11.3 & 11.7
Urban Form	B.1 - Increase density B.2 - Increase land-use mix B.3 - Increase connectivity B.4 - Increase accessibility	11.3
Infrastructure	C - Prioritize Sustainable and Resilient Infrastructures while Minimizing Lifecycle GHG Emissions	9.1 & 9.4

The spatial planning process and urban form can be linked to SDG 11 and targets 11.3 and 11.7. Doing so, the author acknowledges local administrations' capacities for pursuing sustainable urbanization and therefore low-carbon-flux urbanization. The author also acknowledges that appropriate spatial planning policies and the NBS approach would lead to increased access to green public spaces, leading to sustainable urbanization.
The infrastructure recommendation is linked to SDG 9 and targets 9.1 and 9.4. The author also acknowledges that pursuing a reduction of related GHG emissions in municipal infrastructure is a way to enable their sustainability.

5 Chapter B: Monitoring Municipal Climate Change Mitigation Actions

5.1 Introduction

As previously introduced (Section 1.5, the importance of monitor CCM), different authors and organizations highlight the importance and the need to improve CCM monitoring at local levels [16, p. 974], [36, Ch. 2], [38], [46], [47, Ch. 6], [52, p. 59], [53], [127, p. 18]. The UN argues that local and regional governments should define and adapt their own set of monitoring indicators in recognition of the diversity of territories [40, p. 39]. In addition, regarding CCM, the Covenant of Mayors also allocates the responsibility of using appropriate indicators to municipalities for each local measure [52, p. 56]. Unfortunately, the Covenant of Mayors delegated the task of identifying appropriate indicators to municipalities with a deficit in giving specific examples [52]. This lack of examples could increase the risk that municipalities fail to monitor their local climate actions. This chapter aims to facilitate the local CCM monitoring process for European municipalities by offering a list of created, compiled and adapted science-based indicators. To align with the UN's promotion of bottom-up approaches for effectively pursuing SD [40] and CCM, appropriate municipal staff would give their feedback from the list of the indicators proposed regarding their adequacy for the municipal context. Involving the local administration in the process of choosing appropriate indicators for measuring their CCM progress could reduce the risk of non-acceptance and lead to increased municipal accountability.

5.2 Methodology

Relying on participatory-action research [128] and inductive reasoning [129, p. 57], the author designed and structured the methodology of this chapter in three different phases: compiling, adapting, and suggesting ideal indicators for local CCM, collecting data via the municipalities' participatory validation of the indicators, and suggesting an approach for data interpretation.

5.2.1 Indicators: Compilation, adaptation, and suggestions

In order to track the progress of each local CCM recommendation from Chapter A, the author compiled, adapted, and/or suggested a set of ideal indicators to link at least one indicator per recommendation. Following the same principle for the literature review in Chapter A, the author used the snowball technique for reviewing related articles, reports, texts, and other related grey literature in setting the indicators [57, p. 56]. The author mainly compiled and adapted indicators from international agencies and related reports, namely the City Resilience Profiling Program, *the Climate Change Enhancer* (UN Habitat, 2018) [49], the *Tier Classification for Global SDG Indicators* (IAEG-SDGs, 2018) [48], *Climate Change Mitigation* (IPCC, 2014) [16], and other EU reports. In addition, in order to analyze the local perspective, the author consulted a list of indicators from the Portuguese National Institute [130] and CESOP [131] and the indicators used by the Portuguese municipalities of Loulé [132] and Cascais

[53]. Connecting the global and local perspectives, the author also analyzed the benchmarking used in the BEACON project to track European municipal-level CCM progress.

Following a similar approach to the one used by the authors from CESOP, when the analyzed bibliography did not offer an appropriate indicator for the recommendations proposed, a new indicator was created based on the results of the literature research from Chapter A. The author identifies created indicators using the source "University of Lisbon". All the indicators suggested were designed following the aspects defined by Schomaker (1997) and by the Covenant of Mayors guidelines [52, p. 52]. To the furthest extent possible, the indicators are specific, measurable, achievable, relevant/realistic, and time bound (i.e., "SMART").

The author suggested a total of 143 indicators divided among the eight domains for local CCM action identified in Chapter A: Governance (18 indicators proposed), Education & Communication (7 indicators proposed), Land Use (24 indicators proposed), Consumption Patterns (15 indicators proposed), Waste Management (14 indicators proposed), Energy (22 indicators proposed), Transportation & Mobility (26 indicators proposed), Spatial Planning (17 indicators proposed). The complete list of indicators can be found in Annex 4.

5.2.2 Data collection and analysis

This section introduces the means of data collection, the participating municipalities, and data analysis process.

5.2.2.1 Survey description

In order to verify the suitability of the list of indicators prepared for the municipal context, the author collected data using online surveys addressed to the participant municipalities. The author built a total of eight surveys, one per each CCM domain identified in Chapter A, using the SmartSurvey platform [133] and following the instructions of the working paper *"A construção de um questionario"* [134].

Table 10 – Questions proposed and associated with each indicator in the eight surveys.

Question	Multiple-Choice Options	Justification (Optional)
Q1 (Mandatory) - Based on your experience, do you find the indicator adequate for the local administration/municipality?	Likert Scale: 1 - No, I Strongly Disagree 2 - No, I Disagree 3 - Yes, I Agree 4 - Yes, I Strongly Agree	If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree," please, feel free to share with us why and/or propose an alternative
Q2 (Optional) - Is this indicator (or a similar one) used for monitoring purposes in your municipality?	Yes/No answer: A) No, neither this nor similar B) Yes, the same or similar indicator	If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using

The eight surveys follow the same structure. They present an introductory text that explains how to answer the survey. Participant information is then collected, and the recommendations proposed for the survey's domain are presented and access to the Roadmap Publication is included. With the aim of increasing municipalities' participation, the author used only two multiple-choice questions per

indicator, one mandatory (Q1) and one optional (Q2), and only one answer per question could be selected. The author decided to not include the neutral option in the questions in order to better analyze the tendency of the answers. In addition, both questions have a blank space for participants to justify negative answers for Q1 and to justify positive answers for Q2. Table 10 displays the questions and their characteristics. Annex 5 displays a complete example questionnaire. The surveys were conducted mainly in English with the translation available in Czech, German, Greek, Polish, and Romanian.

5.2.2.2 Target public, participating municipalities

The author shared the surveys among the 35 EU municipalities participating in the BEACON project, which integrates municipalities from Czech Republic, Greece, Germany, Poland, Portugal, and Romania. Focusing on municipalities involved in a project such as BEACON, which enhances municipal capacity and supports local CCM, may enable more accurate answers regarding the suitability of the indicators. All the municipalities are listed in Annex 2.

5.2.2.3 Data analysis

Data collected from both questions are qualitative, offering discrete variables to analyze. The first question provides ordinal data, and the second question provides nominal data. Following the most common framework for analyzing qualitative data, the author uses inductive reasoning where a theory or expectations to begin research were not required [129, p. 57].

In order to better analyze the qualitative results, the author proceed with quantitizing the data obtained through the surveys. Quantitizing refers to the process of assigning numerical (nominal or ordinal) values to non-numerical data [135]. In other words, quantitizing is the numerical translation, transformation, or conversion of qualitative data [135]. Quantitizing is a common procedure for accommodating the analysis of segments of text in written transcripts or field notes produced from interviews or participant observations [135] and is thus perfectly suitable for this research.

The author analyzed the personal data of the participants and the data obtained through the indicator questions (Q1 and Q2). Following the same approach as Holey et al. (2007) [136], the author used simple statistics to analyze the data, using the Microsoft Office Excel tool.

- *Participant's personal data analysis*

Personal data from participants was gathered from "The Basics" section of the survey. The instructions given for answering the surveys note the importance of being the appropriate municipal responsible for the domain when answering the correspondent survey (for example, municipal staff from the energy department would be best suited to answer the survey related to energy indicators). Thus, the analysis of the participants' personal data was analyzed for each survey with the aim of acknowledging the quality of the respondents. The author analyzed the following two mandatory inputs: years of experience working in the local administration and the area where the participant works for at the municipality (for example, climate action department, energy department, mobility department, etc.).

Regarding the years of experience, the author calculated the arithmetic average and standard deviation of all the survey participants. This information helps reveal how broad the participants' knowledge is regarding the context and practical reality of a municipality.

In terms of the participants' areas of expertise, the author calculated the percentage of participants that recognized being a part of the same working area as the survey's domain. Participants' area of expertise could reveal the accuracy of their answers.
As each municipality has their own internal structure, belonging to the general climate action area of

expertise is possible. The author also calculated the percentage of survey participants belonging to a climate action department and the percentage of those who belonged to both climate action and the survey's domain area.

- *Question 1 data analysis*

Question 1 is the only mandatory question in the survey's indicator section. Thus, Q1 is the focus of the analyses regarding the suitability of the indicators for the municipal context. The author used simple statistics to analyze the answers, including the arithmetic mean ($\overline{X}$), absolute frequency (n), and relative frequency (f), population standard deviation (σ), and the coefficient of variation (cv) [136].

Question 1 offers four Likert-scale answers. In quantitizing these answers, the author associated numbers to each answer, from 1 for the most negative answer (No, I strongly disagree) to 4, for the most positive answer (Yes, I strongly agree). The author avoided using 0 in the questionnaire to avoid conditioning participants in their answers [135].

The author used the optional justification of negative answers to Q1 in order to orient the discussion.

- *Question 2 data analysis*

Question 2 is an optional yes/no question used to collect data about the usage of the proposed indicator or similar indicators.
No number was given directly in the survey, but in order to facilitate analysis of the data, the author translated answers into a binary matrix, denoting negative answers as 0 and positive answers as 1. Then, the author calculated the percentage of municipalities that recognized using this indicator or a similar one for municipal monitoring.

The optional justification text associated with this question was used to orient the discussion of the data interpretation.

5.2.3 Data interpretation

With the aim to interpret the qualitative data for Q1, the author followed an approach that is similar to multi-criteria decision analysis [137] by suggesting guiding values for the resulting data from Q1 in order to classify the indicators.

Table 11 – Contributions of each answer option to the positive or negative category related to Question 1 (Q1).

Q1	Answers Options	Absolute Frequency	Weight (W)	Final Contribution
Negative	1 - No, I **strongly** disagree	n_1	$W_1 = n_1 \times 2$	$W_1 + W_2$
	2 - No, I disagree	n_2	$W_2 = n_2$	
Positive	3 - Yes, I agree	n_3	$W_3 = n_3$	$W_3 + W_4$
	4 - Yes, I **strongly** agree	n_4	$W_4 = n_4 \times 2$	

The author divided the types of answers into negative ("1 – No, I strongly disagree" and "2 – No, I disagree) and positive ("3 – Yes, I agree" and "4 – Yes, I strongly agree"). The absolute frequency (n)

of the answers is the base to associate value to the negative and the positive category. Participants that chose Answers 2 or 3 contributed in a proportion 1:1 to the corresponding negative or positive category. Answers with the word "strongly" embedded (Answers 1 and 4), contributed double to the corresponding categories. Table 11 presents the distribution of the weights and the final contribution to the negative and positive categories.

In order to classify each indicator, the author used the relative positive contribution (RPC) as the main reference:

$$\text{Relative Positive Contribution (RPC)} = \frac{\sum(Positive\ Contributions)}{\sum(Total\ Contributions)}\ x\ 100.$$

The resulting RPC reveals the level of agreement of the municipalities participating with respect to the suitability of the indicators. The RPC therefore allows for the categorization of the indicators. These categories are "highly recommended indicator (municipal consensus)," "recommended indicator (high agreement)," "recommended indicator only in specific situations (medium agreement)," "recommended indicator after incurring significant adaptation (low agreement)," and "not a recommended indicator (no agreement)." Table 12 displays the values attributed to each grade of acceptance.

Table 12 – Classification of the ideal indicators proposed by the level of municipal agreement.

Grade of acceptance (RPC)	Category
100%	**Municipal Consensus!** Highly recommended indicator
99,99% - 90,00%	**High Agreement:** Recommended indicator
89,99 – 75,00%	**Medium Agreement**: Recommended indicator in specific situations
74,99% - 50,00%	**Low Agreement:** Recommended indicator only after significant adaptation to the municipal context
49,99% - 0,00%	**No agreement:** Not a recommended indicator

If an indicator is recommended, this means that municipalities participating in the surveys have agreed that the indicator is adequate for monitoring CCM at the municipal level. The set of indicators provided in the surveys are a compilation from the ideal indicators suggested by specialized organizations to monitor CCM. The answers from municipalities are validating those ideal indicators, bringing the more practical side of the suitability of the indicators selected.

5.3 Results

The participation of municipalities in the surveys differed depending on the domain, varying from a minimum of 11 municipalities (regarding the land-use domain) up to 15 (for the governance and energy domains). Municipalities from Czech Republic, Greece, Portugal, and Romania participated in all surveys. Municipalities from Poland and Germany have contributed to only some surveys (see Tables 13, 15, 17, 19, 21, 23, 25, and 27).

Regarding the participants' years of experience in local administration, a minimum of 10 years of experience on average was found for all the domains. The highest mean level of experience was found for the waste management domain (14,38 ± 7,44 years), and the lowest was found for the governance domain (10.73 ± 8.51 years; see Tables 13, 15, 17, 19, 21, 23, 25, and 27).
In terms of the participants' areas of expertise, in most surveys, the percentage of participants that worked in a department related to the survey domain (same area as domain, climate action area, or both) was greater than those who did not (see Figures 10 through 17). There was one exception, the land-use domain, where none of the participants acknowledged being experts in the land use sector alone (see Figure 12).

5.3.1 Governance indicators

From the 18 proposed indicators for monitoring municipal CCM actions related to the governance domain, participants considered six indicators as adequate for local administration by consensus, five as adequate with high agreement, and the other seven indicators as adequate with medium agreement. The answers with a coefficient of variation equal to or greater than 20% included only indicators G5, G9, and G15. All the proposed indicators are used (the same or similar indicator) in at least one of the municipalities participating in the survey, with indicators G2, G12, G13 being used in over half the municipalities. The results regarding the quality of the participants are displayed in Table 13 and Figure 10. The results regarding the quality of the indicators are in Table 14. The complete list of indicators can be consulted in Annex 4, and the comments from participants can be found in Annex 6.

Table 13 – Municipalities participating in the governance indicators survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation)

Municipalities Participating	
Czech Republic	Milevsko, Přeštice, Prachatice, Rožnov pod Radhoštěm
Germany	Pirna
Greece	Dorida, Syros-Hermoupolis
Poland	Sztum, Zamość
Portugal	Braga, Coruche, Loulé, Setúbal
Romania	Râmnicu Vâlcea, Deva
Total	15
Years of Experience (mean and standard deviation)	10,73 ± 8,51

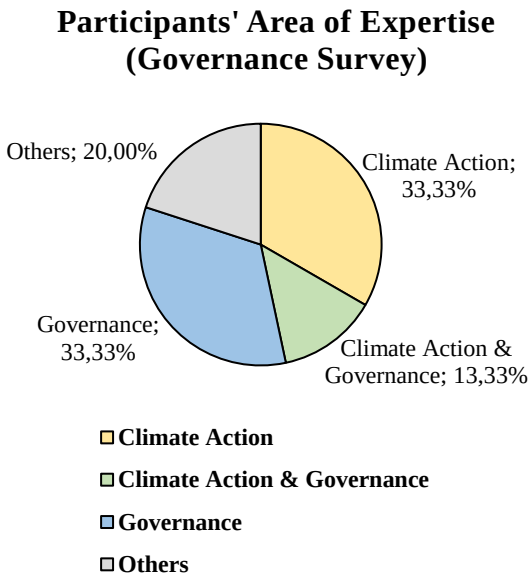

Figure 18 – Area of expertise in the local administration from participants of the governance indicator survey.

Table 14 –– Results from the Governance indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC) and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
G1	A	3,27 ± 0,57	17,56%	0	1	9	5	0,00%	6,67%	60,00%	33,33%	95,00%	33%
G2	B	3,4 ± 0,49	14,41%	0	0	9	6	0,00%	0,00%	60,00%	40,00%	100,00%	40%
G3	B	3,13 ± 0,62	19,73%	0	2	9	4	0,00%	13,33%	60,00%	26,67%	89,47%	27%
G4	B	3,13 ± 0,34	10,85%	0	0	13	2	0,00%	0,00%	86,67%	13,33%	100,00%	13%
G5	C	3,07 ± 0,68	22,17%	0	3	8	4	0,00%	20,00%	53,33%	26,67%	84,21%	27%
G6	C	2,93 ± 0,44	15,08%	0	2	12	1	0,00%	13,33%	80,00%	6,67%	87,50%	7%
G7	D	3 ± 0,52	17,21%	0	2	11	2	0,00%	13,33%	73,33%	13,33%	88,24%	13%
G8	E	3,13 ± 0,62	19,73%	0	2	9	4	0,00%	13,33%	60,00%	26,67%	89,47%	27%
G9	E	3,2 ± 0,75	23,39%	0	3	6	6	0,00%	20,00%	40,00%	40,00%	85,71%	40%
G10	E	3 ± 0,37	12,17%	0	1	13	1	0,00%	6,67%	86,67%	6,67%	93,75%	7%
G11	E	3,07 ± 0,57	18,70%	0	2	10	3	0,00%	13,33%	66,67%	20,00%	88,89%	20%
G12	E	3,53 ± 0,5	14,12%	0	0	7	8	0,00%	0,00%	46,67%	53,33%	100,00%	53%
G13	F	3,53 ± 0,5	14,12%	0	0	7	8	0,00%	0,00%	46,67%	53,33%	100,00%	53%
G14	F	3,13 ± 0,5	15,92%	0	1	11	3	0,00%	6,67%	73,33%	20,00%	94,44%	20%
G15	F	3,2 ± 0,65	20,41%	0	2	8	5	0,00%	13,33%	53,33%	33,33%	90,00%	33%
G16	G	3,2 ± 0,4	12,50%	0	0	12	3	0,00%	0,00%	80,00%	20,00%	100,00%	20%
G17	G	3,33 ± 0,47	14,14%	0	0	10	5	0,00%	0,00%	66,67%	33,33%	100,00%	33%
G18	G	3,2 ± 0,54	16,93%	0	1	10	4	0,00%	6,67%	66,67%	26,67%	94,74%	27%

5.3.2 Education and communication indicators

From the seven proposed indicators for monitoring municipal CCM actions related to the education and communication domain, participants considered three indicators as adequate for local administration by consensus, two as adequate with high agreement, and the two remaining indicators as adequate with medium agreement. The answers with a coefficient of variation equal to or greater than 20% included only indicators EC3 and EC5. Despite the variation in the answers regarding indicator EC3, this indicator, together with indicators EC2 and EC7, are used in one-third of the municipalities participating in the survey. The results regarding the quality of the participants are displayed in Table 15 and Figure 11.

The results regarding the quality of the indicators are in Table 16. The complete list of indicators is found in Annex 4, and the comments from participants, in Annex 6.

Table 15 – Municipalities participating in the education and communication indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating		
Czech Republic	Přeštice, Prachatice	
Greece	Dorida, Syros-Hermoupolis	
Poland	Sztum	
Portugal	Braga, Coruche, Loulé, Setúbal	
Romania	Râmnicu Vâlcea, Deva	
Total		12
Years of Experience (mean and standard deviation)		11,64 ± 8,45

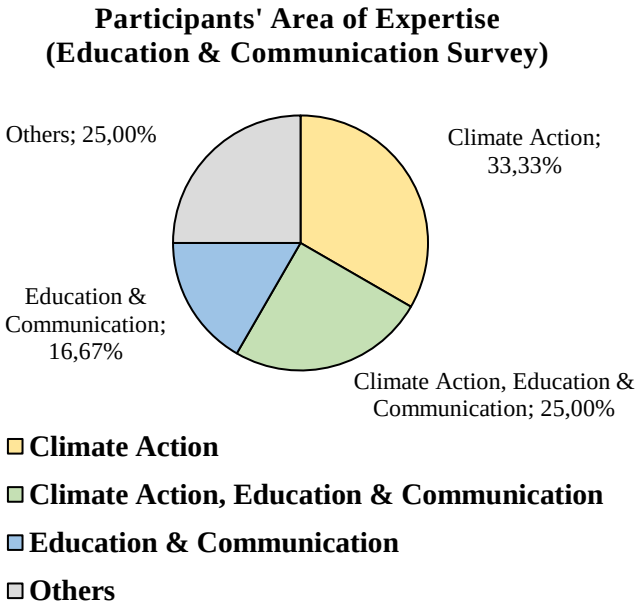

Figure 19 – Area of expertise in the local administration from participants of the Education and Communication indicators' survey.

Table 16 – Results from the education and communication indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC) and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
EC1	A.1	3,17 ± 0,37	11,77%	0	0	10	2	0,00%	0,00%	83,33%	16,67%	100,00%	16,67%
EC2	A.1	3,33 ± 0,47	14,14%	0	0	8	4	0,00%	0,00%	66,67%	33,33%	100,00%	41,67%
EC3	A.2	3,08 ± 0,64	20,76%	0	2	7	3	0,00%	16,67%	58,33%	25,00%	86,67%	33,33%
EC4	B.1	3,17 ± 0,37	11,77%	0	0	10	2	0,00%	0,00%	83,33%	16,67%	100,00%	25,00%
EC5	B.1	3,08 ± 0,86	27,96%	1	1	6	4	8,33%	8,33%	50,00%	33,33%	82,35%	25,00%
EC6	B.2	3,25 ± 0,6	18,31%	0	1	7	4	0,00%	8,33%	58,33%	33,33%	93,75%	16,67%
EC7	B.3	3,08 ± 0,49	15,99%	0	1	9	2	0,00%	8,33%	75,00%	16,67%	92,86%	33,33%

5.3.3 Land-use indicators

From the 24 proposed indicators for monitoring municipal CCM actions related to the land-use domain, participants considered seven indicators as adequate for local administration by consensus, five as adequate with high agreement, nine as adequate with medium agreement, and two as adequate with low agreement. The answers with a coefficient of variation equal to or greater than 20% included seven indicators (L5, L7, L9, L10, L11, L12, and L13). Indicator L13, which is related to the municipal indigenous plantations, showed the highest variability and thus the lowest level of agreement. Indicators L6, L9, L20, and L23 (or similar) were not integrated in participant municipalities, but indicator L23 should potentially be included as part of municipal monitoring systems because it was accepted by consensus. The results regarding the quality of the participants are displayed in Table 17 and Figure 12. The results regarding the quality of the indicators is shown in Table 18. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 17 – Municipalities participating in the land use indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating		
Czech Republic	Milevsko, Přeštice, Prachatice	
Germany	Pirna	
Greece	Dorida, Syros-Hermoupolis	
Portugal	Braga, Coruche, Loulé, Setúbal	
Romania	Râmnicu Vâlcea, Deva	
Total		11
Years of Experience (mean and standard deviation)		11,58 ± 8,24

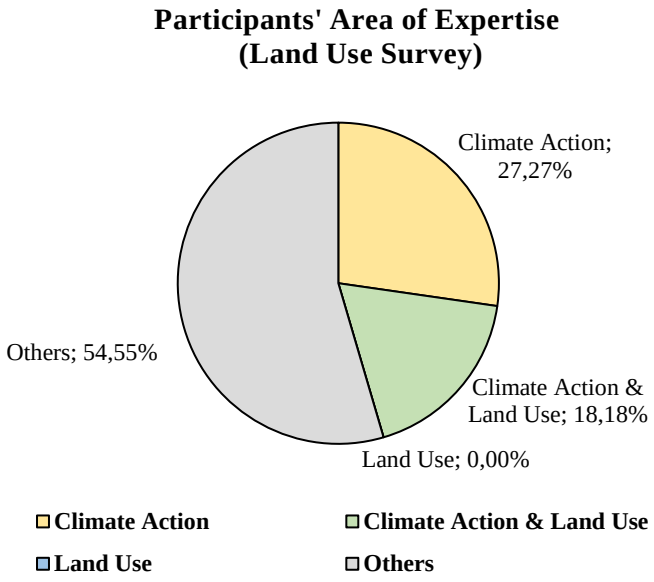

Figure 20 – Area of expertise in the local administration from participants of the land use indicator survey

Table 18 – Results from the land use indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC), and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
L1	A	3,18 ± 0,39	12,12%	0	0	9	2	0,00%	0,00%	81,82%	18,18%	100,00%	27%
L2	B.1	2,91 ± 0,29	9,88%	0	1	10	0	0,00%	9,09%	90,91%	0,00%	90,91%	9%
L3	B.1	2,82 ± 0,39	13,69%	0	2	9	0	0,00%	18,18%	81,82%	0,00%	81,82%	9%
L4	B.1	2,82 ± 0,39	13,69%	0	2	9	0	0,00%	18,18%	81,82%	0,00%	81,82%	9%
L5	B.1	3 ± 0,6	20,10%	0	2	7	2	0,00%	18,18%	63,64%	18,18%	84,62%	9%
L6	B.1	2,91 ± 0,51	17,68%	0	2	8	1	0,00%	18,18%	72,73%	9,09%	83,33%	0%
L7	B.2	3 ± 0,6	20,10%	0	2	7	2	0,00%	18,18%	63,64%	18,18%	84,62%	18%
L8	B.2	3,27 ± 0,45	13,61%	0	0	8	3	0,00%	0,00%	72,73%	27,27%	100,00%	27%
L9	B.3	3,09 ± 0,79	25,64%	1	0	7	3	9,09%	0,00%	63,64%	27,27%	86,67%	0%
L10	B.3	3,18 ± 0,83	26,19%	1	0	6	4	9,09%	0,00%	54,55%	36,36%	87,50%	9%
L11	B.3	2,82 ± 0,72	25,40%	1	1	8	1	9,09%	9,09%	72,73%	9,09%	76,92%	18%
L12	C.1	2,91 ± 0,79	27,24%	1	1	7	2	9,09%	9,09%	63,64%	18,18%	78,57%	27%
L13	C.1	2,73 ± 0,86	31,62%	1	3	5	2	9,09%	27,27%	45,45%	18,18%	64,29%	9%
L14	C.1	3,18 ± 0,39	12,12%	0	0	9	2	0,00%	0,00%	81,82%	18,18%	100,00%	18%
L15	C.1	3,18 ± 0,39	12,12%	0	0	9	2	0,00%	0,00%	81,82%	18,18%	100,00%	27%
L16	C.2	3 ± 0,43	14,21%	0	1	9	1	0,00%	9,09%	81,82%	9,09%	91,67%	9%
L17	C.3	2,91 ± 0,51	17,68%	0	2	8	1	0,00%	18,18%	72,73%	9,09%	83,33%	18%
L18	C.4	3,18 ± 0,39	12,12%	0	0	9	2	0,00%	0,00%	81,82%	18,18%	100,00%	36%
L19	D	3,36 ± 0,48	14,30%	0	0	7	4	0,00%	0,00%	63,64%	36,36%	100,00%	18%
L20	D	2,73 ± 0,45	16,33%	0	3	8	0	0,00%	27,27%	72,73%	0,00%	72,73%	0%
L21	E	3,36 ± 0,64	19,11%	0	1	5	5	0,00%	9,09%	45,45%	45,45%	93,75%	27%
L22	E	3,18 ± 0,57	18,07%	0	1	7	3	0,00%	9,09%	63,64%	27,27%	92,86%	27%
L23	E	3,27 ± 0,45	13,61%	0	0	8	3	0,00%	0,00%	72,73%	27,27%	100,00%	0%
L24	E	3,09 ± 0,51	16,64%	0	1	8	2	0,00%	9,09%	72,73%	18,18%	92,31%	18%

5.3.4 Consumption patterns indicators

From the 15 proposed indicators for monitoring municipal CCM actions related to the consumption patterns domain, participants considered four indicators adequate for local administration by consensus (those related to A and B recommendations: carbon footprint methodology and green public procurement), three as adequate with high agreement, three as adequate with low agreement, and the five remaining as adequate with medium agreement. The answers with a coefficient of variation equal to or greater than 20% included all indicators with low agreement and indicators C6, C7, and C14, indicators related to the consumption of local and seasonal products. Indicators C4, C3, C11, and C15 (or similar) are not yet used by participating municipalities despite their high level of agreement or consensus. The results regarding the quality of the participants are displayed in Table 19 and Figure 13. The results regarding the quality of the indicators are in Table 20. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 19 – Municipalities participating in the consumption patterns indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating	
Czech Republic	Přeštice, Prachatice
Germany	Pirna
Greece	Dorida, Syros-Hermoupolis
Poland	Sztum
Portugal	Braga, Coruche, Loulé, Setúbal
Romania	Râmnicu Vâlcea, Deva
Total	12
Years of Experience (mean and standard deviation)	10,75 ± 8,29

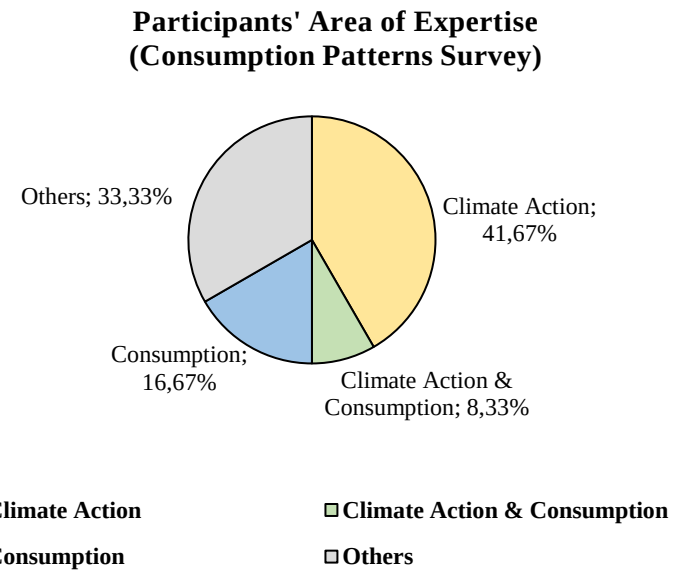

Figure 21 – Area of expertise in the local administration from participants of the consumption patterns indicator survey.

Table 20 – Results from the consumption patterns indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC), and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
C1	A	3,08 ± 0,28	8,96%	0	0	11	1	0,00%	0,00%	91,67%	8,33%	100,00%	42%
C2	B	3,42 ± 0,49	14,43%	0	0	7	5	0,00%	0,00%	58,33%	41,67%	100,00%	8%
C3	B	3,33 ± 0,47	14,14%	0	0	8	4	0,00%	0,00%	66,67%	33,33%	100,00%	0%
C4	B	3,25 ± 0,43	13,32%	0	0	9	3	0,00%	0,00%	75,00%	25,00%	100,00%	0%
C5	C	2,67 ± 0,75	27,95%	1	3	7	1	8,33%	25,00%	58,33%	8,33%	64,29%	8%
C6	C	3,08 ± 0,64	20,76%	0	2	7	3	0,00%	16,67%	58,33%	25,00%	86,67%	8%
C7	C	3 ± 0,71	23,57%	0	3	6	3	0,00%	25,00%	50,00%	25,00%	80,00%	8%
C8	C	2,83 ± 0,8	28,21%	1	2	7	2	8,33%	16,67%	58,33%	16,67%	73,33%	0%
C9	D	3,17 ± 0,55	17,46%	0	1	8	3	0,00%	8,33%	66,67%	25,00%	93,33%	8%
C10	D	3 ± 0,58	19,25%	0	2	8	2	0,00%	16,67%	66,67%	16,67%	85,71%	25%
C11	E	3 ± 0,41	13,61%	0	1	10	1	0,00%	8,33%	83,33%	8,33%	92,31%	0%
C12	E	2,58 ± 0,86	33,37%	2	2	7	1	16,67%	16,67%	58,33%	8,33%	60,00%	0%
C13	E	3 ± 0,58	19,25%	0	2	8	2	0,00%	16,67%	66,67%	16,67%	85,71%	17%
C14	F	3,17 ± 0,69	21,70%	0	2	6	4	0,00%	16,67%	50,00%	33,33%	87,50%	17%
C15	F	3 ± 0,41	13,61%	0	1	10	1	0,00%	8,33%	83,33%	8,33%	92,31%	0%

5.3.5 Waste management indicators

From the 14 proposed indicators for monitoring municipal CCM actions related to the waste management domain, participants considered two indicators as adequate for local administration by consensus (these concerned recycling and wastewater treatment), four as adequate with low agreement, and the remaining as adequate with medium agreement. The answers with a coefficient of variation equal to or greater than 20% included all indicators except those accepted by consensus. Despite the variability of the answers, the only indicators (or similar) that are yet not used by participant municipalities are W5 and W6, which are both related to recommendation B. The results regarding the quality of the participants are displayed in Table 21 and Figure 14. The results regarding the quality of the indicators are in Table 22. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 21 – Municipalities participating in the waste management indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating	
Czech Republic	Milevsko, Přeštice, Prachatice
Greece	Dorida, Kalamata, Syros-Hermoupolis,
Poland	Sztum
Portugal	Braga, Coruche, Loulé, Setúbal
Romania	Râmnicu Vâlcea, Deva
Total	13
Years of Experience (mean and standard deviation)	14,38 ± 7,44

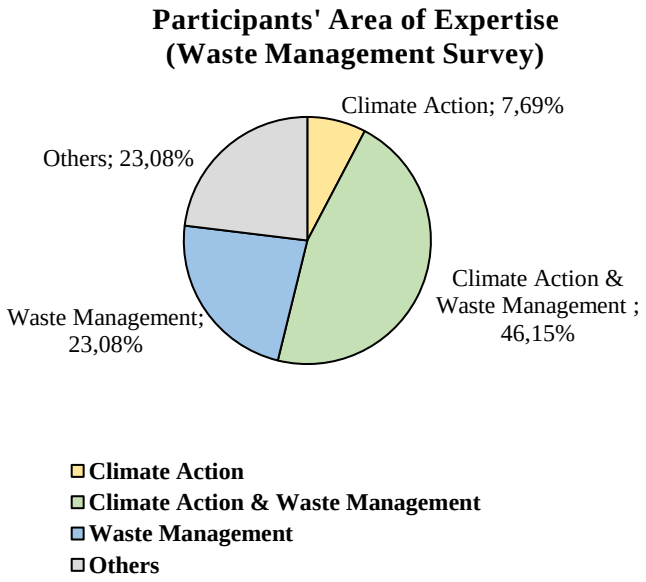

Figure 22 – Area of expertise in the local administration from participants of the waste management indicator survey.

Table 22 – Results from the waste management indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC), and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
W1	A	3 ± 0,96	32,03%	1	3	4	5	7,69%	23,08%	30,77%	38,46%	73,68%	15%
W2	A	3 ± 0,88	29,24%	1	2	6	4	7,69%	15,38%	46,15%	30,77%	77,78%	8%
W3	A	3 ± 0,88	29,24%	1	2	6	4	7,69%	15,38%	46,15%	30,77%	77,78%	31%
W4	B	2,85 ± 0,86	30,34%	1	3	6	3	7,69%	23,08%	46,15%	23,08%	70,59%	8%
W5	B	2,85 ± 0,77	27,03%	0	5	5	3	0,00%	38,46%	38,46%	23,08%	68,75%	0%
W6	B	3,08 ± 0,62	20,00%	0	2	8	3	0,00%	15,38%	61,54%	23,08%	87,50%	0%
W7	C	3,54 ± 0,5	14,09%	0	0	6	7	0,00%	0,00%	46,15%	53,85%	100,00%	69%
W8	C	3,23 ± 0,8	24,74%	1	0	7	5	7,69%	0,00%	53,85%	38,46%	89,47%	54%
W9	D.1	3,08 ± 0,62	20,00%	0	2	8	3	0,00%	15,38%	61,54%	23,08%	87,50%	46%
W10	D.1	3,08 ± 0,62	20,00%	0	2	8	3	0,00%	15,38%	61,54%	23,08%	87,50%	38%
W11	D.1	3 ± 0,68	22,65%	0	3	7	3	0,00%	23,08%	53,85%	23,08%	81,25%	23%
W12	D.2	2,92 ± 0,92	31,36%	1	3	5	4	7,69%	23,08%	38,46%	30,77%	72,22%	8%
W13	D.3	3,08 ± 0,92	29,79%	1	2	5	5	7,69%	15,38%	38,46%	38,46%	78,95%	46%
W14	D.4	3,38 ± 0,49	14,37%	0	0	8	5	0,00%	0,00%	61,54%	38,46%	100,00%	62%

5.3.6 Energy indicators

From the 22 proposed indicators for monitoring municipal CCM actions related to the energy domain, participants considered only three indicators as adequate for local administration by consensus, seven as adequate with high agreement, and 11 as adequate with medium agreement. Only indicator E9 regarding municipal ownership and management of the energy distribution grid showed a low level of agreement. Answers related to three indicators accepted with high agreement had a coefficient of variation equal to or greater than 20% (E1, E11, and E17). All indicators proposed (or similar) are used by at least one of the participant municipalities. The results regarding the quality of the participants are displayed in Table 23 and Figure 15. The results regarding the quality of the indicators are in Table 24. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 23 – Municipalities participating in the energy indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating		
Czech Republic	Milevsko, Písek, Přeštice, Prachatice	
Germany	Pirna	
Greece	Dorida, Kalamata, Syros-Hermoupolis	
Poland	Sztum	
Portugal	Braga, Coruche, Loulé, Setúbal	
Romania	Râmnicu Vâlcea, Deva	
Total		15
Years of Experience (mean and standard deviation)		12,13 ± 10,8

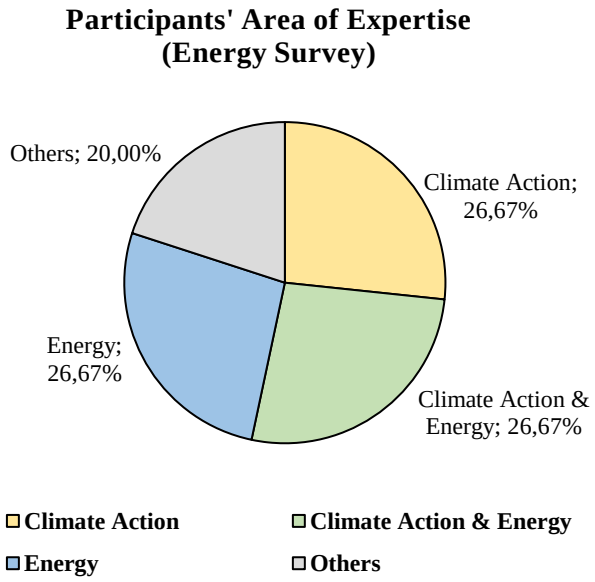

Figure 23 – Area of expertise in the local administration from participants of the energy indicator survey.

Table 24 – Results from the energy indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC), and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
E1	A	3,27 ± 0,68	20,81%	0	2	7	6	0,00%	13,33%	46,67%	40,00%	90,48%	20%
E2	A	3,13 ± 0,72	22,92%	0	3	7	5	0,00%	20,00%	46,67%	33,33%	85,00%	13%
E3	B	3,07 ± 0,68	22,17%	0	3	8	4	0,00%	20,00%	53,33%	26,67%	84,21%	20%
E4	B	3 ± 0,63	21,08%	0	3	9	3	0,00%	20,00%	60,00%	20,00%	83,33%	7%
E5	C	2,93 ± 0,68	23,18%	0	4	8	3	0,00%	26,67%	53,33%	20,00%	77,78%	13%
E6	C	2,8 ± 0,54	19,34%	0	4	10	1	0,00%	26,67%	66,67%	6,67%	75,00%	7%
E7	C	3 ± 0,52	17,21%	0	2	11	2	0,00%	13,33%	73,33%	13,33%	88,24%	13%
E8	C	2,93 ± 0,44	15,08%	0	2	12	1	0,00%	13,33%	80,00%	6,67%	87,50%	7%
E9	C	2,6 ± 0,61	23,50%	1	4	10	0	6,67%	26,67%	66,67%	0,00%	62,50%	27%
E10	C	2,87 ± 0,5	17,40%	0	3	11	1	0,00%	20,00%	73,33%	6,67%	81,25%	13%
E11	C	3,2 ± 0,65	20,41%	0	2	8	5	0,00%	13,33%	53,33%	33,33%	90,00%	33%
E12	D	3,2 ± 0,4	12,50%	0	0	12	3	0,00%	0,00%	80,00%	20,00%	100,00%	33%
E13	D	3,27 ± 0,57	17,56%	0	1	9	5	0,00%	6,67%	60,00%	33,33%	95,00%	47%
E14	D	3,2 ± 0,75	23,39%	0	3	6	6	0,00%	20,00%	40,00%	40,00%	85,71%	27%
E15	E	3 ± 0,52	17,21%	0	2	11	2	0,00%	13,33%	73,33%	13,33%	88,24%	27%
E16	E	3,07 ± 0,57	18,70%	0	2	10	3	0,00%	13,33%	66,67%	20,00%	88,89%	20%
E17	F	3,27 ± 0,68	20,81%	0	2	7	6	0,00%	13,33%	46,67%	40,00%	90,48%	53%
E18	F	3,33 ± 0,6	17,89%	0	1	8	6	0,00%	6,67%	53,33%	40,00%	95,24%	27%
E19	F	3,2 ± 0,54	16,93%	0	1	10	4	0,00%	6,67%	66,67%	26,67%	94,74%	33%
E20	F	3,27 ± 0,57	17,56%	0	1	9	5	0,00%	6,67%	60,00%	33,33%	95,00%	20%
E21	F	3,2 ± 0,4	12,50%	0	0	12	3	0,00%	0,00%	80,00%	20,00%	100,00%	13%
E22	F	3,13 ± 0,34	10,85%	0	0	13	2	0,00%	0,00%	86,67%	13,33%	100,00%	13%

5.3.7 Transportation and mobility indicators

From the 26 proposed indicators for monitoring municipal CCM actions related to the transportation and mobility domain, participants considered three indicators as adequate for local administration by consensus, five indicators as adequate with high agreement, 13 as adequate with medium agreement, and five as adequate with low agreement. Indicator T15 has the same number of municipalities who agree with its suitability as participants who do not. Regarding the indicators with a medium level of agreement, answers related to T1, T2, T6, T7, T8, T11, T12, T14, and T19 present a coefficient of variation equal to or greater than 20%. Only four indicators (or similar) are not used by the participating municipalities (T13, T14, T18, and T23). The results regarding the quality of the participants are displayed in Table 25 and Figure 16. The results regarding the quality of the indicators are in Table 26. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 25 – Municipalities participating in the transportation and mobility indicator survey, displayed by country, including the over-all years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating		
Czech Republic	Milevsko, Přeštice, Prachatice	
Germany	Bielefeld, Pirna	
Greece	Dorida, Kalamata, Syros-Hermoupolis	
Portugal	Braga, Coruche, Loulé, Setúbal	
Romania	Râmnicu Vâlcea, Deva	
Total		14
Years of Experience (mean and standard deviation)		12,14 ± 9,83

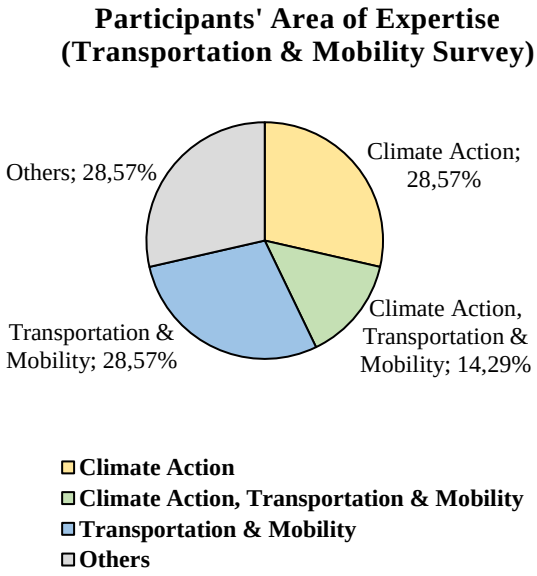

Figure 24 – Area of expertise in the local administration from participants of the transportation and mobility indicator survey.

Table 26 – Results from the transportation and mobility indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1), namely mean ($\bar{X}$), population standard deviation (σ), absolute (n), and relative (f) frequency for each answer's option, the relative positive contributions (RPC), and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
T1	A	3,29 ± 0,8	24,21%	0	3	4	7	0,00%	21,43%	28,57%	50,00%	85,71%	43%
T2	A	3,14 ± 0,64	20,33%	0	2	8	4	0,00%	14,29%	57,14%	28,57%	88,89%	21%
T3	A	3,21 ± 0,56	17,36%	0	1	9	4	0,00%	7,14%	64,29%	28,57%	94,44%	14%
T4	B	2,71 ± 0,88	32,44%	1	5	5	3	7,14%	35,71%	35,71%	21,43%	61,11%	21%
T5	C	3,07 ± 0,59	19,32%	0	2	9	3	0,00%	14,29%	64,29%	21,43%	88,24%	29%
T6	D	3 ± 0,65	21,82%	0	3	8	3	0,00%	21,43%	57,14%	21,43%	82,35%	14%
T7	D	2,86 ± 0,64	22,36%	0	4	8	2	0,00%	28,57%	57,14%	14,29%	75,00%	14%
T8	D	2,93 ± 0,7	24,02%	0	4	7	3	0,00%	28,57%	50,00%	21,43%	76,47%	29%
T9	D	3,29 ± 0,59	17,93%	0	1	8	5	0,00%	7,14%	57,14%	35,71%	94,74%	29%
T10	E	3,07 ± 0,59	19,32%	0	2	9	3	0,00%	14,29%	64,29%	21,43%	88,24%	7%
T11	E	3,14 ± 0,64	20,33%	0	2	8	4	0,00%	14,29%	57,14%	28,57%	88,89%	29%
T12	E	3,07 ± 0,7	22,90%	0	3	7	4	0,00%	21,43%	50,00%	28,57%	83,33%	21%
T13	E	3,07 ± 0,59	19,32%	0	2	9	3	0,00%	14,29%	64,29%	21,43%	88,24%	0%
T14	E	2,86 ± 0,64	22,36%	0	4	8	2	0,00%	28,57%	57,14%	14,29%	75,00%	0%
T15	E	2,57 ± 0,82	31,91%	1	6	5	2	7,14%	42,86%	35,71%	14,29%	52,94%	21%
T16	F	3,07 ± 0,46	14,89%	0	1	11	2	0,00%	7,14%	78,57%	14,29%	93,75%	21%
T17	F	3,07 ± 0,59	19,32%	0	2	9	3	0,00%	14,29%	64,29%	21,43%	88,24%	21%
T18	F	2,64 ± 0,72	27,16%	1	4	8	1	7,14%	28,57%	57,14%	7,14%	62,50%	0%
T19	F	3,14 ± 0,64	20,33%	0	2	8	4	0,00%	14,29%	57,14%	28,57%	88,89%	36%
T20	F	3,29 ± 0,59	17,93%	0	1	8	5	0,00%	7,14%	57,14%	35,71%	94,74%	43%
T21	F	3,36 ± 0,48	14,27%	0	0	9	5	0,00%	0,00%	64,29%	35,71%	100,00%	29%
T22	F	3,29 ± 0,59	17,93%	0	1	8	5	0,00%	7,14%	57,14%	35,71%	94,74%	21%
T23	G	2,86 ± 0,74	25,98%	0	5	6	3	0,00%	35,71%	42,86%	21,43%	70,59%	0%
T24	G	3,36 ± 0,48	14,27%	0	0	9	5	0,00%	0,00%	64,29%	35,71%	100,00%	14%
T25	G	3,43 ± 0,49	14,43%	0	0	8	6	0,00%	0,00%	57,14%	42,86%	100,00%	29%
T26	G	2,64 ± 0,81	30,70%	1	5	6	2	7,14%	35,71%	42,86%	14,29%	58,82%	7%

5.3.8 Spatial planning indicators

From the 17 proposed indicators for monitoring municipal CCM actions related to the spatial planning domain, participants considered five indicators as adequate for local administration by consensus, three as adequate with medium agreement (SP5, SP11, and SP17), and the remaining as adequate with high agreement. The answers with a coefficient of variation equal to or greater than 20% included only indicators SP5 and SP17. The only indicators (or similar) that are not yet used by participant municipalities are SP11, SP13, and SP16. The results regarding the quality of the participants are displayed in Table 27 and Figure 17. The results regarding the quality of the indicators are in Table 28. The complete list of indicators can be consulted in Annex 4, and the comments from participants, in Annex 6.

Table 27 – Municipalities participating in the spatial planning indicator survey, displayed by country, including the overall years of experience of the participants in the local administration (mean and statistical standard deviation).

Municipalities Participating	
Czech Republic	Milevsko, Přeštice, Prachatice
Germany	Pirna
Greece	Dorida, Syros-Hermoupolis
Poland	Sztum
Portugal	Braga, Coruche, Loulé, Setúbal
Romania	Râmnicu Vâlcea, Deva
Total	13
Years of Experience (mean and standard deviation)	10,92 ± 7,82

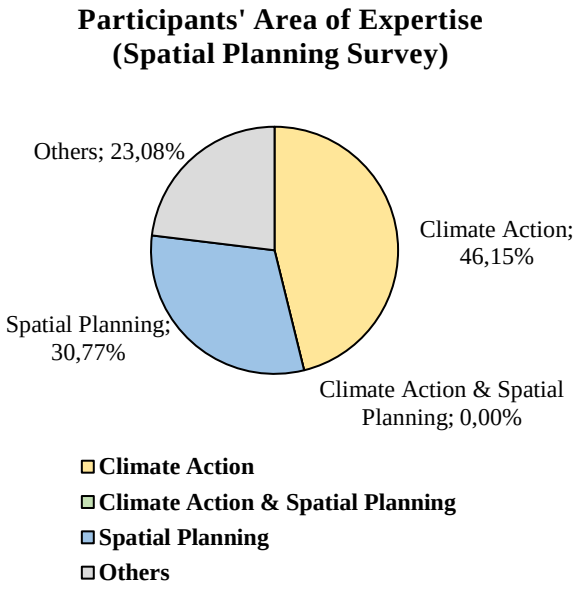

Figure 25 – Area of expertise in the local administration from participants of the spatial planning indicator survey.

*Table 28 – Results from the spatial planning indicator survey. The table includes the indicators and their associated recommendations (RECO), the analysis from Question 1 (Q1) namely mean ($\bar{X}$), population standard deviation (σ), absolute (n) and relative (*f*) frequency for each answer's option, the relative positive contributions (RPC) and the analysis of Question 2 (Q2) expressed by the percentage of participants using the same or similar indicator. Colors illustrate the classification of the indicator in accordance with Table 12.*

Indicator	RECO	Q1 Answers										Grade of Acceptance	Q2 Answers
		$\bar{X} \pm \sigma$	cv	n_1	n_2	n_3	n_4	f_1	f_2	f_3	f_4	RPC	Using this or similar indicator
SP1	A.1	3,31 ± 0,46	13,95%	0	0	9	4	0,00%	0,00%	69,23%	30,77%	100,00%	8%
SP2	A.2	3,23 ± 0,58	17,82%	0	1	8	4	0,00%	7,69%	61,54%	30,77%	94,12%	8%
SP3	A.2	3,54 ± 0,5	14,09%	0	0	6	7	0,00%	0,00%	46,15%	53,85%	100,00%	54%
SP4	A.3	3,08 ± 0,47	15,41%	0	1	10	2	0,00%	7,69%	76,92%	15,38%	93,33%	8%
SP5	B.1	3 ± 0,68	22,65%	0	3	7	3	0,00%	23,08%	53,85%	23,08%	81,25%	46%
SP6	B.1	3,08 ± 0,27	8,66%	0	0	12	1	0,00%	0,00%	92,31%	7,69%	100,00%	23%
SP7	B.1	3 ± 0,39	13,07%	0	1	11	1	0,00%	7,69%	84,62%	7,69%	92,86%	23%
SP8	B.2	2,92 ± 0,27	9,12%	0	1	12	0	0,00%	7,69%	92,31%	0,00%	92,31%	23%
SP9	B.2	3,08 ± 0,47	15,41%	0	1	10	2	0,00%	7,69%	76,92%	15,38%	93,33%	23%
SP10	B.3	3 ± 0,39	13,07%	0	1	11	1	0,00%	7,69%	84,62%	7,69%	92,86%	15%
SP11	B.4	2,85 ± 0,53	18,72%	0	3	9	1	0,00%	23,08%	69,23%	7,69%	78,57%	0%
SP12	B.4	3,31 ± 0,46	13,95%	0	0	9	4	0,00%	0,00%	69,23%	30,77%	100,00%	8%
SP13	B.4	3,08 ± 0,47	15,41%	0	1	10	2	0,00%	7,69%	76,92%	15,38%	93,33%	0%
SP14	B.4	3,15 ± 0,36	11,44%	0	0	11	2	0,00%	0,00%	84,62%	15,38%	100,00%	38%
SP15	C	3,46 ± 0,63	18,32%	0	1	5	7	0,00%	7,69%	38,46%	53,85%	95,00%	15%
SP16	C	3 ± 0,39	13,07%	0	1	11	1	0,00%	7,69%	84,62%	7,69%	92,86%	0%
SP17	C	3,08 ± 0,62	20,00%	0	2	8	3	0,00%	15,38%	61,54%	23,08%	87,50%	8%

5.4 Discussion

The level of participation in the surveys is insufficient for extrapolating this study's findings to the wider community of EU municipalities. However, the results' trends, together with the participants' comments, reaffirm some of the arguments raised earlier in this study. This section analyzes the level of participation and details the reasons for inadequate indicators.

5.4.1 Quality of participation

The surveys have been shared among 35 municipalities participating in the BEACON project. Since the start of the project in March 2018, the municipalities have been supported by national and international experts to improve and increase their CCM actions in their territory [45]. Thus, the author assumes that CCM is a relevant and well-known topic among these municipalities. From the 35 municipalities that participated in the survey 17 contributed (49%) in only some of the surveys. Therefore, the number of participants for each survey ranged from a minimum of 11 (31%; in the land-use survey) to a maximum of 15 (42%; in the governance and energy survey). Although there may be many reasons for why municipalities would not participate in a given survey, moderate participation could indicate the level of interest of the participating municipalities regarding improving their CCM monitoring process, aligned with the arguments of the different authors previously mentioned [16, p. 974], [36, Ch. 2], [38], [46], [47, Ch. 6], [52, p. 59], [53], [127, p. 18].
Regardless of the participation rate, this study would still not allow for the results to be extrapolated to all European municipalities. Nonetheless, the results could establish a basis from which to continue exploring municipal CCM planning and monitoring.

The area of expertise of the participants might also hint at which areas or departments are more active and connected to local climate action. If so, the waste management and energy domains are the most active and connected, as more participants work in these areas of expertise (69.23% and 53.33%, respectively). The EU has promoted these topics as flagship domains for the desired climate transition. Waste management is integrated into the circular economy EU strategy, which is addressed directly to municipalities [103]. The same is true in the energy domain, where the EU has specific objectives for reducing energy consumption, domain where EU municipalities have been supported through the Covenant of Mayors initiative since its creation [26], [43]. By contrast, the land-use domain survey had the fewest participants belonging to that area of expertise (18.18%). The integration of land use and CCM matters seems to be poor in comparison with the other domains. This fact is perhaps due to the limited competence of the municipalities regarding land use (for instance, regarding the agricultural production aspect), the controversy related to land allocated to activities with low contributions to GDP in their territories (agricultural activities) [138], or the limited support from upper levels of government regarding sustainable land-use practices. The poor integration of land use and CCM matters in the municipality happens despite the IPCC highlighting the importance and the urgent need to develop sustainable land-use practices. The EU Common Agriculture Policy, which shapes the EU agricultural sector, does not perform well regarding sustainability because it enables practices that lead to biodiversity loss and land degradation [39], [139].
Independent from the cause, the author suggests that municipalities increase their support and contributions to sustainable land practices, with a special focus on sustainable food production.

All the participants accounted for a minimum of 10 years of experience on average. The survey questions sought the opinions of the local administrations, and thus, years of experience is a relevant factor concerning the robustness of the answers. The author assumes that the higher participants' level of experience is, the greater their knowledge is with respect to their municipal policy instruments, capacities,

resources, and local context. Thus, the average of 10 years of experience could be considered enough for assuming the accuracy of the answers for this thesis' purpose.

5.4.2 Potential drivers for inadequate indicators

The participants had the opportunity to justify why they had not found a given indicator appropriate to the municipal context. The author identified the following drivers for why an indicator many not be appropriate: an indicator's design (process indicators and units), action-related challenges (local capacity, legislation coherence, non-suitability), and data management (data collection and municipal database).

5.4.2.1 Indicator design

The indicators that were analyzed by the participating municipalities had been adapted and shaped to suit European municipalities in general (following the sustainability principle of leaving no one behind) and with the final aim of providing accurate monitoring information about municipalities' CCM actions. Therefore, as most of the indicators are looking to fit any municipal reality, they are generally "impact indicators," which measure final outcomes of actions taken and focus on the objectives of the overall recommendations of reducing direct and indirect municipal GHG emissions, but they do not focus on the process. Nonetheless, some of the proposed indicators are intended to measure specific processes, especially in the transportation and mobility domain. The processes that the municipalities choose to achieve the same end may vary depending on the local context, leading to disagreement. For example, indicators T15 and T18 could be considered process indicators, as they track the status of a means to achieve an end. T15 concerns the implementation of exclusive lanes for public transportation as a way to promote low-carbon collective transportation (E RECO). T18 concerns the amount of time that the center of an urban area is closed to private LDVs as a way to promote and increase accessibility and safety for NMT (F RECO). These indicators showed a low level of agreement (52.94% and 62.50%, respectively). As confirmed by the comments from participants that disagreed with the use of these indicators, process indicators are less likely to be generalizable for all EU municipalities.

Regarding the units of the proposed indicators, the author prioritized rates instead of absolute values in order to ensure representativeness of the information, leading to an improved vision of the municipals' progress. In addition, the author prioritized short time periods to foster efficient action planning and to reduce the potential risk associated with changes in the municipal executive.
Some participants suggested changing the proposed units to favor their context. For example, some municipalities are already using similar indicators with different reporting periods (e.g., EC2 or L12) or have shown a preference for absolute values over rates (e.g., G8). Given that the indicators were designed to acknowledge the evolution of each municipal's CCM through time rather than to compare performance between municipalities, the author suggests that units be adjusted to each municipal context whenever doing so ensures the representativeness of the municipality and adequate timing to evaluate the actions.

5.4.2.2 Action-related challenges

Although the surveys intended to assess the suitability of the indicators, comments from participants also referred to the actions associated with the indicators.

Participants noted that a main barrier is the incompatibility of national legislation with some of the proposed indicators or actions. As an example of this lack of legislative coherence, a Romanian municipality explained that indicators associated with related energy communities are not suitable for them

because their national legislation has not yet adopted the related EU framework that enables such communities (e.g., indicators E1 to E8). As the IPCC remarks, to foster CCM actions is imperatively necessary the institutional capacity to strength policy coherence and avoid fragmentation.[16]

In accordance with the remarks of the IPCC, the lack of municipal capacity and resources was highlighted as a reason for declaring some indicators as inadequate (e.g., G3, G5, and EC6). The scarcity situation that municipalities suffer could be improved by increasing collaboration among municipalities. In the last BEACON Vertical Workshop in Portugal, which gathered representatives from different levels of governance (municipal, regional, and central government) [45], the figure of the intermunicipal community arose as a way to increase cooperation among municipalities and increase their capacity to implement and monitor CCM actions. The Covenant of Mayors also suggests preparing joint SECAPs with neighbor municipalities when resources and capacities are limited [43]. Collaboration among equals could also promote stakeholder engagement, which is also identified as a difficult task by smaller municipalities (e.g., G10 and G11). Collaboration among municipalities could also foster the local CCM monitoring process. As an example, a Portuguese municipality declared that some indicators (e.g., T2, T11, and T13) related to the transportation and mobility domain are provided by the Lisbon Metropolitan Area (AML), which consolidates 18 municipalities in this structure.
In contrast, the scope of indicators seems to be a reason why some participants found certain indicators inappropriate. As an example, some indicators related to waste management (W10, W12) pertain to the regional level and are thus out of the municipal scope. In cases of regional indicators, the author suggests disclosing by municipal territory the information provided in the regional indicator, in order to the facilitate appropriate municipal policies' implementation.

The non-suitability of certain indicators' related actions also led to some indicators being deemed inadequate (e.g., W1, T15, T1, and SP11), notably in the transportation and mobility domain. For instance, indicators related to public transportation (e.g., T10, T12, and T13) were refused by municipalities considered "not urban municipalities." The author proposed these recommendations and related indicators in order to suit every EU municipality, preferring to explore all relevant areas of local CCM without exclusion. However, because of the municipal context, some domains may not be a priority for some municipalities. The author suggests focusing on the priority areas of the municipality and then exploring new pathways to take action. For example, with public transportation, non-urban municipalities could adapt related indicators from the regional public transportation services.
Another action disputed by the participants was the (re)municipalization of municipal services as a medium for pursuing CCM. The author highlighted the importance of the municipality in managing their own services in order to ensure their sustainability and efficiency based on the report from Kishimoto and Petijean (2017) [66]. Indicators related to that topic are G7 (refused by 2 of 15 municipalities), E9 (refused by 5 of 15 municipalities), and T4 (refused by 6 of 14 municipalities). None of these indicators were accepted with high agreement or consensus. Comments from participants not only demonstrate a misunderstanding of how publicly managed services could promote CCM policies but also a misunderstanding of the (low) benefits associated with such high-cost action. The author encourages municipalities to consider the (re)municipalization option when possible in order to support the provision of sustainable services in and by the municipality.

5.4.2.3 Data management

Data collection is a broader concern raised by participants, especially where data management involves private sector data that is not normally provided to the local administration. This challenge has been mentioned across multiple sectors, including the energy domain (e.g., E1, E2, E4, E5, E6, E7, E10, E13, E19, E18, and E17), the land-use domain (e.g., L5, L11, and L13), the transportation and mobility domain (e.g., T14 and T26), the waste management domain (e.g., W4 and W5), and the governance domain

(e.g., G8 and G9). The domain that seems most affected regarding data collection is the consumption patterns domain (e.g., C11, C12, C13, C14, and C15), where the private sector is the main provider of goods and services. Acknowledging the availability of sustainable products and services in the municipality, the purchasing and consumption decisions of local citizens could be essential in promoting sustainable consumption, waste prevention, reduced energy consumption, and other goals. Thus, the private sector should be supported and pressed to share their internal information with the local administration in order to address CCM. As noted by the participants, the private sector could appeal to their right of confidentiality to avoid sharing their data (e.g., G9). This controversial situation could be interceded by superior levels of governance. The national government could regulate the transfer of information from the private sector to local authorities by either making the information anonymous or providing it in bulk, by neighborhood or parish, or at a scale that maintains the confidentiality of customers. In addition, the author suggests relying on national statistical agencies to support municipal data acquisition. As a practical example, indicators related to petrol, gasoline, and diesel consumption (T6, T7, and T8) were considered difficult to obtain as the relevant providers do not share their data. In Portugal, information on these indicators is available and managed by the National Statistical Institute, expressing the indicator in tep/habitant, disclosed by location and updated every year [140]. Following the Portuguese example, the author calls for increased support from national agencies or other related institutions in collecting and managing useful data for municipalities, especially when data that involves the private sector. The author also encourages municipalities to specify which data they may find useful for monitoring CCM at the local level, thus enabling the submission of municipal proposals to statistical institutions. For instance, indicator E13 was considered to be a great indicator for municipal purposes, but it presents challenges in data collection. This instance could be a perfect example where municipalities could ask for support from national statistical agencies or other related institutions.

Participants have also highlighted the lack of territorial data regarding land use (e.g., L3 and L6) and activities such as jobs per district (e.g., SP8 and SP11). The author finds it essential that municipalities have a complete municipal territorial database in order to implement appropriate CCM measures and facilitate the monitoring process. The creation of a proper municipal database could contribute to increasing municipal capacity, and it could also be supported by the national authorities.

6 Conclusion

This thesis' research question asks what indicators do European municipalities find most adequate for monitoring local CCM in the European context. The question is answered by the indicators' classification, being the most adequate the 33 indicators chosen by consensus. The author suggests that the municipalities adopt these indicators in their CCM monitoring process. Involving multiple municipalities with different local contexts allows for enough flexibility to also recommend the 36 indicators classified as high agreement. The 56 indicators with medium agreement can also be considered appropriate in specific municipalities. The 15 indicators with low agreement can only be recommended after significantly modifying them in favor of the municipal strategies and with respect to data availability.
Despite this illustrative classification, the low level of participation in this study entails the indicators cannot be recommended unreservedly to municipalities not involved in the research. In order to support the global municipal CCM process and to follow the recommendations of Castán Broto (2017), the author encourages EU municipalities to consider integrating the recommended indicators into their internal monitoring processes by adapting them to their municipal contexts when necessary and by establishing the means to gather the necessary data, including consulting national statistical agencies or other institutions' support.

6.1 Impact and future steps

This research is novel in that it presents a list of CCM recommendations and associated indicators for EU municipalities. The author produced this research with the SD principle of leaving no one behind in mind. This principle directly implicates EU municipalities and therefore fosters the bottom-up approach promoted by participatory-action research.
In addition, this work considered the different existing global frameworks for CMM, such as the Covenant of Mayors and the Agenda 2030, to facilitate local action and monitoring of CCM while contributing to SD and municipal development plans.
Moreover, this research supports local institutions' capacities by presenting a wide range of possibilities for local CCM and by developing a basis for a common CCM monitoring framework. The common framework could foster collaboration among municipalities, such as facilitating information sharing on specific topics like municipal best practices for climate action.

This research is also innovative, as information related on how to pursue CCM at a municipal level is still rare. In terms of the indicators proposed, this research presents highly recommended indicators that have not yet been used in the participant municipalities (e.g., C3, C4, and L23). In addition, more than the half of the indicators considered adequate by consensus and adequate with high agreement were suggested by the author.

Innovation comes with potential risks that should be considered. This research is based on the latest IPCC report on CCM (AR5, Working group III, 2014) [16] because of its scientific robustness and global perspective. Despite the IPCC's efforts in gathering all relevant information related to CCM, little is addressed to local contexts (aside from some chapters where the local context is inherent to the topic, such as the spatial planning chapter). In researching how to localize the IPCC guidelines, the author acknowledges that not all the information available was analyzed because it is fragmented and thus difficult to access. In order to reduce associated risk, a literature review was conducted and several global organizations were consulted.
Emerging interest in this research's topic could lead to future studies that improve upon the present research. Nonetheless, this research could be considered the first steps toward an EU municipal framework that supports municipal planning and the monitoring of CCM actions.

Further steps could be done in the future. The author suggests reshaping the indicators proposed according to the concerns and proposals provided by the participants and repeating the surveys among a greater number of EU municipalities. Ideally, the extent to which the proposed indicators are adopted by the municipalities would be analyzed, establishing means for data collection. In addition, the author encourages researchers to analyze if the proposed indicators are suitable for directly measuring municipal performance with respect to the SDGs.

6.2 Final remarks

Local monitoring processes need to be reinforced to best mitigate climate change. The diversity of EU municipalities complicates the elaboration of appropriate top-down guidelines that promote local CCM actions and their assessment. Municipalities should take the lead in designing, implementing, and monitoring effective climate actions adequate to their local context.
Based on participatory-action research, which supports the involvement of EU municipalities, the author developed a comprehensive study intended to establish a common municipal capacity index for planning and monitoring CCM.
Based on the literature review, recommendations for local CCM were categorized according to different priority domains associated with the SDGs to clarify the relationship between CCM and SD. A set of

ideal indicators were linked to the recommendations and proposed to EU municipalities for their validation. Seventeen EU municipalities assessed the adequacy of the indicators with respect to the municipal context. The author classified these indicators according to the level of municipal agreement.

To conclude, results were derived, and comments from participants were analyzed. These comments revealed common challenges including a lack of municipal resources and capacities, fragmented legislation, and obstacles in data collection and management.

Despite the need to repeat this study among a wider sample of EU municipalities to extrapolate the results, this research sets a basis for establishing a common framework supporting EU CCM municipal actions that integrates the local perspective, improves institutional capacity, and aims to foster collaboration.

Further research could examine the extent to which the proposed indicators have been adopted by EU municipalities or examine how to facilitate data collection, management, and dissemination.

7 Bibliography

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Annex 1: The Sustainable Development Goals and Targets [35]

Goal 1. End poverty in all its forms everywhere

1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day

1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions

1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable

1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance

1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

1.a Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programs and policies to end poverty in all its dimensions

1.b Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

Goal 3. Ensure healthy lives and promote well-being for all at all ages

3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births

3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and underJ5 mortality to at least as low as 25 per 1,000 live births

3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being

3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol

3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents

3.7 By 2030, ensure universal access to sexual and reproductive health-care

services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes

3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

3.a Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate

3.b Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all

3.c Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States

3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes

4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education

4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university

4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy

4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all

4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries

4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States

Goal 5. Achieve gender equality and empower all women and girls

5.1 End all forms of discrimination against all women and girls everywhere

5.2 Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation

5.3 Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation

5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate

5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life

5.6 Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences

5.a Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property,

financial services, inheritance and natural resources, in accordance with national laws

5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women

5.c Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels

Goal 6. Ensure availability and sustainable management of water and sanitation for all

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency

and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and land-locked developing countries, in accordance with their respective programmes of support

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries

8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors

8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services

8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10JYear Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead

8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value

8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training

8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms

8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment

8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products

8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all

8.a Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-related Technical Assistance to Least Developed Countries

8.b By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries

9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets

9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States

9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities

9.c Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020

Goal 10. Reduce inequality within and among countries

10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average

10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status

10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard

10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality

10.5 Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations

10.6 Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions

10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies

10.a Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements

10.b Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes

10.c By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage

11.5 By 2030, significantly reduce the number of deaths and the number of

people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015J2030, holistic disaster risk management at all levels

11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal 12. Ensure sustainable consumption and production patterns

12.1 Implement the 10JYear Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities

12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production

12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products

12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

Goal 13. Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in

particular from land-based activities, including marine debris and nutrient pollution

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation

14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

14.b Provide access for small-scale artisanal fishers to marine resources and markets

14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of “The future we want”

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems

15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation

15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

16.1 Significantly reduce all forms of violence and related death rates everywhere

16.2 End abuse, exploitation, trafficking and all forms of violence against and

torture of children

16.3 Promote the rule of law at the national and international levels and ensure equal access to justice for all

16.4 By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime

16.5 Substantially reduce corruption and bribery in all their forms

16.6 Develop effective, accountable and transparent institutions at all levels

16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels

16.8 Broaden and strengthen the participation of developing countries in the institutions of global governance

16.9 By 2030, provide legal identity for all, including birth registration

16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements

16.a Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime

16.b Promote and enforce non-discriminatory laws and policies for sustainable development

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Finance

17.1 Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection

17.2 Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of gross national income for official development assistance (ODA/GNI) to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries; ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries

17.3 Mobilize additional financial resources for developing countries from multiple sources

17.4 Assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress

17.5 Adopt and implement investment promotion regimes for least developed countries

Technology

17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism

17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed

17.8 Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology

Capacity-building

17.9 Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North-South, South-South and triangular cooperation

Trade

17.10 Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda

17.11 Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020

17.12 Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access

Systemic issues

Policy and institutional coherence

17.13 Enhance global macroeconomic stability, including through policy coordination and policy coherence

17.14 Enhance policy coherence for sustainable development

17.15 Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development

Multi-stakeholder partnerships

17.16 Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries

17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

Data, monitoring and accountability

17.18 By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts

17.19 By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries

Annex 2: Information from the BEACON Project and Participating Municipalities*

[45]

*Braga Municipality (Portugal) is also included in the project through municipal partnerships.

BEACON Bridging European & Local Climate Action

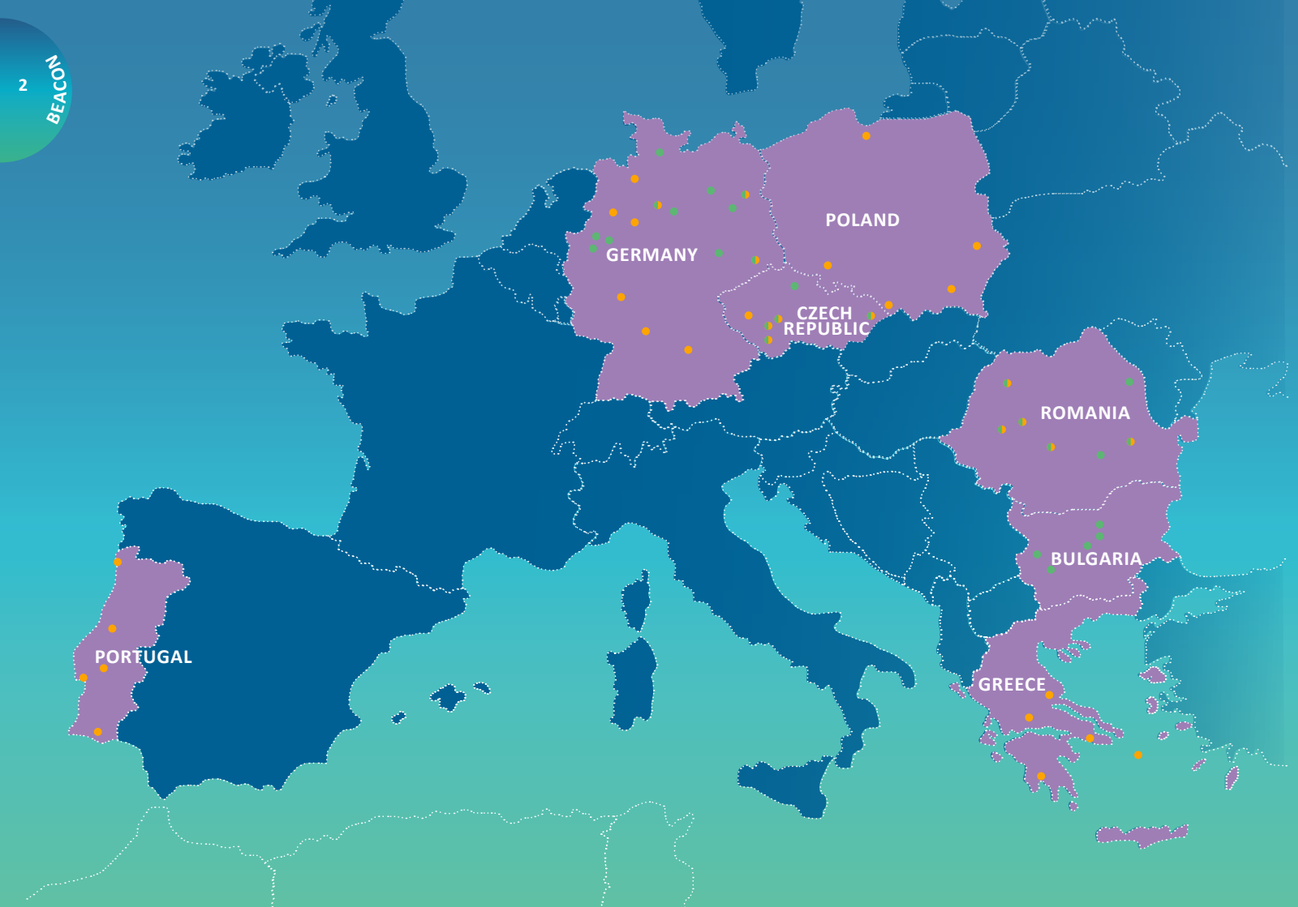
CONNECTING AND COLLABORATING FOR CLIMATE: THE BEACON PROJECT

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

European
Climate Initiative
EUKI



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At the UN Climate Change Conference in 2015, then French President François Hollande, French Foreign Affairs Minister Laurent Fabius and UN Secretary-General Ban Ki-Moon applaud the conclusion of negotiations on the Paris Agreement.

The realisation of the **global and EU-wide commitments** depends, to a large extent, on **national governments** creating and implementing effective policies and framework conditions.

An increasingly large role will be played by **municipalities and local governments**. These stakeholders can be pioneers and drivers of profound decarbonisation and social transformation processes as their actions have considerable potential for increasing energy efficiency and reducing greenhouse gas emissions.

Schools and other educational institutions can play a key role by reducing their energy consumption and educating future generations for a climate friendly world.

To successfully implement the Paris Agreement and European climate and energy targets for 2030 and beyond, climate action needs to be enhanced on all levels of governance.

Good examples of successful climate protection measures that tackle obstacles to climate action ambitions already exist across Europe on both national and local levels. There are communities and actors leading the way to becoming carbon neutral and more climate friendly. In addition to environmental and climate protection reasons, these stakeholders have recognised other **benefits of climate action** such as increasing the well-being of the population, promoting innovation, and stimulating the local economy.

Local initiatives such a renewable energy projects and the development of climate action plans can be facilitated with targeted, **needs-based support** and can have a lasting impact through the exchange and capacity building of multipliers and by connecting with relevant national stakeholders.

BRIDGING EUROPEAN AND LOCAL CLIMATE ACTION (BEACON)

The Bridging European and Local Climate Action (BEACON) project promotes climate action and facilitates exchange between and among national governments, municipalities, and schools in Europe.

The aim of the project is to **strengthen bilateral and multilateral cooperation** and create common ambition to realise the Paris Agreement. Through joint learning, networking, and tailored advisory services, policymakers, municipal actors, and educators gain technical and process-related skills that help them develop, refine, and **implement measures for reducing greenhouse gas emissions.**

Good practices in local climate action will be identified and shared in a network of 34 municipalities from the Czech Republic, Romania, Greece, Poland, Portugal, and Germany. At home, each municipality receives needs-based technical support and on-the-job coaching that can be applied and implemented in everyday work. Workshops at the regional level bring participating municipalities together to exchange information on topics of joint interest. The work with municipalities also includes the support of five municipal climate partnerships.

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"In highlighting successful climate action measures and the associated benefits, we create understanding, acceptance, and support for climate protection."

Moritz Schäfer,
BEACON Project Manager (Navigant)

www.euki.de/euki-projects/beacon

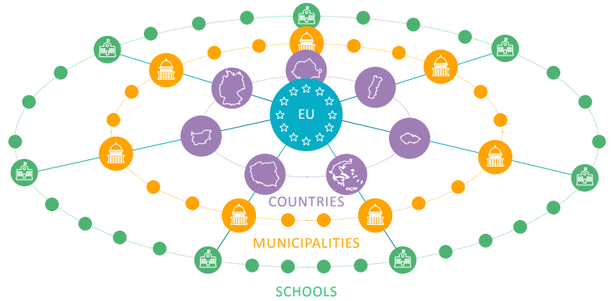
BEACON

Bridging European & Local Climate Action

To increase awareness about climate change and action on the individual level, 57 schools in Bulgaria, the Czech Republic, Romania, and Germany are involved in the project. From developing incentive models for energy savings with government and school officials to measuring temperature and CO_2 concentrations with teachers and pupils, a wide range of activities targeting a variety of stakeholders take place in schools. The project team and participants also analyse climate action in school curricula and existing educational programs, create energy savings action plans in schools, and conduct workshops and trainings. Study tours also facilitate exchange between teachers and administrators in Germany and the partner countries.

At the national level, emissions reductions and corresponding good practices in national climate protection policies and instruments from across the EU are analysed in detail and shared with relevant national stakeholders. The focus of this work includes the buildings, transport, small industry, and agriculture sectors. Workshops with national, regional, and local actors will be organised in selected partner countries to work jointly on specific challenges.

By bringing diverse actors together, BEACON contributes to European integration, reducing greenhouse gas emissions, building capacity for local climate action, and raising awareness for climate action.



The BEACON project is financed by the European Climate Initiative (EUKI). EUKI is a financing instrument by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Led by Navigant, the project team is a consortium of 11 organisations from across Europe. The work in municipalities and schools is led by adelphi and the Independent Institute for Environmental Issues (UfU), respectively, and supported by partner organisations in each of the target countries.

Duration: April 2018-March 2021
Countries: Bulgaria, Germany, Greece, Poland, Portugal, Romania, Czech Republic

ACCELERATING CLIMATE ACTION, STRENGTHENING EUROPE: THE EUROPEAN CLIMATE INITIATIVE (EUKI)

Close cross-border cooperation is a key success factor in the realisation of the Paris Agreement in Europe.
In 2017, the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) launched the European Climate Initiative (EUKI) to finance projects aimed at promoting closer European cooperation in climate action.

The initiative is working towards several goals:

- Creating awareness and pooling knowledge
- Establishing networks and exchanging succesful models
- Developing capacity and building a bridge for EU funding

EUKI finances a variety of innovative, cross-border projects all over Europe to help achieve the objectives of the Paris Agreement.
For example, EUKI actors support governments in creating long-term climate strategies, disseminating approaches for the agricultural use of rewetted peatlands, and advocating an end to coal heating in private households. In total, the EUKI finances projects in eight core areas.

Stefan Bundscherer, Head of the EUKI financing instrument, at the annual EUKI networking conference

© GIZ / André Wagenzik

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

European **Climate Initiative** EUKI

of the Federal Republic of Germany

"The Federal Government launched a European Climate Initiative because we do not just want to take steps here at home but also want to look at how our neighbours and other Member States of the European Union are getting on with achieving their targets."

German Chancellor Angela Merkel

Non-governmental organisations, municipalities, and other public authorities; non-profit enterprises; and scientific and educational institutions based in the EU are eligible for funding. Organisations can participate in the EUKI tender procedures or in the annual EU-wide call for project ideas.

Since 2017, EUKI has promoted more than 60 projects in 24 EU countries. Over 140 organisations are involved in EUKI projects, forming a strong network for climate action in Europe. Within its EUKI Academy, the initiative offers trainings on challenges and opportunities of climate action as well as on methodological skills.

BEACON is financed through EUKI and a committed partner in the EUKI community.

www.euki.de

School children plant trees and vegetables whilst learning about the effects of eating habits on climate change

© Manfred-Hermsen-Stiftung

EUKI fosters the exchange of climate-friendly land use practices and brings together scientists and practitioners

© Jan Peters

CONNECTING AND COLLABORATING ON NATIONAL CLIMATE POLICIES

Policy instruments that are already successful in one country can potentially be transferred to other countries.

Workshop in Berlin, 10 October 2018

Whether social, economic, or environmental, successful national climate policy or instrument design face many constraints within the national context. In many cases, however, it would be effective for countries to **learn from one another and exchange on experiences.** By doing so, policy instruments that are already successful in one country could be transferred to others and facilitate additional emissions reductions.

Exchange at transnational and European levels is a critical part of BEACON and contributes to the overarching aim of facilitating European integration via bilateral and multilateral dialogue. Our work in this area involved policies and instruments outside the EU Emissions Trading System (ETS) in the **transport, buildings, small industry, and agriculture sectors** as they are responsible for 60% of EU-wide emissions and decarbonising these sectors is challenging. These sectors fall under the EU's Effort Sharing Regulation (ESD) and are subject to binding national targets to reduce greenhouse gas emissions.

The key question guiding our analysis was: *What are the sector-specific policy instruments from European countries that Germany and other EU Member States can learn from and use to improve their climate policy, particularly in Effort Sharing Decision sectors?*

The initial study included an analysis of **greenhouse gas emissions reductions and ESD target achievement** in all EU Member States and sector-specific developments. Based on this research, country-sector combinations were selected where substantial emissions reductions were achieved between 2005 and 2015.

The results of this analysis were captured in a policy paper. Based on this research, specific policy instruments were selected for in-depth analysis.

Eighteen individual climate-related policies and instruments as well as **three climate change laws** from eight European countries were outlined in detailed factsheets authored by Navigant and adelphi. Rather than pick winners, the policy instruments were evaluated using a common framework with a focus on effectiveness and transferability.

From the bonus-malus vehicle incentive system in France to the Green in Savings Program in the Czech Republic, the factsheets cover a range of countries and sectors from which policymakers can learn. The climate protection laws of the UK, France, and Sweden were also analysed.

From the analysis and subsequent **workshops with national stakeholders**, it is clear that the exchange of successful policy instruments in other European countries can make a considerable contribution and provide concrete impetus for national energy and climate action plans. While achieving emissions reductions in the transport, buildings, small industrial installations, and agriculture sectors is difficult, countries across Europe are using a range of policy tools to make progress against their greenhouse gas emissions reduction targets.

Industry

Tax reduction for energy savings: Through the corporate energy tax deduction, companies in Belgium can apply their investment in energy efficiency measures to the profit tax. In place since 2015, the one-time tax deduction amounts to 13.5% and gives industrial companies incentives to invest in energy efficiency measures.

Energy Efficiency Obligation: To achieve Art. 7 target of the EU Energy Efficiency Directive, Denmark has used energy efficiency commitments with companies. Targets for energy efficiency improvements are set for and distributed among electricity, gas, oil, and district heating companies. The companies then carry out energy efficiency measures at the end customer or through a third party. The savings achieved are credited against the target.

Climate Change Agreements: The Climate Change Agreements (CCA) and the Climate Change Levy (CCL) are important levers to reach UK climate targets through industrial energy efficiency and clean energy. The CCL is an energy tax on the commercial consumption of electricity from fossil fuels. In sector- or company-specific agreements, companies from energy-intensive sectors voluntarily commit themselves to energy efficiency or CO_2 reduction targets and receive tax credits on the CCL in return.

CO_2 Tax: Introduced in 1991, the Swedish carbon tax is the country's central climate policy instrument and the world's strongest CO_2 price signal. The tax covers energy emissions not covered by the EU ETS in the industrial, building (heat), and transport sectors and has been a highly effective instrument in reducing emissions.

Transport

Incentives for e-mobility: Thanks to a range of policy measures and incentives, Norway has the world's highest market penetration of electric vehicles. These include the exemption from a 25% VAT on the purchase or lease of electric vehicles as well as the exemption from registration taxes. Other incentives include lower company car and vehicle taxes, exemption from urban parking fees and tolls, and the free use of ferries.

Company car taxation: To reduce fuel consumption and emissions, the Swedish government has implemented various incentives to promote the registration of low-emission company cars, which make up a large percentage of cars on Swedish roads. For example, the taxable benefit of hybrid or electric cars is 60% or 80%, respectively, lower compared to more emissions-intensive vehicles.

Bonus-malus scheme: Since 2008, the bonus-malus system in France has provided direct financial incentives for vehicle buyers to opt for less CO_2-intensive vehicles. Buyers of electric and hybrid cars receive a bonus, while buyers of new cars with high CO_2 emissions are required to pay a penalty.

Modal shift: Switzerland has a comprehensive package of measures to shift freight traffic from roadways to railways, including an expansion and modernisation of the railways, a ban on night driving for lorries, and a charge on heavy goods vehicles. Support from Germany and Italy in constructed transshipment terminals has also helped reduce the number of trucks on Swiss roadways.

Agriculture

Action Plan Aquatic Environment: Three Action Plans for the Aquatic Environment (APAEs) were implemented in Denmark in the period between 1990 and 2010. They contained a range of measures and have successfully introduced regulation to improve the use of manure and implement more stringent regulations on the use of nitrogen-based fertiliser, thereby reducing CO_2 emissions.

Biomethane support: The French Energy Methanisation Autonomy Azote (EMAA) plan provides a legal framework for agricultural methanation in France, in addition to a number of supportive measures that produce biogas and biomethane waste. The plan facilitates investment grants for research and technical equipment as well as minimum prices for bioenergy products.

GHG Action Plan: In 2011, the UK agricultural sector adopted the Greenhouse Gas Action Plan for Agriculture (GHGAP). It provides farmers with advice, training, and information and leads to measures that promote better efficiency and modern farming practices, thereby reducing emissions.

Agrocovenant: The Agrocovenant is a voluntary public-private agreement between the government of the Netherlands and a variety of agricultural sector organisations on various targets as well as measures and instruments for reducing emissions and increasing energy efficiency. If the sector's greenhouse gas reduction targets are not achieved, regulatory measures are taken.

Buildings

Latvian Baltic Energy Efficiency Facility (LABEEF): LABEEF is a company that supports energy service companies (ESCOs) in the long-term financing of renovations of multifamily buildings through energy performance contracting. The contract between the ESCOs and the building owners is forfeited by a third party. Thus, the execution risk stays with the ESCO while the financing risk is transferred to LABEEF. LABEEF enables large financial institutions to audit this financial product (due diligence).

Energy transition tax benefit: The energy transition tax credit in France allows 30% of housing expenditure for energy-efficient refurbishment to be deducted from income tax. The maximum tax deduction is up to €8,000 for an individual and €16,000 for a multi-person household within 5 years. The tax creates incentives for building owners to implement energy efficiency measures in their homes.

Innovation cluster: In Sweden's building sector, networks of industry/market actors and the state promote innovative energy-savings solutions through technology-oriented demand bundling (innovation clusters) in order to bring them to the market faster. The clusters use demonstration projects to showcase actual savings.

Energy Performance Certificate Database: In 1997, Denmark was one of the first European countries to introduce a central building energy performance certificate database. It now includes the entire energy performance certificates of about one-third of all Danish dwellings on a publicly available website. It allows relevant stakeholders to access and use a wealth of information to raise awareness of energy savings and improve decision-making.

New Green in Savings: The Green in Savings programmes consist of a financial scheme to support renovation, efficient heating systems, and nearly zero energy buildings, which have significantly contributed to the Czech climate achievements in the residential buildings sector. The programme obtains most of its financial resources through EU ETS auction revenues.

Slovak Sustainable Energy Financing Facility (SlovSEFF) Programme: The EBRD launched this programme in 2007 to encourage sustainable energy investments in companies and housing associations by providing loans and incentive payments in the case of successful completion and verification of a project. Integral to the project design is a supplemental grant funding for technical assistance.

To download the studies visit: **www.euki.de/en/news/successful-climate-protection-policies-in-europe/**

CONNECTING AND COLLABORATING AMONG MUNICIPALITIES

To exchange information and best practices and build capacity on the local level, 25 municipalities from the Czech Republic, Poland, Romania, Greece, and Portugal, as well as nine German municipalities have been selected to participate in the project. Each municipality in the target countries receives hands-on, needs-based technical support and on-the-job coaching on a wide range of climate action topics. In addition, at the transnational and regional levels, workshops and city partnerships bring participating municipalities together to exchange best practices and experiences.

The various dialogue and consulting formats provide the municipalities with specialist knowledge and know-how:

- In **transnational workshops**, good practices of municipal climate protection are discussed. Through an open dialogue about obstacles and opportunities, new impulses for the implementation of climate protection measures on the ground are created.
- The **individual consultation services** provided to each of the 25 European municipalities consist of hands-on, needs-based technical support and on-the-job coaching on a wide range of climate action topics and enable a deepening and operationalisation of this knowledge.
- Valuable experiences, proven strategies, and examples from Germany are made available through the **translation and country-specific adaptation of existing guidelines.**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Partnership Workshop in Agios Dimitrios, November 2019

"I believe that the partnership meetings with Bottrop generate new impetus to the climate change initiatives for both of our cities."

Maria Androutsou, Mayor of Agios Dimitrios, Greece

- Participants in the **five municipal climate partnerships** have the opportunity to exchange expertise and develop joint projects with expert support through one-to-one advice.
- **Two municipal conferences** are held to present initial project results and serve as a source of inspiration and a platform for trans-European networking in a collegial atmosphere.

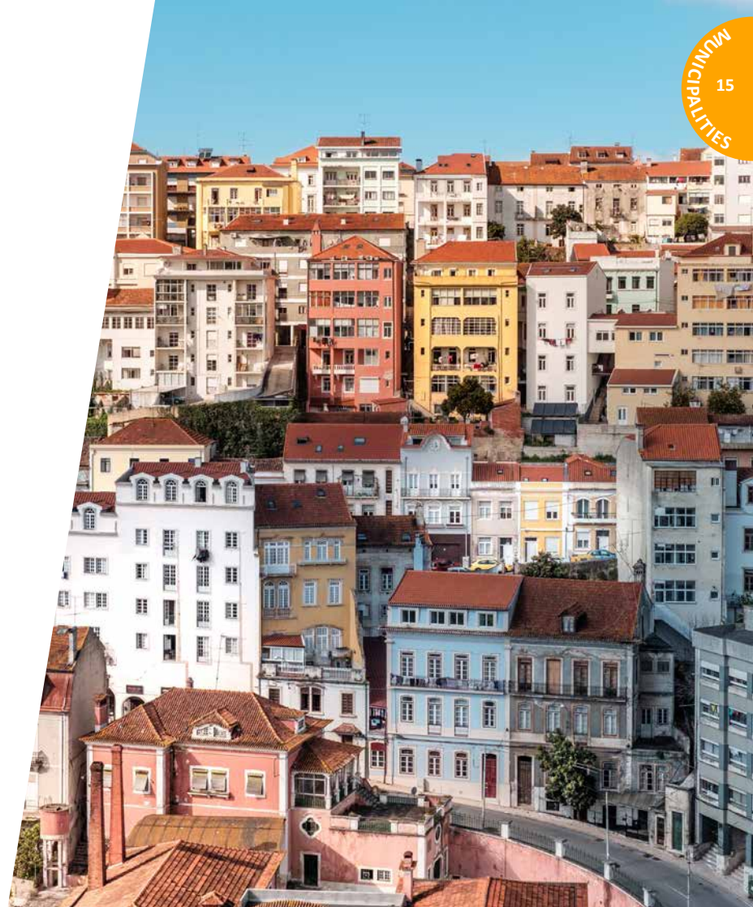
34 MUNICIPALITIES

The following pages present each of the participating municipalities and include information about their climate action priorities, the related topics they can share experience in, and the topics that they would like to learn about.
The icons below and in each of the municipality portraits correspond to these elements.

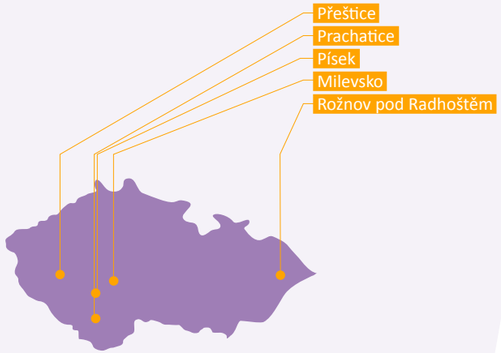
Priorities

We can share experience in…

We would like to learn about…



CZECH REPUBLIC




Townhall of Milevsko

MILEVSKO

CZECH REPUBLIC

Contact: Vít Král, kral@zivemilevsko.cz
Population: 8,500

Sustainable mobility • Raising public awareness for climate action • Becoming a smart city • Implementing a Sustainable Urban Mobility Plan (SUMP) • Water management

Waste, water, and soil management • Carbon-negative technologies and nutrient recovery • City e-bike programme

Motivating citizens to become engaged in climate action • Modernising and increasing the efficiency of the street lighting system • Introducing an energy management system to provide an overview of energy consumption and costs • Developing a waste management system

PÍSEK

CZECH REPUBLIC

Contact: Edita Kučerová, edita.kucerova@mupisek.cz
Population: 30,119

Sustainable mobility and development • Monitoring energy consumption and air quality • Reducing the energy intensity of public buildings • Renovating energy infrastructure, e.g., heat distribution network • Transitioning from fossil fuels to biofuels in the energy mix

Energy performance contracting • Developing an energy web portal (http://portal-pisek.enesa.cz) and a transportation web portal (http://parkovani.pisek.eu) • Developing and implementing a municipal thermal energy policy

Developing a general energy concept • Increasing the energy literacy of residents • Sustainable mobility • Improving the indoor climate of municipal buildings • Raising awareness for and improving understanding of renewable energy sources among the general public


Aerial view of Písek


A view of the hills around Prachatice

PRACHATICE

CZECH REPUBLIC

Contact: Marie Peřinková, mperinkova@mupt.cz
Population: 10,852

Saving energy • Managing waste efficiently and sustainably • Improving air quality • Ecological education in schools • Sustainable transportation • Creating a city energy strategy • Developing a waste management strategy for residential neighbourhoods

Waste management • Raising public awareness of climate action and waste management

Engaging citizens in energy-saving measures • Decreasing waste production and using waste to produce energy • Encouraging cycling and pedestrian transport in the city • Obtaining an overview of energy consumption and costs

PŘEŠTICE

CZECH REPUBLIC

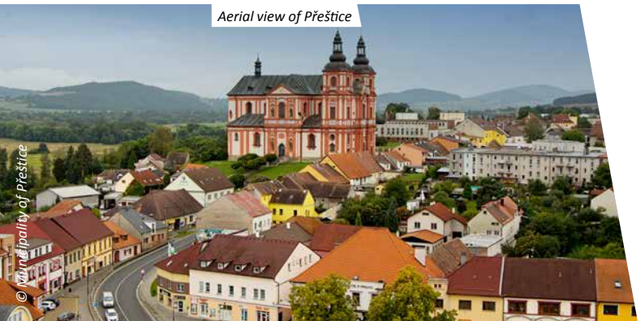
Contact: Marek Krivda, krivda@prestice-mesto.cz

Population: 7,114

Reducing energy consumption in municipal buildings • Increasing the share of renewables in the municipal heat supply • Sustainable mobility • Environmental education

Modernising the municipal district heating system and reducing natural gas consumption by maximising the efficiency of residual heat produced by biogas cogeneration units

Effectively communicating municipal climate action projects to citizens • Using sorted waste in municipal district heating • Saving energy and improving the air quality in schools



Aerial view of Přeštice

Roznov pod Radhostem, in the heart of Beskydy mountain range

ROŽNOV POD RADHOŠTĚM

CZECH REPUBLIC

Contact: Jan Cieslar, jan.cieslar@roznov.cz

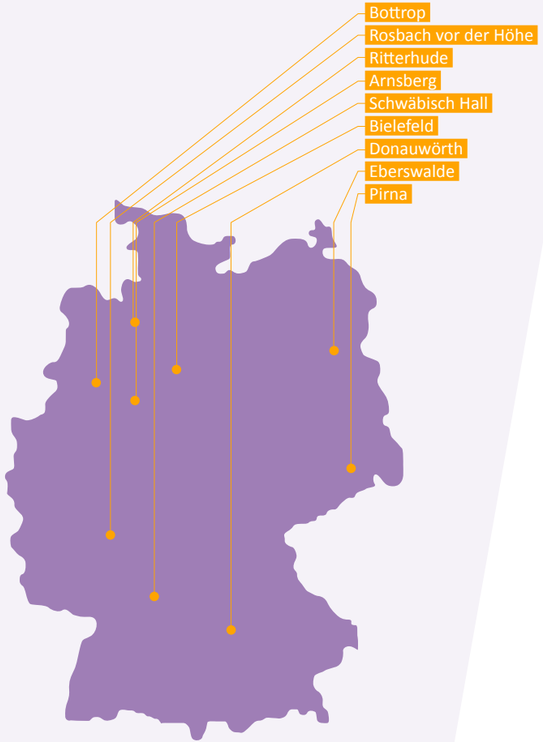
Population: 16,469

Sustainable mobility • Rainwater retention and water management • Monitoring energy consumption and air quality • Increasing energy efficiency in buildings and of the heat supply

Renovating buildings • Increasing the efficiency of the public lighting system • Energy management systems • Implementing eco-school programmes • Building bike paths and promoting sustainable tourism

Sustainable public transport • Implementing energy-saving projects • Increasing share of renewables in the city's energy mix • Using waste for energy production • Developing and implementing a plan for sustainable mobility • Further modernisation of street lighting

GERMANY



Old town with view of the church bell tower

ARNSBERG

GERMANY

Contact: Sebastian Marcel Witte, s.witte@arnsberg.de

Population: 75,000

Achieving climate neutrality by 2050 • Integrating climate change mitigation and adaptation • Increasing the share of renewables in the energy mix

Education for sustainable development • Sustainable urban development • Improving energy efficiency in private households • Adapting to climate change, especially regarding forests, river landscapes, and tributaries • Implementing a sustainability strategy • Organising a sustainability festival

Sustainable mobility • Holistic approaches to achieving CO_2 neutrality • Smart and resilient cities • Eco-friendly mobility

BIELEFELD

GERMANY

Contact: Olaf Lewald, olaf.lewald@bielefeld.de

Population: 340,000

Change of mobility behaviour: reducing private motorised traffic to 25% and increasing sustainable mobility (e.g., cycling, public transport) to 75% of modal split by 2030 • Zero Emission Zone in city centre • Effectively engaging stake-holders on climate action

Integrating action planning and networking at the local and transnational levels • Redesigning central traffic routes to reduce emissions from cars • Developing air quality plans • Building bicycle-friendly infrastructure

Climate policy and a future-oriented investment policy • Stakeholder engagement approaches • E-mobility and auto-nomous driving • Increasing citizen engagement on climate action • Using urban space intelligently and sustainably

Bielefeld – The Green City

© Bielefeld Marketing

Historic town hall of Bottrop

© Stadt Bottrop

BOTTROP

GERMANY

Contact: Tilman Christian, tilman.christian@bottrop.de

Population: 116,800

Climate-friendly urban redevelopment • Increasing the share of renewables in the energy mix

Smart air quality control • Cross-financing projects with a range of stakeholders • Energy monitoring systems • Green procurement

Implementing Sustainable Development Goals (SDGs) and linking measures to climate action goals • Implementing green urban infrastructure and augmenting existing green spaces • Energy efficiency in new building construction and renovation • Addressing structural and social changes along with climate action • Developing a mobility concept

DONAUWÖRTH

GERMANY

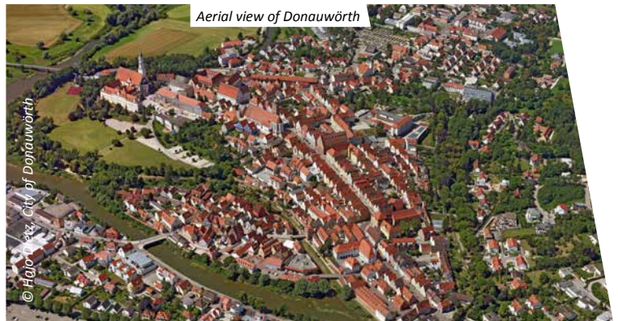
Contact: Andreas Reiner, andreas.reiner@donauwoerth.de

Population: 20,400

Implementing renewable energy and energy efficiency projects • Sustainable urban mobility via electric vehicles, public transport, and cycling lanes

Addressing barriers to implementation of climate action measures • Rapidly implementing and demonstrating success in climate protection measures

Improving communication with citizens on climate action • Creatively communicating the benefits and need for climate action with innovative channels beyond traditional newspaper and radio outlets • Strategies for gaining cross-department support • Reducing car traffic • Introducing cycling lanes in hilly terrain • Connecting with local businesses and industries • Creating local e-mobility infrastructure



Aerial view of Donauwörth

© Hallo Foto, City of Donauwörth

City centre of Eberswalde – Sustainable city development between forests and water

© Sören Tetzlaff, City of Eberswalde

EBERSWALDE

GERMANY

Contact: Severine Wolff, s.wolff@eberswalde.de

Population: 41,380

Managing the transition towards a sustainable mobility system in the city • 2020 climate action plan

Incorporating energy efficiency into various aspects of the public administration (e.g., management, procurement) • Increasing sustainability and energy efficiency in public and private buildings, planning, and residential areas • Creating climate-resilient urban structures • Implementing sustainable mobility measures regarding e-mobility, cycling, and public transport

Motivating citizens to engage on climate action • Promoting the city's own climate action activities • Undertaking energetic refurbishment in historic buildings

PIRNA

GERMANY

Contact: Thomas Freitag, thomas.freitag@pirna.de
Population: 39,250

Transforming the district heating system to be CO_2 neutral • Climate-friendly mobility • Communicating climate action with citizens • Collaborating with local companies to implement climate action measures

Municipal energy management • Sustainable mobility (i.e., charging stations, public transport, cycling)

Cooperating with schools to save energy • Green heat production • E-mobility in public transport and public car-pooling • Raising awareness about climate change among community members • Setting and implementing energy efficiency standards in existing building stock and new building plans • Obtaining funding for climate action measures

View of the marketplace and the church of St. Mary

© Jens Domke, City of Pirna

Historic town hall

© Marcus Lorenzcat, Municipality of Ritterhude

RITTERHUDE

GERMANY

Contact: Ulrich Müller, um@local-ritterhude.de
Population: 14,598

Setting up an energy-related district revitalisation concept • Raising awareness among homeowners to invest in energy refurbishment measures

Renewables and public buildings (solar panels and combined heat and power plant) • Citizen participation in investments for PV plants on public buildings

Effective communication and citizen mobilisation strategies

ROSBACH VOR DER HÖHE

GERMANY

Contact: Monika Jost, jost@rosbach-hessen.de
Population: 13,300

Becoming a Master Plan city for climate protection • Raising awareness among citizens for climate action • Developing and communicating recommendations for sustainable living

Implementing mobility action days together with a partner city • Energy management for municipal buildings • Modernising street lighting • Citizen solar energy systems on municipal buildings • Bike and ride systems at railway stations • Upgrading to a more sustainable municipal vehicle fleet • Sustainable land-use planning and housing construction

Securing funding for projects • Motivating citizens to take climate action • Effective climate mitigation measures • Integrating climate mitigation into the curricula of local schools

2018 Mobility Action Day in Rosbach vor der Höhe

© City of Rosbach vor der Höhe

View from Grasbödele to the old town of Schwäbisch Hallbisch Hall

© Nico Kurth, City of Schwäbisch Hall

SCHWÄBISCH HALL

GERMANY

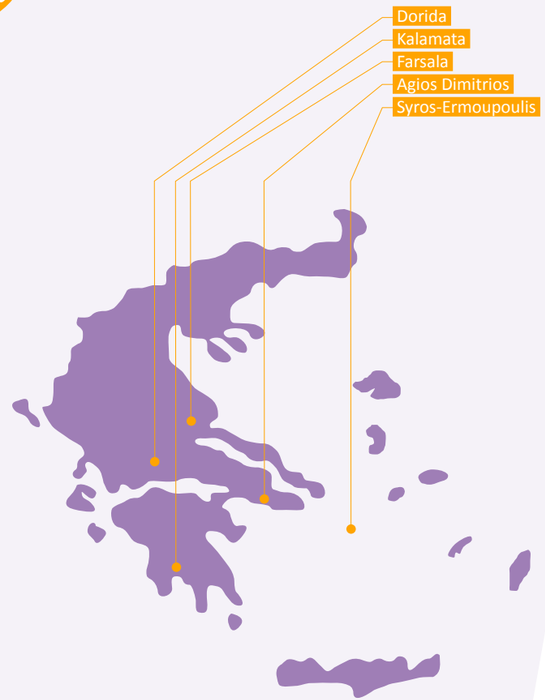
Contact: Heiner Schwarz-Leuser, heiner.schwarz-leuser@schwaebischhall.de
Population: 40,600

Achieving 100% renewables in electricity and heating by 2030

Reaching 100% renewables in electricity (2018) • Developing an extensive district heating network with combined heat and power generation and renewable energy technologies • Municipal energy management • Energy savings contracting in selected municipal buildings • Conversion of street lighting to LED • Citizen-related climate change mitigation projects, e.g., the campaign Klimaschutzbotschafter (climate ambassador) • Certification process for European Energy Award • Cooperating in climate change mitigation policy with various partners in Namibia

Motivating pupils to initiate their own climate change mitigation activities in schools • Sustainable mobility in rural areas • Securing European funding

GREECE



An urban green place for leisure and culture activities in downtown Agios Dimitrios

AGIOS DIMITRIOS

GREECE

Contact: Ilias Savvakis, isavvakis@dad.gr
Population: 70,970

Refurbishing public buildings • Smart metering • Sustainable urban mobility • Sustainable urban development

Reporting on sustainable development (e.g., Global Reporting Initiative, SDGs, UN Global Compact) • Mapping stakeholders • Energy retrofitting and energy management

Securing EU funding for climate action projects • Protecting and promoting the city's natural streams • Utilising crowdfunding for climate action implementation • Energy communities • Stakeholder engagement, especially in schools • Capturing data on energy savings and greenhouse gas emissions

DORIDA

GREECE

Contact: Epaminondas Trivillos, ntrivilos@gmail.com
Population: 13,627

EU funding opportunities • Protecting the natural environment

Reducing energy consumption by replacing street lighting lamps • Mapping municipal needs in terms of energy efficiency improvements

Reducing the energy footprint of the municipality • Implementing a Sustainable Energy Action Plan (SEAP) • Energy efficiency in public and private buildings, public lighting, and water pumping stations • Sustainable tourism • Co-benefits of climate action measures, e.g., local economy, public health • Raising awareness for and improving understanding of climate action measures among citizens

Lidoriki, capital of the municipality of Dorida. View of Mornos Lake

Homeric Hero Achilles and his mother Thetis – Bioclimatic regeneration of public space

FARSALA

GREECE

Contact: Ilectra Theloura, itheloura@hotmail.com
Population: 18,545

Confronting climate change confrontation • Contributing to the achievement of national and European objectives for environmental protection • Creating a realistic local climate action plan

Energy saving in municipal buildings • Bioclimatic regeneration in public spaces

Energy communities • Securing EU funding • Raising awareness for and improving understanding of climate action measures among citizens • Targeting the public through education and visible climate action measures • Improving the municipality's knowledge of financial tools and opportunities • Smart energy systems • Nexus of urban sustainability and cultural heritage • Sustainable mobility

KALAMATA

GREECE

Contact: Vassilis Dionysopoulos, vdionyso@kalamata.gr

Population: 69,849

Development of partnerships with other institutions to combat climate change • Reducing energy consumption of municipal infrastructure • Installing more PV systems on buildings and exploring the use of other forms of renewable energy • Strengthening existing recycling networks • Developing a strategy to expand the use of smart city technologies

Energy management of buildings • Urban redevelopment and bicycle paths • Effective management of green spaces and water • Recycling • Utilising information and communication technology (ICT) in climate action measures

Best practices from EU institutions • Securing funding for project implementation • Using smart city technologies and the Internet of Things to manage city infrastructure • Increasing public awareness of sustainable mobility and sustainable tourism • Integrated solutions for public buildings, renewables, and sustainable mobility

View of Kalmata from the foot of Mount Taygetus

St. Nicholas' Cathedral and the Vaporia neighborhood in Syros

SYROS-ERMOUPOULIS

GREECE

Contact: Michail Zouloufos, michalis.zouloufos@gmail.com

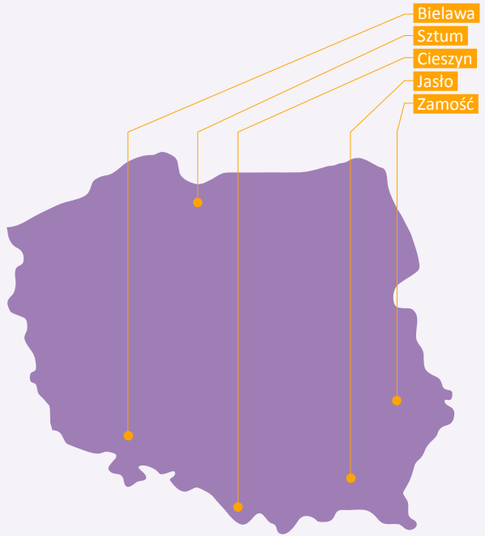
Population: 22,000

Creating a realistic local climate action plan • Reducing total energy costs and the energy consumption of public buildings • Reducing environmental footprint of water desalination units and of sanitary landfill operation • Sustainable tourism • Sustainable agricultural / farming activities

Waste and water management • Incorporating consideration of citizens' quality of life in climate action measures • Urban planning • Year-long tourism policies and activities • Collaboration with universities and the industry to write up project proposals

Energy communities • Municipal energy management • Securing EU funding • Increase environmental interventions • Possible change of legal framework

POLAND



Bielawa – model ecological city in the Sowie Mountains

BIELAWA

POLAND

Contact: Ewa Wnuk, wnuk@um.bielawa.pl

Population: 30,000

Bielawa as a model eco-town • Improving the quality of citizens' lives and the city's attractiveness for tourists • Improving air quality • Increasing the share of renewables in the energy mix

Ecological education • Thermal retrofitting of public buildings • Natural resources management

Reducing energy consumption • Involving citizens in climate action • Building bike lanes and making cycling an attractive mode of transportation • Inspiring climate action projects

CIESZYN

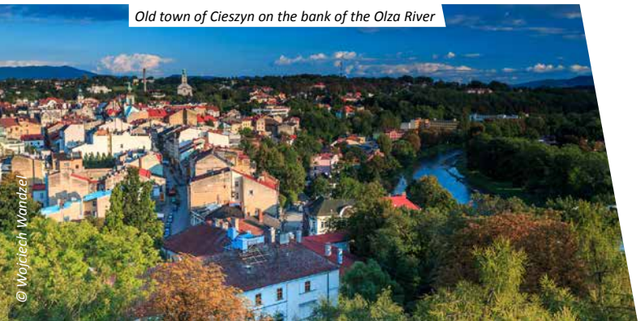
POLAND

Contact: Małgorzata Wegierek, ochrona@um.cieszyn.pl
Population: 32,924

Improving the air quality by changing the local energy mix and introducing energy-saving transport measures • Reducing energy consumption and costs • Increasing the use of renewable energy sources • Improving the attractiveness of the city for tourists

Smart city lighting • Thermal retrofitting of public buildings • Creating a local energy market (Cieszynski Energy Cluster) • Developing a low-carbon economy plan • Using a subsidy programme to replace the heat source in residential buildings

Developing a local strategy for e-mobility • Energy management in buildings • Increasing awareness among and engagement of citizens on climate action


Old town of Cieszyn on the bank of the Olza River

© Wojciech Wondze


Panoramic view of Jasło

© Wojciech Zebracki

JASŁO

POLAND

Contact: Agnieszka Piecuch-Mularska, a.piecuch-mularska@um.jaslo.pl
Population: 35,700

Improving air quality • Sustainable and efficient use of energy • Reducing final energy consumption and greenhouse gas emissions • Increasing the share of renewables in the energy mix

Implementing projects with national and European funding • Developing a Low Emission Economy Action Plan (LEEAP) • Monitoring and reducing energy consumption • Installing solar panels on public and private buildings

Effectively utilising renewable energy sources • Creating a sustainable (public) transport system • Proven measures for rational waste management • Creating urban green areas • Sustainable water management • Engaging civil society in climate action measures • Developing a climate strategy and managing human resources within the municipality to implement it

SZTUM

POLAND

Contact: Michal Mroczkowski, michal.mroczkowski@sztum.pl
Population: 18,000

Improving air quality • Tackling energy poverty • Energy efficiency in buildings • Saving energy in schools and other public buildings

Smart city lighting • Increasing the portion of renewable energy in the energy mix • Securing European funding at the regional level for renewable energy and energy efficiency projects • Developing a local energy cluster and connecting the municipality with local businesses and other municipalities

Energy cooperatives • Building a local energy market • Energy management in buildings • Efficiently managing water resources • Increasing awareness among and engagement of citizens on climate action • Improving cycling infrastructure


Panoramic view of Sztum

© Municipality of Sztum


City hall on the Great Market of Zamość

© Urząd

ZAMOŚĆ

POLAND

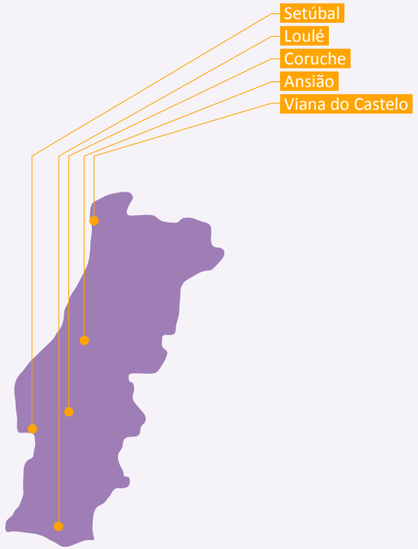
Contact: Bogusław Klimczuk, klimczuk@wp.pl
Population: 65,000

Climate action education • Improving air quality

Thermal retrofitting of public buildings • Sustainable public transport • Raising EU funds to finance energy efficiency and other climate measures • Creating a local energy market (Zamoyski Energy Cluster) • Designing urban green spaces

Innovative solutions for improving air quality, decreasing CO_2 emissions and other pollutants, developing a sustainable urban transport system • Increasing awareness among and engagement of citizens on climate action • Improving the energy infrastructure • Sustainable and efficient waste management • Engaging educational institutions on climate action • Ecological education in schools

PORTUGAL




© Municipality of Ansião

Past and present holding hands to a brighter future. Using wind power before it was cool.

ANSIÃO

PORTUGAL

Contact: Maria da Graça Campos Pinto, graca.pinto@cm-ansiao.pt
Population: 13,128

Reducing the energy consumption of municipal buildings • Real-time monitoring of the energy consumption in municipal buildings and incentivising behavioural and routine changes • Implementing a grid of electric charging stations in the main populated areas • Replacing the municipal vehicle fleet with electric cars in fixed routes • Introducing autonomous vehicles to support waste collection in industrial zones • Organic waste management and composting

Integrating citizens' daily lives with nature • Developing a municipal strategy to involve the population with the forest and fields, creating new attractions • Promoting trail running by allying sports with nature

Implementing environmental mitigation measures in low demographic density and dispersed population clusters • Raising awareness about utilising endogenous resources from a sustainable perspective

CORUCHE

PORTUGAL

Contact: Rosa Lopes, rosa.lopes@cm-coruche.pt
Population: 19,944

Implementing and monitoring the Sustainable Energy Action Plan – reduction of at least 20% of emissions by 2020 • Reducing the greenhouse gas emissions produced by coal ovens • Implementing and monitoring the Municipal Strategy and the Intermunicipal Plan for Mitigation and Adaptation to Climate Change

Water efficiency projects: efficient water management in green space irrigation – reuse of water from washing pool filters for irrigation • Energy efficiency: change public illumination to LED technology (investment of €792,796) • Energy efficiency: improving energy efficiency of public buildings (swimming pools, sports pavilion, and museum) • Promoting low carbon strategies and sustainable multimodal mobility (investment of €985,000)


© Municipality of Coruche

Coruche


© Municipality of Loulé

Loulé by night

LOULÉ

PORTUGAL

Contact: Lídia Terra, lidia.terra@cm-loule.pt /
Inês Rafael, ines.rafael@cm-loule.pt
Population: 70,622

Developing a Sustainable Energy and Climate Action Plan • Monitoring SDGs • Strengthening technical capacity within the municipal administration • Reinforcing internal governance and communicating between municipal services

Developing and implementing a Municipal Strategy for Adaptation to Climate Change (MSACC) and Municipal Plan for Adaptation to Climate Change • Promoting the Local Council, involving local stakeholders in MSACC implementation • Monitoring municipal climate action, including the development of the Municipal Observatory for Environment and Territory • Awareness and environmental education

Improving energy efficiency in schools and public buildings • Realising the energy transition on the municipal level • Measures to improve urban environmental sustainability • Territorial decarbonisation

SETÚBAL

PORTUGAL

Contact: Rute Vieira, rute.vieira@mun-setubal.pt
Population: 121,185

Pursuing more ambitious recycling goals • Creating a more circular economy producing less waste and using it in other processes • Engaging local industry to contribute to ambitious climate action and decarbonisation

Energetic efficiency in public buildings with LED technology • Environmental education in schools and with several campaigns • Waste management

Improving the capacity of municipal technicians on climate change mitigation • Supporting the implementation of local renewable energy projects • Developing and monitoring the implementation of SDGs in the region • Building good practices in urban metabolism to decrease ecological footprint

The Bay of Setúbal

© Municipality of Setúbal

© Municipality of Viana do Castelo

Viana do Castelo, Land of Sustainable Opportunity: Sea, River and Mountain

VIANA DO CASTELO

PORTUGAL

Contact: Elizabeth Pimentel de Matos, elizabeth@cm-viana-castelo.pt
Population: 88,725

Implementing local renewable energy projects • Creating a biomass/biogas plant to reduce emissions and produce renewable energy

Energy efficiency: Covenant of Mayors; public lighting; solar collectors and PV panels in swimming pools, pavilions, and schools • Energy production: wind farm and windfloat off-shore; biogas production at landfill site • Electric mobility: renewal of the car fleet for electric cars and bike; Mobi-E net-work/loading system • Climate change in local planning: public green spaces to reduce potable water; creating a monitoring committee for local strategies on adaptation and mitigation; environmental education to change consumer behaviour; project on fire prevention and fighting

Monitoring progress against sustainable energy and climate goals • Biomass and composting

ROMANIA

© Romulus Opriscan

Alba Iulia, the first Romanian city to test 100 solutions of a smart city

ALBA IULIA

ROMANIA

Contact: Gabriel Pleșa, gabiplesa_viva@yahoo.com
Population: 63,000

Decarbonising energy consumption in the main sectors, with priority given to public buildings • Increasing the amount of renewables in the local energy mix • Implementing a sustainable urban mobility strategy for a better standard of living for its citizens • Introducing and promoting smart solutions for citizens

Using renewables in the energy supply of public buildings • Integrating small-scale, smart solutions at city level in the mobility and energy sectors

Integrated energy management solutions for public buildings • Innovative financing solutions for sustainable energy projects • Creating a high level of awareness and involvement among citizens in the sustainable development of the city • Waste management

BUZĂU

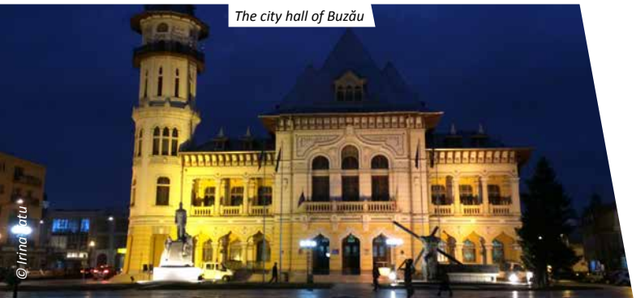
ROMANIA

Contact: George Florea, floreageorge1@yahoo.com
Population: 115,494

Implementing the Europe 2020 Strategy for smart, sustainable, and inclusive growth • Reducing CO_2 emissions by 20% by 2020 compared to 2015 levels • Increasing the energy efficiency of public and private buildings

Writing and implementing projects on energy efficiency funded through European structural funds; currently five projects with a value of €4.2 million ongoing • Renovating public transport stations and creating pedestrian areas • Waste management

Instruments for data collection regarding the consumption of electricity, natural gas, and heat supply • Measures to reduce the energy consumption in public and private buildings • Reducing CO_2 emissions from public transport • Increasing the efficiency of the public lighting system


© Irina Botu

The city hall of Buzău


© Deva Municipality

Aerial view of Deva Fortress and the city

DEVA

ROMANIA

Contact: Mariana Miha, mariana.miha@primariadeva.ro
Population: 69,000

Sustainable urban mobility, promoting public transport via electric buses and bike lanes • Retrofitting municipal buildings to reduce their energy consumption • Supporting owners and building associations in increasing the energy efficiency inresidential buildings • Developing/extending urban green spaces • Monitoring energy consumption in municipal buildings

Creating and implementing projects financed from European structural funds • Implementing energy efficiency measures in public and residential buildings • Monitoring energy consumption in municipal buildings

Communicating with citizens about climate actions and sustainable energy • Sustainable urban mobility • Green public procurement • Managing and creating synergies between urban planning documents

RÂMNICU VÂLCEA

ROMANIA

Contact: Mirela Turcu, mirela.turcu@primariavl.ro
Population: 118,398

Developing and implementing green projects aimed at reducing urban pollution • Improving the energy efficiency of buildings • Increasing the share of renewables in the energy mix • Efficient and sustainable waste management

Energy efficiency of buildings • Improving the energy efficiency of the public lighting system • Sustainable mobility

Innovative social and economic climate change mitigation measures • Solutions and tips for raising awareness and involving citizens in climate action • Obtaining support for the local administration's climate action measures • Identifying financing sources for climate action measures • Improving communication and coordination among the departments of local government

Zăvoi city park – rehabilitation example of urban green spaces through European funds


© Râmnicu Vâlcea Municipality


© Zalău Municipality

Zalău – Energy efficient building renovation & examples of sustainable mobility measures

ZALĂU

ROMANIA

Contact: Rodica Ciurte, ciurterodica@zalausj.ro
Population: 69,535

Reducing energy consumption in public buildings and public services • Sustainable mobility and the use of electric buses in the public transport system • Renewable energy production and use

Securing structural funds for energy efficiency investments • Renovating residential and municipal buildings, especially schools • Improving the efficiency of the public lighting system

Technical solutions to reduce energy consumption in public buildings and services • Tools for sustainable energy management • Solutions for adapting to climate changes • Managing and creating synergies between urban planning documents • Facilitating reduced energy consumption of private buildings • Incorporating climate actions into a general urban plan and in other urban planning documents

CONNECTING AND COLLABORATING AMONG SCHOOLS

BEACON's work in schools aims to understand the local educational context in the target countries, jointly develop and modify energy-saving models in schools, develop capacity and raise awareness for climate action among teachers and pupils, and share diverse experiences and best practices with other schools and policymakers. The project involves 45 schools from the Czech Republic, Romania, and Bulgaria as well as twelve from Germany.

The diverse range of activities is characterised by a participatory and holistic approach as all stakeholders in schools play a role in creating an open, comfortable, and energy efficient environment in which to learn.

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Hannover school participates in Global Climate Strike for Future on 15 March 2019

BEACON aims to promote behavioural change and achieve energy savings.

57 SCHOOLS

Project activities include:

- Analysing of **climate action in lessons plans and curricula** to identify potential gaps in learning goals and outcomes related to climate action
- **Workshops on climate change** with a range of stakeholders from schools and government to develop a joint understanding of the local context
- **Continuing education for teachers and administrators** to increase capacity to improve climate action education
- **Climate action days** for pupils to engage and motivate students
- Providing of **measuring equipment** to use in the classroom to facilitate and create hands-on learning experiences on energy
- Developing an **incentive system for realising energy savings** in schools to create a lasting model that can be scaled to other schools within the respective country
- Implementing of **concrete energy savings measures** to realise energy savings goals and plans
- **Study tours** from target countries to Germany to incorporate best practices and experiences from German schools

BEACON aims to promote behavioural change and achieve energy savings through these activities. Our work in schools should empower stakeholders to take practical measures to make a difference in the fight against climate change in their schools and communities.


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UfU staff explains quick response thermometer at a teacher training in Bulgaria

Bulgaria

15

Veliko Tarnovo	Vasil Drumev High School of Mathematics and Informatics
	St. Patriarch Evtimii Elementary School
	PR Slaveykov Primary School
Kilifarevo	Neofit Rilski Primary School
Pavel Banya	Nikola Y. Vaptsarov Primary School
	Hristo Botev High School
	Vocational High School of Restaurant and Hospitality
	General Skobelev Primary School
Sofia	56 Konstantin Irechek Secondary School
	79 Indira Gandhi Secondary School
	40 Louis Pasteur Secondary School
	90 Gen. Jose de San Martín Secondary School
Samokov	Nikola Velchev Sports School
	Otets Paisiy Secondary School
	Hristo Maximov Primary School

Teachers from Pavel Banya and trainers from UfU during the teacher training in Sofia

© NTEF

Pupils from 56 Konstantin Irechek Secondary School, Sofia

© NTEF

© Scoala Gimnaziala Ion Agarbiceanu

Students from Scoala Gimnaziala Ion Agarbiceanu in Alba Iulia discuss why climate change is important.

Pupils from Goethe Kolleg in Bucharest

© Goethe Kolleg

Romania

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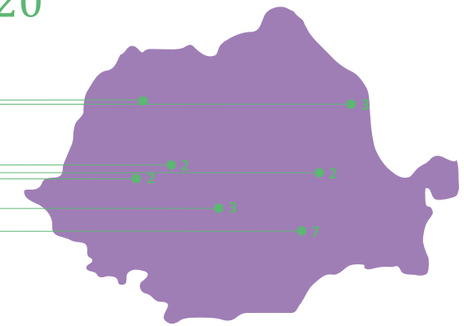
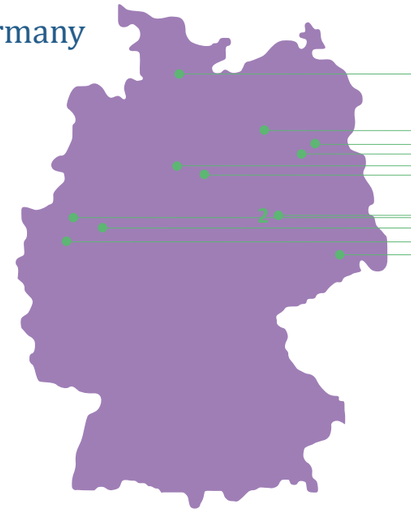


Zalău	Scoala Gimnaziala Simion Barnutiu
Barlad	Scoala Gimnaziala Episcop Iacov Antonovici
	Scoala Gimnaziala Manolache Costache Epureanu
	Liceul Tehnologic Petru Rares
Alba Iulia	Scoala Gimnaziala Mihai Eminescu
	Scoala Gimnaziala Ion Agarbiceanu
Buzău	Scola Gimnaziala Nr. 7
	Liceul Teoretic Alexandru Marghiloman
Deva	Colegiul Tehnic Energetic Dragomir Hurmuzescu
	Colegiul Tehnic Transilvania
Ploiesti	Colegiul Tehnic Lazar Edeleanu
Râmnicu Vâlcea	Scoala Gimnaziala Anton Pann
	Colegiul National Mircea Cel Batran
Bukarest	Scoala Gimnaziala Nr. 56
	DSBU
	Colegul National Kretelescu
	Goethe Kolleg
	Scoala Gimnaziala Nr. 20
	Scoala Gimnaziala Liviu Rebreanu
	Scoala Gimnaziala Cezar Bolliac

Germany



Norderstedt	Lise-Meitner-Gymnasium
Hohennauen	Kleine Grundschule Hohennauen
Eberswalde	Grundschule Finow
Potsdam	Grundschule am Humboldt-Ring
Hannover	Grundschule Beuthener Straße
Braunschweig	Realschule Nibelungen
Halle	St. Franziskus Grundschule
	Neues Städtisches Gymnasium
Bottrop	Josef-Albers-Gymnasium
Arnsberg	Städtisches Gymnasium Laurentianum
Düsseldorf	Martin-Luther-Grundschule
Pirna	Grundschule Graupa

12


© Martin-Luther-Grundschule

Martin-Luther-Grundschule pupils create posters for climate action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Teachers at kickoff meeting for schools partnerships in Hannover

© BEACON

Measuring instruments are provided to participating schools


© UfU e.V.

Czech teachers participate in introductory workshop with UfU staff

Czech Republic

ZŠ Kněžice	Kněžice
ZŠ 5. Května	Rožnov pod
Radhoštěm	
ZŠ Pod Skalkou	
ZŠ Josefa Hlávky	Přeštice
1. ZŠ T.G. Masaryka	Milevsko
2. ZŠ Komenského	
Gymnázium Milevsko	
ZŠ a MŠ Josefa Kajetána Tyla	Písek
ZŠ Národní	Prachatice
ZŠ Zlatá stezka	

10

MEET THE TEAM

- Navigant
- adelphi
- Independent Institute for Environmental Issues (UfU)
- The Association of Municipalities Polish Network (PNEC)
- SEVEn, The Energy Efficiency Center
- National Trust Ecofund Bulgaria (NTEF)
- Energy Cities Romania (OER)
- ENVIRON Association
- Centre for Renewable Energy Sources and Saving (CRES)
- FCiências.ID – University of Lisbon
- Energy Cities

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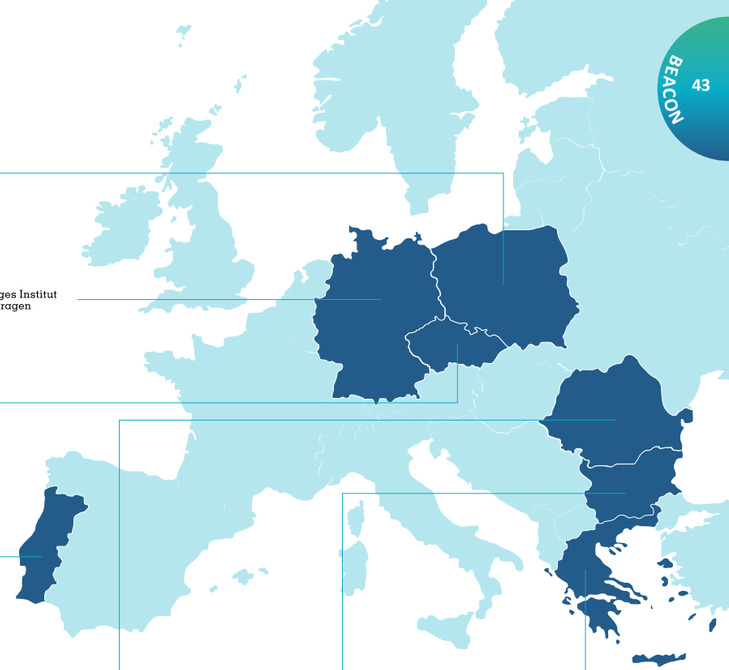

Network partner:

Visit the BEACON page on the EUKI website:
www.euki.de/euki-projects/beacon

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Email us at:
BEACON_HelpDesk@navigant.com

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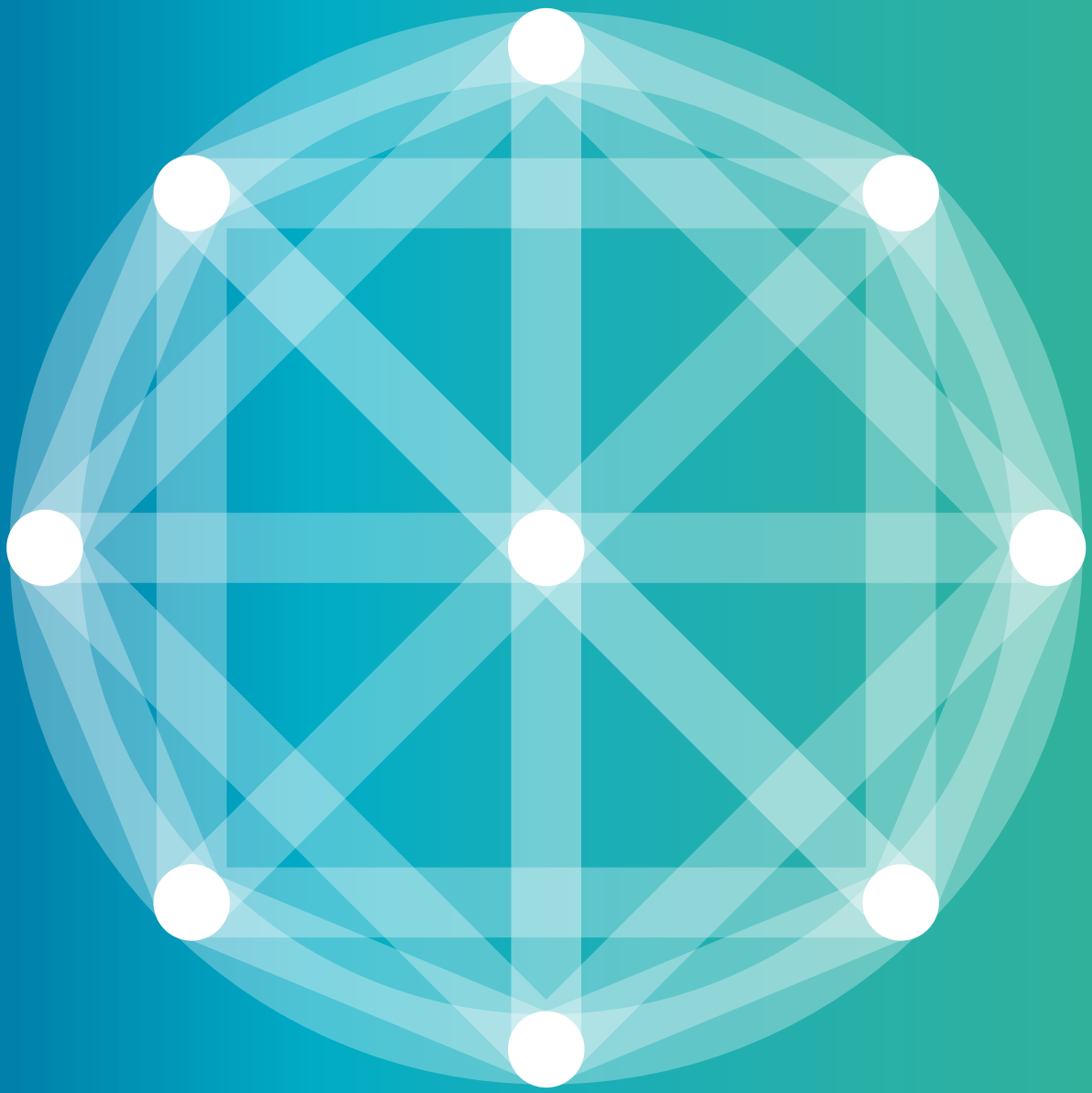
Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

European
Climate Initiative
EUKI

Annex 3: Roadmap for Local Climate Change Mitigation



Roadmap for local climate change mitigation

A science-based policy brief to guide municipal administrations towards their own climate change mitigation pathways

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BEACON Bridging European & Local Climate Action

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Introduction

The Paris Agreement intends to limit global warming to 1.5°C above pre-industrial levels.[1] The European Green Deal aims to achieve carbon neutrality in Europe by 2050.[2] The sustainable development goals (SDGs) aim to take urgent action to combat climate change and its impacts.[3] It is clear that the world, including citizens across Europe, are demanding that different levels of government increase their efforts in mitigating climate change. Local governments can play an important role in achieving the desired reduction of emissions whilst fostering sustainable development. [4]

What can I learn from this Roadmap?

This science-based policy brief constitutes a comprehensive roadmap to approach climate change mitigation at the municipal level; it is designed for European and other countries from the Organisation for Economic Co-operation and Development (OECD). It presents general guidelines that local authorities can follow to support mitigation pathways that are adaptable to each municipal context. It addresses the existing gap between what the science proposes and what could potentially be accomplished by local governments in practice. In addition, this roadmap promotes a better understanding of the breadth and multi-sectoral character of the climate change mitigation challenge. It enhances the existing links among different local measures, projects, and other related municipal initiatives in climate action, with the aim of reducing municipal efforts and increasing efficacy and efficiency.

How this road map for local mitigation is structured:

The recommendations provided are framed by the main domains of a municipality's competencies and are primarily anchored in the guidelines of the Intergovernmental Panel on Climate Change (IPCC). The different domains where mitigation can take place at the local level include the following:

- Governance
- Education & Communication
- Land Use (Agriculture, forestry and other land use)
- Consumption Patterns
- Waste Management
- Energy
- Transportation and Mobility
- Spatial Planning

A decision was made to link each mitigation recommendation to its related sustainable development target in order to further support local governments. This allows the municipality to move forward on both dimensions (climate action and sustainable development) simultaneously.

Which recommendations ideally fit with your municipality context?

Each municipality has its own reality. For that reason, your municipality may prefer some recommendations over others. That is completely normal, as these recommendations are not site-specific and are broad in order to fit any European or OECD municipality. Nonetheless, the aim of this document is to provide an initial roadmap to implement mitigation in your municipality, relying on local government knowledge and experience to adjust the recommendations to each situation.

How can you use this policy brief?

From the eight domains considered for climate change mitigation, we recommend starting with the domain that would have the highest interest and impact for your municipality and thereafter setting your own priorities and goals within this framework. Furthermore, we encourage you to analyse the lesser-explored domains, as these may inspire you to integrate them into your current municipal climate action plans – enhancing your implementation strategy, as well as, helping to realise short to medium term local impacts.

Learning from European Peers: Case Examples and Practical Examples

Throughout the document cases and examples are presented to elaborate and substantiate the recommendations. Case examples draw from experiences from implemented projects where as practical examples are general suggestions and tips for what concrete steps one can take next.

Collaboration starts here!

To ensure its success, it is crucial to share the Roadmap with your colleagues and others specialised in the chosen domains.

Co-create with us!

If you would like to promote your success stories and inspire other municipalities or see what other municipalities have been doing lately around Europe then check out our catalogue of experiences. The stories can be accessed via *this link*. Please follow the instructions on the page to add your story. For any questions feel to contact **mmgarcia@fc.ul.pt** or **bernstein@adelphi.de**

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Recommendations for local climate change mitigation	SDGs and Targets
A. Provisioning Sustainable Services/ Green Public Procurement	 **13.2:** Integrate climate change measures into national policies, strategies and planning.[3]
B. Promote Information Policies	
C. Undertake Voluntary Actions	 **17.14:** Enhance policy coherence for sustainable development.[3]
D. (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation	
E. Establish Stakeholder Partnerships	 **17.16:** Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries.[3] **17.17** Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.[3]
F. Re-arrange Internal Structures of the Local administration	
G. Capacity Building for Local Administrations in Climate Action	 **13.3:** Improve education, awareness-rising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.[3]

Governance capacity is highly related to the effectiveness of climate policy.[5, p. 41] Climate change mitigation is a technically feasible exercise, but it necessitates that institutional arrangements, governance mechanisms, and financial resources are aligned with the goal of reducing greenhouse gas emissions.[5, p. 92]

Governing framework for climate change mitigation.
Local authorities can follow the following complementary styles:

- Governing by provision: The municipality takes the lead in providing sustainable services (water, electricity, public housing, transport, and so on).[6]
- Governing by enabling: The municipality acts as a facilitator, such as by enacting subsidies and loan schemes, distributing information, coordinating climate action among actors and establishing public-private partnerships.[6] Voluntary actions and information policies can be included in this style of governing.

The model of governing for climate change mitigation can be summarised by the following:
It involves governing by provisioning sustainable services and using all available politic instruments for climate change mitigation, specifically the information policies and voluntary actions, increasing (re) municipalisation of municipal services, enhancing the collaboration and participating through stakeholder-partnership.

Recommendations

A- Provisioning Sustainable Services/Green Public Procurement

The provisioning of sustainable services could be the key to fostering climate change mitigation among municipal actors.

Practical Example

The integration of green public procurement and the obtainment of environmental certifications in public services like the EU Eco-Management and Audit Scheme (EMAS) or the International Organisation for Standardisation (ISO) can be the starting point for achieving this recommendation. (See chapter on Consumption Patterns, p. 23).

Related Sustainable Development Goals (SDGs):

This recommendation is linked to SDG 13 (Climate Action), adapting the national context to the local level, and SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5, p. 116] The concrete targets include the following:

13.2: Integrate climate change measures into national policies, strategies and planning.[3]

17.14: Enhance policy coherence for sustainable development.[3]

B- Promote Information Policies

By governing by enabling, informing the population about the status of the municipality in terms of climate change mitigation can not only support policymakers in proceeding with efficient and effective climate policy but additionally contribute to raising awareness among local actors and citizens. (See chapter on Education and Communication, p. 13).

Practical Example

Invest in monitoring municipal greenhouse gases emissions through the creation of an emissions inventory. The Mitigation Goal Standard published by the Greenhouse Gas Protocol provides an accounting and reporting standard for national and subnational GHG reduction goals.[7] Details include, *inter alia*, designing a mitigation goal, estimating base year emissions, accounting for the land sector and monitoring and verification.

Recommendations

Related SDGs:

This recommendation is linked to SDG 13 (Climate Action), adapting the national context to the local level, and SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5, p. 116] The concrete targets include the following:

13.2: Integrate climate change measures into national policies, strategies and planning.[3]

17.14: Enhance policy coherence for sustainable development.[3]

C- Undertake Voluntary Actions

Often national or EU-level mandates and regulations do not perfectly align or match local municipal ambition. Non-mandatory actions can support the desired model of climate change mitigation governance.

Practical Example

The Covenant of Mayors aims to introduce a bottom-up approach to climate action action plans from the municipalities to upper-level administrations (regional to national level). This produces multi-level cooperation and creates a local context-framework for action.[8]

Related SDGs:

This recommendation is linked to SDG 13 (Climate Action), adapting the national context to the local level, and SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5,p. 116] The concrete targets include the following:

13.2: Integrate climate change measures into national policies, strategies and planning.[3]

17.14: Enhance policy coherence for sustainable development.[3]

D- (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation

(Re)municipalisation is the process of bringing previously private or privatised services under local public control and management, including services that have frequently been in private hands or services that do not yet exist.[9]

Did you know?

Publicly managed services are generally more focused on quality, universal access, affordability and the delivery of broader social and environmental objectives.[9] Thus, (re)municipalisation could be the key to achieving local climate change mitigation goals[9], particularly in the energy sector, where new local public companies and co-operatives have been pioneering an energy transition based on renewables. It is relevant for other sectors as well, such as transportation and waste management services.[9]

Related SDGs:

This recommendation is linked to SDG 13 (Climate Action), adapting the national context to the local level, and SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5, p. 116] The concrete targets include the following:

13.2: Integrate climate change measures into national policies, strategies and planning.[3]

17.14: Enhance policy coherence for sustainable development.[3]

E- Establish Stakeholder Partnerships

Partnerships are crucial**.** They extend the operation of the state by facilitating further action form external actors.[10] Four core groups have been identified to foster collaboration and participation with local administration in the local climate change mitigation process:

- Private sector. Local business and industry can have an important role in contributing to the reduction and capture of territorial GHG emissions.
- NGOs or associations. These can play an important role in connecting knowledge with responsibility and promoting norms of accountability.[5, p. 1186]

Recommendations

- Civil society. Civil society can increase the likelihood of success for climate policy through increased participation.

- Other related local authorities or public institutions. Local administrations can receive support by collaborating with other municipalities or regional agencies. Additionally, they can foster climate action by establishing partnerships with local educational institutions.

Case example

In 2019, the Sztum City Council held a climate change session inviting representatives from various local circles working with energy and environment including the Sztum energy cluster.[11]Leaders from the town joined city councillors in discussing local climate change strategy.

Case example

The Irish government established a Citizens' Assembly between 2016-2018 to, inter alia, answer questions about the future of irish climate policy.[12] The assembly brought together 99 citizens and gave them the time, space and structure to consider climate policy questions in a deliberative manner. Not only were the outcomes internalised by the government, the assembly provided a platform for engaging and communicating with the wider citizenry on climate change.

Related SDGs:

This recommendation is linked to SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5, p. 116] The concrete targets include the following:

17.16: Enhance global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilise and share knowledge, expertise, technology and financial resources to support the achievement of the SDGs in all countries, particularly in developing countries.[3]

17.17: Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.[3]

F- Rearrange the Internal Structure of the Local Administration

Effective climate policy involves building institutions and the capacity for governance.[5, p. 41]Due to the multidisciplinary character of the climate change challenge, fostering collaboration, cooperation, and information sharing among local administration divisions may play an important role in the implementation of local policies for climate change mitigation.

Internal structures for effective climate action: three main structures were identified for local administrations to encourage climate action policy implementation.[13]

- **Climate unit, centralised climate structure:** The municipality creates a team led by a coordinator, who is the central focal point. The unit leads the communication with all relevant stakeholders (both internal and external) and coordinates the implementation of the climate action strategy. The technical departments are supported in their daily work by this multidisciplinary team. The unit ensures suitable information flow among departments, initiates projects, looks for funding, collects information and contacts, and keeps track of progress. The coordinator additionally ensures that the various projects complement each other and support the achievement of both climate change mitigation and adaptation. The coordinator has to be well-connected with and well respected by decision-makers and other departments.

- **Expert team, decentralised climate structure:** The municipality assigns persons responsible for climate action in all departments. They coordinate activities in their specific area and meet on a regular basis, for instance in the form of internal roundtables (for example, Bottrop in Germany, Ansião in Portugal). Taskforces or working groups convene every (other) month, for example. Central reporting obligations and well-structured meetings help keep track of progress and avoid overlaps.

- **Hybrid, decentralised expert team led by one coordinator:** It is often difficult to significantly rearrange internal structures; therefore, it may be easier to assign a central (well-respected and well-connected) coordinator who is supported by a decentralised, multidisciplinary team, instead of reorganising the entire administration and creating a single climate division. In this scenario, the coordinator keeps the decentralised team on track.

Recommendations

Regardless of the chosen structure, it is important to ensure the flow of the information among departments and continuously improve the structure.

Related SDGs:

This recommendation is linked to SDG 17 (Partnership for the Goals), understanding that climate action is an inherent part of sustainable development.[5, p. 116] The concrete targets include the following:

17.16: Enhance global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilise and share knowledge, expertise, technology and financial resources to support the achievement of the SDGs in all countries, particularly in developing countries.[3]

17.17: Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.[3]

G- Capacity Building for Local Administrations in Climate Action

Decision-makers frequently have insufficient or imperfect knowledge about climate risk deficits that can and need to be addressed with better data and public education.[5, p. 160] Building capacity in climate action at the local administrative level, using both general and area- specific training, can improve municipal competencies to increase accountability in the mitigation process.

Related SDGs:

This recommendation is linked to SDG 13 (Climate Action) and includes the following targets:

13.3: Improve education, raise awareness and increase human and institutional capacity for climate change mitigation, adaptation, impact reduction and early warning.[3]

Recommendations for local climate change mitigation	SDGs and Targets
A. Education on Climate Change	
A.1 Promote climate change education in schools and other educational institutions	 **4.7:** By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.[3]
A.2 Promote climate change education for citizens not currently enrolled in an education	
B. Communication on Climate Change	
B.1 Dissemination of general information on climate change and local environmental conditions	
B.2 Dissemination of information on actions taken by the municipality to mitigate climate change	 **13.3:** Improve education, awareness-rising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.[3]
B.3 Invest in non-comercial advertising campaigns to increase citizen awareness about the climate change crisis and regenerative responses	

Did you know?

Education and communication on climate situation may be crucial for inducing a behaviour change in the citizenry, promoting their contribution to climate change mitigation and strengthening the work of the local administration.

This chapter focuses on the education and communication of climate change topics more generally, since the other domains presented already include a specific education and communication component.

Related SDGs:

The following recommendations are divided into their education and communication components, both being linked to SDGs 4 (Quality Education) and 13 (Climate Action). They include the following concrete targets:

4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.[3]

13.3: Improve education, awareness-rising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.[3]

Recommendations

A- Education on Climate Change

Local authorities should promote education on climate change and additionally increase the capacity for climate action among their citizens.

Did you know?

As part of education-related sustainable development[14], education for climate action aims to empower learners to make informed decisions on climate change mitigation, thus transforming society.

Generally, education on climate change mitigation can be used to explain the severity of the climate crisis, its potential consequences and the potential solutions that can be implemented.

Case example

In the Czech Republic, supported by the Ministry of environment, the network of environmental education centres (Ecocentres) offers a wide array of educational products for schools and the general public.[15]

Practical example

Many NGOs and associations are taking the lead in environmental education. Municipalities can additionally collaborate, increasing the capacity for climate action among their citizens.

For better results in the education component, it may be important to address education by differentiating by age and separating the target audience dependent on whether they are currently enrolled in an educational program or not.

Related recommendations

A.1- Promote climate change education in schools and other educational institutions

Using schools as hotspots for inducing climate change education is a formula that several municipalities are following.

Case example

In the BEACON project, 57 schools in Germany, the Czech-Republic, Romania and Bulgaria, in collaboration with their municipalities, are working to increase awareness of climate change issues.[16]

Recommendations

A.2- Promote climate change education for citizens not currently enrolled in an education

Persons not enrolled in an education also need to have the ability to tackle climate change! Increasing general education on the topic among the wider public can increase the degree of acceptance towards municipal measures taken for climate change mitigation.

Practical example

Conferences and training sessions can be offered by a municipality at different periods throughout the year to increase awareness on the climate change issue.

B- Communication on Climate Change

Communication is the basis for increasing awareness in the population. We encourage municipalities to disseminate general information on the issue and the actions being taken by the local administration by communicating through effective advertising campaigns that reach a wide audience.

Related recommendations

B.1- Dissemination of general information on climate change and local environmental conditions

Practical example

Municipalities can put relevant climate change information at the top of their communication agendas to keep citizens informed about the current approach for inducing climate action.

Case example

The Municipality of Setúbal reports real time information on air pollution in certain streets within the municipality.[17, 18]

B.2- Dissemination of information on actions taken by the municipality to mitigate climate change

Local authorities should inform citizens about the measures taken to mitigate climate change in the municipality as this could further incentivise the population to take action as well.

Practical example

Information policies are potential resources for informing the population on the current status of the municipality's climate action (I.e.: emissions inventory) (See chapter on Governance, p. 7).

B.3- Invest in non-comercial advertising campaigns to increase citizen awareness about the climate change crisis and regenerative responses

It is widely known that advertising campaigns can induce behavioural changes.[19, 20]

Practical example

Municipalities could invest in marketing in the way that private enterprises do in order to facilitate the acceptance and adoption of their climate change policies.

Recommendations for local climate change mitigation	SDGs and Targets
A. Promote Sustainable Land Management	 **15.1:** By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forest, wetlands, mountains and drylands, in line with obligations under international agreements.[3] **15.5:** Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.[3] **15.9:** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.[3]
B. Sustainable Food Production **B.1** Promote organic farming systems **B.2** Increase urban and peri-urban organic food production **B.3** Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge	 **2.4:** By 2030, ensure sustainable food production systems and implement resilient practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.[3]
C. Sustainable Forest Management **C.1** Increase municipal forest area **C.2** Reduce forest loss and degradation caused by forestry activity **C.3** Avoid conversion from forest land to other land use, particularly from switching into cropland or monocultures **C.4** Implement operational and effective wildfires management	 **15.2:** By 2020, promote the implementation of sustainable management of all types of forest, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.[3] **15.b:** Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.[3]
D. Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltrations	 **6.6:** By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers and lakes.[3]  **15.3:** By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.[3]
E. Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	 **11.7:** By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.[3]  **15.9:** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.[3]

Land is the main resource of ecosystem services, and its use directly affects the economy and quality of life. [5, p. 818] Not only does it provide food to feed the Earth's population, but it can affect the climate depending on its use or activity.[5, p. 818] Changes in land conditions affect global and regional climates, reducing or accentuating warming and can affect the intensity, frequency, and duration of extreme events.[22, p. 11]

Depending on land use and management, GHG sinks could increase (for example, afforestation, management for soil carbon sequestration...) or decrease, thereby increasing GHG emissions (for example through deforestation, rice cultivation...). [5, Ch. 11]

Did you know?

Land use accounts for 23% of total anthropogenic greenhouse gas emissions (2007–2016), namely 13% of carbon dioxide (CO_2), 44% of methane (CH_4) and 82% of nitrous oxide (N_2O).[22, p. 7]

Local authorities can play an important role in managing land use in their territories and contributing to climate change mitigation. Land use is an important challenge due to the large number of intervention areas that it includes (for example, agriculture, food security, forest management, ecosystem conservation, and so on). [22]

Nevertheless, approaching climate action in the land use sector could lead to several co-benefits, doubling results with less inputs (reduction of land degradation and desertification processes, enhancement of biodiversity and food security, increases in air quality and water regulation, reduction of energy consumption, improvements in public health, and other socio-economic benefits)[22], [23]

Recommendations

A- Promote Sustainable Land Management

Sustainable land management is defined as the use of land resources, including soil, water, animals and plants, for the production of goods to meet changing human needs, while ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. [21]

Practical examples

- Avoid land degradation and deforestation due to land activity.
- Recover or restore degraded land areas.
- Avoid land use competition, as it can lead to a reduction in carbon sink areas (for example, turning forest areas into crops). It is crucial to be consistent and efficient during the municipal spatial planning process.
- Integrate ecosystem or nature-based solutions (E/NBS) into all levels of the local planning process.

Ecosystem-based solutions are sustainable strategies based on natural processes and cycles that use natural flows of matter and energy, taking advantage of local solutions and following the seasonal and temporal changes of the ecosystems.[24] (See chapter on Spatial Planning, p. 44).

Did you know?

Well-designed E/NBS require low energy inputs as they integrate nature's natural energy of nature, being the most suitable solutions for local climate action.

Related SDGs:

This general recommendation can be linked with SDG 15 (Life on Land) concretely, not limited to the following targets:

15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forest, wetlands, mountains and drylands, in line with obligations under international agreements.[3]

15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.[3]

Recommendations

15.9: By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.[3]

B- Sustainable Food Production:

The vision of the Food and Agriculture Organisation (FAO) related to sustainable food production aims for a world in which food is nutritious and accessible for all, and natural resources are managed in a way that allows ecosystem functions to support current as well as future human needs.[25, p. 143]

Did you know?

The sustainable food production system is not compatible with the "conventional" food production system, which often leads to the depletion of agroecological resilience and, hence, natural capital.[24], [25, p. 140]

This "conventional" system that is spread across the world is based on homogeneity: genetic uniform varieties grown with high levels of complementary inputs like non-sustainable irrigation practices, fertiliser, and pesticides.[24], [25, Ch. 10], [26]

A practical framework for sustainable food production: Sustainable food production can be framed as organic farming, following the European Union (EU) standards for organic food production,[27] which respects the natural fluctuations that maintain ecosystem functions that are associated with organic soil carbon management.

Related SDGs:

The following proposed recommendation related to food production is linked to SDG 2 (Zero Hunger) and includes the following concrete target:

2.4: By 2030, ensure sustainable food production systems and implement resilient practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.[3]

Related recommendations

B.1: Promote the organic farming systems

Local authorities should promote organic farming (in line with EU standards) among existing or potential local food producers, turning as much of the municipal food production as possible into organic farming.

Did you know?

Organic farming not only contributes to climate change mitigation but additionally leads to human adaptation to climate change, increasing food security and combatting desertification and land degradation.[22, p. 19]

Practical example

Agroforestry is an agricultural technique for food production that qualifies under the EU standards of organic farming. Agroforestry has the important advantage of leading to a mitigation-adaptation synergy in the agriculture sector.[5, p. 847]

B.2: Increase urban and peri-urban organic food production

Local authorities should collaborate to increase food production in the urban and peri-urban areas in order to supply the local population. Supply food near where it is demanded; this reduces the emissions associated with food's transportation and can potentially prevent food losses. (See chapter on Consumption Patterns, p. 23).

Did you know?

Regarding the location of food production, industrial agriculture, along with subsistence agriculture, is the most significant driver of deforestation in tropical and subtropical countries, accounting for 80% of deforestation from 2000-2010.[28]

Avoiding land use competition is another co-benefit resulting from the increase in urban and peri-urban food production, moving food production close to where the majority of the demand is generated.

B.3: Promote improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge

A municipality should support "conventional" local agricultural producers in switching to organic farming. At the same time, it is important to recognise ancestral knowledge in the agricultural sector, defined as knowledge existing before the green revolution which

Recommendations

started in 1950, the starting point of unsustainable "conventional" agricultural practices. [22, p. 31], [25, p. 140]

Did you know?

Ancestral knowledge in some agricultural practices contributes to overcoming combined challenges, including climate change, food security, biodiversity conservation, desertification and land degradation.[22, p. 31]

The role of the municipality would be to enhance or rescue these practices normally held by the indigenous and or local elderly citizens, and integrate them into the process of improving capacity and facilitating the switch to organic food production.

Practical example

Municipalities can integrate pedagogic gardens into municipal schools to to start teaching about organic farming at an early age.

C- Sustainable Forest Management:

Forests (as well as peatlands, bogs, swamplands, mangroves, bodies of water, etc.) have an enormous potential for contributing to climate change mitigation due to their inherent function as carbon sinks. Local authorities should increase their efforts in increasing the value of their forest areas.

What is a forest?

It is important to define what a forest is since the word is frequently used incorrectly to name monocultures of trees. These monocultural practices can induce soil degradation.[26]

It is crucial to follow the natural forest definition provided by the International Union for Conservation of Nature (IUCN), which draws from the Forest Stewardship Council: areas where many of the principal characteristics and key elements of native ecosystems such as complexity, structure and diversity are present[29], as well as approved national and regional standards for forest management.[30]

Related SDGs:

The following recommendations based on the IUCN natural forest definition are linked to SDG 15 (Life on Land) and include the following concrete targets:

15.2: By 2020, promote the implementation of sustainable management of all types of forest, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.[3]

15.b: Mobilise significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries for advancing such management, including for conservation and reforestation.[3]

Related recommendations:

C.1: Increase municipal forest area

Municipal forest area can be increased by protecting the existing municipal forest areas and recovering the degraded areas. Additionally, a municipality can facilitate the establishment of new areas of forest in its territory in order to pursue climate change mitigation.

C.2: Reduce forest loss and degradation caused by forestry activity

Increase sustainable forest management, specifically addressing the forest industry.
A municipality can promote sustainable forest management certification among players in the forestry industry. (See Consumption Patterns chapter, p.23)

C.3: Avoid conversion from forest land to other land use, particularly when switching into cropland or monocultures

Avoid land use competition that drives the loss of forest by conversion into other land activities, particularly monocultures (planting the same types of tree species).

C.4: Implement operational and effective wildfires management

Mobilise resources to ensure operational and effective wildfire management. Additionally, municipalities should increase efforts to prevent these catastrophic events.

Did you know?

Climate change may exacerbate the occurrence of wildfires.[22, p. 16] This not only implies the depletion of the forest and, hence, carbon sinks but, additionally, the release of stored carbon into the atmosphere, aggravating the climate crisis.

Recommendations

D- Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltration

Municipalities should increase soil fertility and soil carbon sequestration by increasing the soil's capacity for storing water. [5, p. 964], [31] Moreover, increasing soil capacity for storing water leads to a potential synergy between mitigation and adaptation since it increases soil carbon sequestration and, simultaneously, can reduce the risk of flooding.[32]

Did you know?

Increasing soil fertility not only contributes to preventing desertification but additionally increases the possibility of capturing carbon in the soil, contributing to climate change mitigation.[22, p. 22]

Solutions to increasing soil fertility include but are not limited to agroforestry, ecosystem-based solutions and organic farming. Additional solutions include adopting a circular economy through reusing organic waste and composting processes. [22], [33] (See Waste Management chapter, p. 30)

Practical example

Local authorities can increase groundwater infiltration by limiting land-impermeable areas in their territory as well as supporting soil creation (both in terms of depth and the content of organic matter).

Related SDGs:

This recommendation can be linked with SDG 15 (Life on Land), having the target 15.3 of increasing soil fertility as a method of combatting desertification. Additionally, linked to SDG 6 (Clean Water and Sanitation), target 6.6 considers the increase of soil water permeability as way of protecting related water ecosystems (for example, aquifers).

6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers and lakes.[3]

15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.[3]

E- Increase Green Urban Spaces and Infrastructure, paying special attention to Local Biodiversity

Municipalities should seek to integrate the ecosystem service approach (via Green Infrastructure, nature-based solutions or both) in their urban planning processes. Further approaches should be to adopt methods for mapping, carry out assessments of ecosystem services, to promote payments for ecosystem services and conduct calculations of the (economic) cost of their use.[34]

Did you know?

The EU Green infrastructure (GI) Strategy defines GI as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services [34] GI can refer to rural, peri-urban, or urban settings, covering terrestrial, coastal and marine areas. [34]One of the key aims of the GI EU Strategy is to enable potential co-benefits, namely climate change mitigation and adaptation, reduced energy use, disaster risk management, food provision, biodiversity conservation, health and well-being, recreation, increased land and property values, competitiveness and economic growth and the enhancement of territorial cohesion. [34] GI is closely linked to ecosystem/nature-based solutions, as both could potentially increase ecosystem services, leading to increased carbon sinks, thereby reducing GHG emissions.

Local authorities should increase green urban infrastructure in urban and peri-urban areas, establishing a balance between urbanisation and green spaces to increase the land use mix. (See Spatial Planning chapter, p. 47).

Related SDGs:

The following recommendation could be linked to SDGs 11 (Sustainable Cities and Communities) and 15 (Life on Land), using the following concrete targets:

11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.[3]

15.9: By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.[3]

Recommendations for local climate change mitigation	SDGs and Targets
A. Promote the Consumption-Based Accounting Methodology for GHG: The Carbon Footprint	 **12.6:** Encourage companies, especially large and transnational companies, to adopt sustainable practises and to integrate sustainability information into their reporting cycles.[3]
B. Adopt Green Public Procurement	**12.7:** Promote public procurement practises that are sustainable, in accordance with national policies and priorities.[3] **(Only for B recommendation)**
C. Promote Seasonal, Organic and Local Produced Food Consumption Without Animal Products	 **12.2:** By 2030, achieve the sustainable management and efficient use of natural resources.[3]
D. Promote a Reduction in Consumerist Behaviour	**12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3] **(Only for D recommendation)**
E. Promote Sustainable Consumption	**12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.[3]
F. Facilitate Locally Produced Product Consumption	

Recommendations

A- Promote the Consumption-Based Accounting Methodology for GHG: The Carbon Footprint

As opposed to production-based accounting, which only considers emissions incurred at the initial production-phase, consumption-based accounting for GHG emissions accounts for the entire carbon footprint of a good or service.

A product's carbon footprint includes all emissions generated during the lifecycle of a good or service – from production and distribution to end-use and disposal or recycling.[5, p. 306] This methodology reduces existing emissions accounting gaps as all the emissions associated with a product or service, including the emissions before its consumption,are taken into account, regardless of the country of origin (upstream emissions).

Without this methodology, an important part of the emissions-chain is not accounted for.[5, Ch. 4.4.2] Furthermore, this methodology shifts the responsibility of the emissions to the consumers, which can promote behavioural changes in consumption patterns.

Did you know?

The cities of Berlin and New York tally (and account for) more upstream emissions than emissions produced within their territories.[35]

Promoting the consumption-based accounting methodology could discourage the exodus of producers in countries with strong climate legislation. As a potential co-benefit, it could lead to a reduction of a country's dependency on imports, increasing self-sufficiency. European and other OECD countries are examples of territories with strong climate legislation; thus, they would benefit from promoting this accounting methodology.

Practical example

Municipalities could incentivise the use of this accounting methodology by demanding knowledge from their suppliers about the carbon footprints of the provided goods and services. Additionally, municipalities can promote the study of their citizens' carbon footprints as part of their information campaigns.

Did you know?

Global consumption of goods and services has dramatically increased in recent decades, in both absolute and per capita terms, and is a key driver of environmental degradation, including global warming.[5, p. 288]

Municipalities can play an important role in moving towards sustainable consumption and sustainable services by being providers of sustainable goods and services to the population. Additionally, municipalities have an important role in increasing awareness about sustainable consumption and reducing consumerism among the population.

Recommendations

Related SDGs:

The following recommendation can be linked to SDG 12 (Responsible Consumption and Production), with the following concrete target:

12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practises and to integrate sustainability information into their reporting cycles.[3]

B- Adopt Green Public Procurement

Local administrations generally purchase products and services. For that reason, public procurement regulations play an important role in transforming the market[5, p. 718], contributing to sustainable consumption and other sustainable goals, simultaneously.[36]

Green Procurement is defined as a process whereby public authorities seek to produce goods, services and works with a reduced environmental impact throughout their lifecycles when compared to goods, services and works with the same primary function that would otherwise be procured.[36] Sustainable public procurement includes both environmental and social criteria in the purchasing decisions.[36]

Practical example

Municipalities can use the EU handbook **"Buying green!"**, which explains how to integrate environmental criteria in the procurement process and how it is possible to articulate them within the current procurement framework.[36]

Practical examples

- Municipalities can promote climate change mitigation through their consumption choices, by including carbon footprints, lifecycle costs or other environmental and sustainable criteria in public procurement contracts.
- Due to the breadth of requirements that can be included green public procurement, it is necessary support to local administrations aiming to adopt this type of procurement model.

Tools to facilitate the identification of sustainable products & services: To facilitate municipal and citizen climate friendly consumption choices, various tools have been developed to inform and identify sustainable products or services:

- **Labels:** Environmental labels based on objective and transparent criteria, awarded by an independent third party, can play an important role in identifying sustainable products or services. Third party ecolabels and declarations have proven to be effective in transforming attitudes towards sustainable consumerism.[5, p. 308] The EU identifies four types of useful labels:
  a. **Multi-criteria label:** This is based on scientific information about the environmental impact of a product or service through production and distribution, the use phase, and final disposal.[36] For example, the EU Ecolabel, Nordic Swan and the Blue Angel.[36]
  b. **Single-use labels:** These are based on one or more pass/fail criteria linked to a specific issue.[36] For example, the EU Organic label or Energy star.
  c. **Sector-specific labels:** These are related to a specific sector, for instance, the forestry sector with the FSC or PEFC-related labels.[36]
  d. **Grade product labels:** Grading products or services according to their environmental performance, rather than using pass or fail criteria.[36] For example, the EU Energy Label grades energy-related products according to their energy efficiency.[36]
- **Life Cycle costing (LCC):** The LCC approach not only accounts for the purchase of the product but additionally accounts for the cost incurred during the use and disposal of these goods.[36] It could be useful for the procurement process to take into account the cost of resource use, maintenance and disposal, which are not usually reflected in the purchase price of a good or service. Also, LCC opens up the possibility to include associated GHG emissions.[36]
- **Environmental management systems and schemes certifications:** Environmental management systems are organisation-related tools aimed at improving overall environmental performance for the implementing organisation.[36] For example, the EU Eco-management and audit scheme (EMAS) or the International Standard on Environmental Systems (EN/ISO 14001) can be followed.[36]
- **Product Origin:** The origin of where a product or service is produced is highly relevant because of its associated trade emissions.

Recommendations

Did you know?

Local consumption increases[37] and protects local economies while reducing the GHG emissions associated with goods transportation. Local production also makes the impacts of the production and consumption directly visible, thereby helping to facilitate the adjustment of the consumer needs' and satisfaction within the ecological limits.[38]

Practical Example

Municipalities can promote local currencies in their territory thereby directly supporting local businesses, leading to an increase in local product consumption.[39] Local currencies not only boost local economies but additionally contribute to sustainable development by community-building and through enabling different consumption patterns that allow for a reduction of the environmental impact.[39]

France already has over 80 (March, 2020) local currencies circulating! [40]

Related SDGs:

Adopting green public procurement can be linked to SDG 12 (Responsible Consumption and Production), with the following targets:

12.6: Encourage companies, particularly large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycles.[3]

12.7: Promote public procurement practices that are sustainable, in accordance with national policies and priorities.[3]

C- Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products

Did you know?

Globally, food is the consumption category with the greatest climate impact, accounting for 20% of GHG emissions.[5, p. 305]

Diet choices can greatly influence climate change. Balanced diets, featuring plant-based foods, such as those based on coarse grains, legumes, fruits and vegetables, nuts and seeds, and animal-sourced food produced in resilient, sustainable and low - GHG emission systems, present major opportunities for adaptation and mitigation while generating significant co-benefits in terms of human health.[22] Additionally, food consumption has potential synergies with the agriculture sector. (See Land Use chapter, p.17).

Criteria to ensure climate change mitigation based on diet choice:

- Animal product exclusion from diets (reduction when agriculture is not an option, for example, small island states, countries with extreme weather, etc.)
- Choosing organic food
- Seasonal food before the end of its season, as it normally requires less energy to be produced than food produced outside of their natural climates
- Locally produced to minimise emissions from transportation

Did you know?:

Moving from current diets to a diet that excludes animal products has transformative potential: it may reduce land use for food by 3.1 billion ha (a 76% reduction), GHG emissions from food by 6.6 billion metric tonnes of CO_2 eq (a 49% reduction), ocean acidification by 50%, eutrophication by 49% and (scarcity-weighted) freshwater withdrawals by 19% (reference from 2010).[41]

Practical example

Municipalities can promote food services (for schools, hospitals and other public canteens) by providing seasonal, organic, and locally produced food without animal products.

Related SDGs:

The following recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete targets:

12.2: By 2030, achieve the sustainable management and efficient use of natural resources.[3]

12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.[3]

Recommendations

D- Promote a Reduction in Consumerist Behaviour

At a certain point, we are not happier if we have more! It was found that a weak relationship exists between income and well-being at higher income levels.[5, p. 310]

Consumerist behaviour manifests itself when the possession and use of an increasing number and variety of goods and services is the principal aspiration and the surest perceived route to personal happiness, social status, and national success.[5, p. 304]
In other words, consumerist behaviour leads to the unnecessary purchasing of a considerable amount of goods/services, thinking that it would bring us happiness, success or to increase our social status.

How much are we buying?

Local authorities should inform the population about the disadvantages of consumerist behaviour, with the aim of **reducing unnecessary consumption.**

Practical example

Municipalities can run awareness-raising campaigns to counteract consumerism by advertising, communicating with and educating local citizens.

Related SDGs:

The following recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete targets:

12.2: By 2030, achieve the sustainable management and efficient use of natural resources.[3]

12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3]

12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.[3]

E- Promote Sustainable Consumption

Sustainable consumption entails formulating consumption strategies that foster a higher quality of life, the efficient use of natural resources, and the satisfaction of human needs while simultaneously promoting equitable social and economic development, economic competition and technological innovation.[5, p. 307]

How is the good or service that I am purchasing produced and distributed?

Following the same framework as in the green public procurement recommendation, municipalities should foster sustainable consumption by incentivising the consumption of products with the lowest carbon footprint.

Practical example

Local authorities should raise awareness among the population to increase sustainable consumption (advertising, communication and education campaigns).[42] Information policies are highly relevant for facilitating choice outcomes and thus are important for promoting environmental standards and proper product labelling.[42]

Related SDGs:

The following recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete targets:

12.2: By 2030, achieve the sustainable management and efficient use of natural resources.[3]

12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.[3]

Recommendations

F- Facilitate Locally Produced Product Consumption

As part of sustainable consumption, municipalities can play an important role in promoting local product consumption and enhancing the local economy while simultaneously reducing the emissions associated with imports.

Practical examples

Municipalities can approach the promotion of local products consumption by doing the following:

- Facilitating the necessary infrastructure for local producers to sell their products.
- Promoting labels to guarantee origin, as is done with some gourmet products (for example, cheese, wine, and so on) recognising the value added by the special regional characteristics of some local products.

Related SDGs:

The following recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete targets:

12.2: By 2030, achieve the sustainable management and efficient use of natural resources.[3]

12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.[3]

Waste Management

Recommendations for local climate change mitigation	SDGs and Targets
A. Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Short-Life Products	 **12.3:** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvested losses.[3] **(Only for A recommendation)** **12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3]
B. Enable the "Right To Repair", Promote the Exchange Of Second-Hand Goods and Increase Awareness About Re-use	
C. Promote Recycling	
D. Waste Treatment	 **11.6:** By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.[3]
D.1 Produce compost, particularly from food or green waste	
D.2 Biogas production: Capture methane from waste management or wastewater management	
D.3 Reduce landfill waste disposal	
D.4 Reduce the amount of untreated wastewater	

Waste is defined as an object that someone discards, intends to discard, or is required to discard.[43]

Did you know?

- The quantity of municipal waste per capita in the period from 1980 to 2005 increased by 29% in North America, 35% in OECD countries and 54% in the then EU15.[5, p. 385]
- The total amount of municipal solid waste generated globally has been estimated at about 1.5 Gt per year, and it is expected to increase to approximately 2.2 Gt by 2025.[5, p. 786]
- Of the current amount, 300 Mt are recycled, 200 Mt are treated with energy recovery, another 200 Mt are disposed in sanitary landfills, and the remaining 800 Mt are discarded in non-sanitary landfills or dumps.[5, p. 786]

In 2010, GHG emissions from waste represented 3% of total GHG emissions, mainly stemming from solid waste disposal on land and wastewater handling.[5, p. 385] Emissions related to waste management are not only associated with waste management itself but additionally include the emissions of the production materials needed to replace those lost in waste.[5, p. 786]

Accordingly, appropriate waste management has important potential for climate change mitigation and a transition towards a circular economy.[44], [45]

The following recommendations for local climate change mitigation are provided to prevent waste generation and influence its sustainable treatment.

Recommendations

A- Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Short-Life Products

Local authorities can prevent waste generation through inducing behavioural change with promotional and information strategies or by enforcing limits on waste generation (regulation policies).[43]

To induce **behavioural change**, the promotion of a reduction of unnecessary consumption is suggested.[43] Promoting a reduction of unnecessary consumption can be achieved through advertising, communication, and awareness- raising campaigns as part of the strategy for reducing consumerist behaviour.[5, p. 310] (See Consumption Patterns chapter, p. 23.)

In terms of regulatory policies, municipalities can target goods with a short life cycle, which may potentially increase waste generation, through promoting a reduction in their usage or even prohibiting the products.[46] For instance, single-use plastics (including plastic packaging) not only increase waste generation but contribute to an increase in oceanic pollution.[46]

Did you know?

Annual production of plastic is about 300 million tonnes, whereof roughly 50% is disposed of after a single use.[46]

Case example

28% of Californian Municipalities have implemented local bans on single-used plastics [46]

Food waste should be another municipal target for reducing municipal waste generation. Preventing food waste may not only reduce emissions, but may additionally contribute to climate change adaptation and decrease land use competition.

Beyond food waste, local authorities can promote local initiatives that recuperate food before its discarded.

Case example

The cooperative *Fruta Feia* (literally 'Ugly Fruit') in Portugal, has already saved 2,500 tonnes of high-quality food that would be discarded due to its appearance.[47]

Other important target resources and products for waste reduction are those specifically included in the new EU circular economy action plan: water and nutrients, electronics and ICT, batteries and vehicles, packaging, textiles, and construction and buildings.[45]

Recommendations

Did you know?

Currently, 25–30% of total food produced is lost or wasted, and contributes to 8-10% of total anthropogenic GHG emissions (Data from the period 2010 – 2016) [22, p. 26]

Related SDGs:

This recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete targets:

12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvested losses.[3]

12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3]

B- Enable the "Right to Repair", Promote the Exchange of Second-Hand Goods and Increase Awareness About Re-use

Reusing products is the next best approach to reducing waste generation after prevention **by increasing product lifetime**[5, P. 744] or **finding other useful functions for a product.**

Did you know?

In its new circular economy action plan, the EU Commission will work towards establish a new "right to repair" through considering new horizontal material rights for consumers, for instance through providing the availability of spare parts or access to repair. [45]

Practical example

Local authorities could promote the re-use of goods by increasing awareness among the population through organizing events or by providing the necessary infrastructure for local circular economy initiatives. Examples include, creating repair offices, organising second-hand goods market, and importantly issuing the licences necessary to facilitate these types of activities.

Related SDGs:

This recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete target:

12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3]

C- Promote Recycling

Did you know?

Globally, only about 20% of municipal solid waste is recycled, and about 14% is treated with energy recovery, while the remainder is deposited in open dumpsites or landfills.[5, p. 82]

The recycling process normally relies on individual responsibility. Thus, local authorities can increase their recycling rate by increasing citizens' awareness of local recycling infrastructure and practices and by facilitating the related infrastructure for that to happen, and by ensuring access to waste collection points.

Related SDGs:

This recommendation can be linked to SDG 12 (Responsible Consumption and Production) and includes the following concrete target:

12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.[3]

D- Waste Treatment:

Before its disposal, waste can be treated, depending on its nature, to potentially increase soil fertility or produce heat and energy.[5, p. 789], [33] For climate change mitigation, municipalities should focus on solid waste disposal and untreated domestic wastewater, as they account for 90% of waste-related emissions[5, p. 791]

Related SDGs:

All waste treatment recommendations can be linked to SDG 11 (Sustainable Cities and Communities) and include the following concrete target:

11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.[3]

Recommendations

D.1: Produce compost, particularly from food or green waste

Composting has an important potential of not only reducing landfill GHG emissions but additionally improving soil fertility[48] when composting is applicable (depending on the nature of the compost).[33] Increasing soil fertility reverses desertification, increasing soil carbon sequestration[22, p. 20], [49]. (See Land Use chapter, p. 17.)

Composting has a significant advantage in that it ensures a sustainable solution for waste treatment, minimising related gasesous emissions.[33]
Various composting techniques exist but depend on the heterogeneity of the waste and the presence or absence of oxygen; they can be classified into two groups:

- **Decentralised small-scale composting (in the presence of oxygen):**
  Small-scale composting is based on encouraging citizens and institutions to manage their own suitable organic waste, producing their own compost. This decentralised system can raise awareness in the population while reducing waste disposal.

  Did you know?

  Good quality compost can replace synthetic fertilisers, useful for municipalities with a high share of agricultural production, or institutions with wide garden areas (for example, universities).

  Case example

  The Lisbon Municipality launched the *Lisboa a Compostar* project to promote composting food waste, where the municipality engaged citizens by offering them a composting box in exchange for attending a training on the composting process. [50]

- **Centralised large-scale composting (without oxygen):**
  The centralised composting process is less restrictive in terms of the nature of waste used, but it needs to be processed in closed biochemicals reactors.[5, p. 789] During this process, methane is generated through the anaerobic digestion of organic waste (biogas), enabling its use in a gas engine to produce energy.[5, p. 789]

Practical example

As in the case of the project *Lisboa a Compostar*, we encourage municipalities to implement or enhance similar projects of small-scale. It not only requires reduced logistics and management but additionally fosters autonomy and decentralisation, involving and engaging citizens during the process, thereby, increasing climate awareness.

D.2: Biogas production: Capture methane from waste management or wastewater management

Solid waste and wastewater management and treatment normally generate considerable amounts of methane (biogas) that can be recovered for producing energy.

Producing energy from biogas may lead to an important reduction in fossil fuel dependency, contributing to climate change mitigation.

D.3: Reduce landfill waste disposal

Municipalities should pursue the reduction of untreated solid waste in landfills. A reduction in waste disposal could be an interesting indicator for understanding the efficiency of the municipality's waste prevention and management process.

D.4: Reduce the amount of untreated wastewater

Municipalities should treat all wastewater in the municipality, as untreated wastewater produces considerable amounts of methane emissions, aggravating climate change.

Case example

Marselisborg Wastewater treatment plant in Aarhus, Denmark, uses the biogas produced through the wastewater treatment process to create energy that can be used to power the processes needed. These range from water production, to water distribution, to wastewater pumping and treatment. The energy produced covers as much as 94% of the energy needed. [51]

	Recommendations for local climate change mitigation	SDGs and Targets
Energy production & supply	**A.** Promote Appropriate Renewable Energy (RE) Production	 **7.2:** By 2030, increase substantially the share of renewable energy in the global mix.[3]
	B. Decentralise Energy Production (Both Social and Technological Aspects)	
	C. Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	
Energy efficiency & end-use	**D.** Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure	 **7.3:** By 2030, double the global rate of improvement in energy efficiency.[3]
	E. Facilitate Citizen and Private Sector Involvement to Increase Energy Efficiency	
	F. Encourage Energy Consumption Reduction	

Energy is a vast topic. Two main areas were structured in order to approach the recommendations for climate change mitigation: **energy production and supply; and energy efficiency and end-use dimensions.**

Did you know?

Electricity and heat production is the sector accounting for most global GHG emissions (25% of global GHG emissions).[5, p. 9]

Energy Production and Supply

Energy production and supply includes all energy extraction, conversion, storage, transmission, and distribution processes, with the exception of those that use final energy to provide energy services in the end-use sectors.[5, p. 516]

The suggested recommendations involve a deep decarbonisation of electricity generation[5, p. 516], where distributed energy systems can play an important role.[5, p. 528], [52]–[54]

Related SDGs:

All the recommendations of the energy production & supply dimension are linked to SDG 7 (Affordable and Clean Energy) and includes the following concrete target:

7.2: By 2030, increase substantially the share of renewable energy in the global mix.[3]

Recommendations

A- Promote Appropriate Renewable Energy (RE) Production

It is important to prioritise renewable energy (RE) as the main source of energy in order to achieve energy decarbonisation, focusing on the selection of appropriate technology, operational adjustments, and facility siting.[5, p. 516]

RE is energy derived from natural, unlimited, and replenishable sources.[55] For this definition, **we exclude nuclear energy** because of the barriers and associated risks (operational risks, safety concerns, uranium mining risks, and unresolved waste management issues).[5, p. 517]

B- Decentralise Energy Production (Both Social and Technological Aspects)

Distributed energy systems can help facilitate energy transitions[56] and sustainable development[52] at the local level.

Did you know?

Depending on the context, distributed energy systems can be cost-efficient, reliable and environmentally friendly.[52], [53] Technological decentralisation of energy supply can lead to an appropriate and diverse use of local resources. [52]

Case example

In 2019, the Barcelona municipality became an energy supplier for its citizens through the public company Barcelona Energia with a 100% share of variable renewable energy.[57]

Case example

In Ostrów Wielkopolski, Poland, energy from locally produced biomass is distributed to citizens via a newly contrsucted municipal grid. The first section built of the local grid provides electricity to 26 apartment blocks and several dozen locally owned facilities and institutional buildings. Electricity costs saved range from 15-20% for the apartment blocs to 50% for the institutional and industry buildings. [58]

Recommendations

C- Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension

Involving the wider population and the private sector in the energy supply dimension can increase participation in the design and operation of power systems.

Did you know?

The bottom-up approach to energy systems, where citizens take the lead, can positively impact the energy market, increasing its flexibility.[54]

RE communities (RECs) concept:

To facilitate energy supply decentralisation, the EU in its 2018/2001 directive defined a renewable energy community (REC) as a legal entity where:

- in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the RE projects that are owned and developed by that legal entity;
- the shareholders or members of which are natural persons, small and medium enterprises (SMEs) or **local authorities, including municipalities;**
- the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits.

RECs are entitled to produce, consume, store and sell renewable energy, including through renewable power purchase agreements, to distribute renewable energy within the community, and to access all suitable markets.[58], [59]

Case example

The Hyperion Energy Community in Greece plans to use virtual net metering for the purpose of collective self-consumption thereby saving on each kWh. Grid fees and other levies and taxes are still paid to the grid operator, only the wholesale price is saved. [60]

Energy efficiency & end-use

In this section, municipal action involves increasing energy efficiency and raising awareness of reducing energy consumption among the population.

Did you know?

The building sector (residential, commercial, public and services sectors) accounted for 32% of the final energy emissions in 2010, with OECD countries being the highest contributors.[5, pp. 22, 678]

Related SDGs:

All the recommendations of the energy efficiency and end-use dimension are linked to SDG 7 (Affordable and Clean Energy) and includes the following concrete target:

7.3: By 2030, double the global rate of improvement in energy efficiency.[3]

D- Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure

The necessary advanced technologies, know-how, and policies enabling energy efficiency are already available for the sector.

Practical example

- Monitoring the energy consumption of public buildings, infrastructure and public spaces could be an important start to increasing energy efficiency in the sector.
- Relying on energy certifications and related audits can guide the improvement of energy efficiency. (See Consumption Patterns chapter, p. 23.)
- Smart metering, can promote energy efficiency through helping to optimise energy usage and through encouraging more consumer awareness. [61]

Recommendations

E- Facilitate Citizen and Private Sector Involvement to Increase Energy Efficiency

Involving citizens and the private sector in the process of increasing energy efficiency could support the actions of the local administrations.

Practical examples

Energy efficiency regulations or subsidies for local actors to retrofit older equipment or technology (e.g. boilers, windows, insulation, etc.) can increase energy efficiency.

Case example

The municipality of Rožnov pod Radhoštěm used Energy Performance Contracting (EPC) - a mechanism to secure financing for energy efficiency measures, using an energy service company - for energy efficiency refurbishments for 11 municipal buildings (a 3rd of all municipal buildings).[16]

F- Encourage Energy Consumption Reduction

Human lifestyle, culture and behaviour are important factors that influence energy end-use.

Did you know?

Teaching the population to responsibly use energy and reduce its energy consumption more generally could reduce energy demand by up to 20% in the short term.[5, p. 23]

Practical example

Internal trainings for the local administration, external trainings for the wider public, public talks and training for educational institutions as well as advertising campaigns can all be used to both raise awareness for energy saving practices and thereafter serve to induce behavioural change.

Recommendations for local climate change mitigation	SDGs and Targets
A. Implement Local Policies for Sustainable Transportation	 **11.2:** By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.[3]
B. (Re)municipalisation of Transportation Services	
C. Reduce Automobile Dependency, Especially Dependency on Light-Duty Vehicles	
D. Promote the Reduction of Fossil Fuel Dependency in Transportation	
E. Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	
F. Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	
G. Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	

Municipalities play a crucial role in this area for achieving climate change mitigation.

Did you know?

Transportation was the third largest sector contributing to climate change in 2018, accounting for 11% (~8.3 Gt CO_2) of global greenhouse gas emissions, with this number expected to double by 2050.[5, p. 21,72], [63]

Related SDGs:

All transportation and mobility recommendations are related to SDG 11 (Sustainable cities and communities) and include the following concrete target:

11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.[3]

Recommendations

A- Implement Local Policies for Sustainable Transportation

Sustainable transportation means defending accessibility for all to help meet basic daily mobility needs consistent with human and ecosystem health. It additionally means constraining GHG emissions.[5, p. 603]

Depending on its local context, each municipality should evaluate the most appropriate implementation measures.

Practical example

Eltis – the Urban Mobility Observatory has published the second edition of the Developing And Implementing A Sustainable Urban Mobility Plan (SUMP).[62] The guidelines provide a step by step approach from preparation and analysis, to strategy development, to measures planning, to implementation and monitoring of a SUMP.

B- (Re)municipalisation Of Transportation Services

Publicly managed services are generally focused on quality, universal access and affordability, and on delivering broader social and environmental objectives.[9]

Bringing previously private or privatised services under local public control and management (re-municipalisation) could be the key to inducing the change needed to move towards sustainable transportations systems, due to increased alignment with local urban development policies.[9, p. 31] (See Governance chapter, p. 7)

C- Reduce Automobile Dependency, Especially Dependency on Light-Duty Vehicles

Road transportation is the mode of transportation that accounts for the highest emissions globally.[5, p. 606]

Did you know?

The number of light-duty vehicles (LDVs) (cars and passenger vans) is expected to double in the next few decades from the current global level of 1 billion (data from 2011).[5, p. 611]
Promoting alternative modes of transportation can lead to a **reduction in the amount of LDVs**, contributing to a reduction of the associated carbon emissions.

Practical examples

- Regulations such as parking regulations or speed-limited areas
- Providing alternatives modes of transportation and increasing the efficiency of public transportation
- Improving the spatial planning process in favour of sustainable mobility (See Spatial Planning chapter, p. 44)
- Minimising journeys by, for example, offering remote-work days to employees.

Recommendations

D- Promote the Reduction of Fossil Fuel Dependency in Transportation

When collective transportation (bus, train, etc.) **or non-motorised transportation** (biking, walking, etc.) is impractical (for instance, in more remote areas), **it is important to incentivise low/zero-carbon transportation** (for example, by providing infrastructure for electric vehicles) **as a second option.**

It is important to note that replacing all current LDVs with low-carbon transportation is not an alone-standing sustainable path to climate change mitigation as the production of new low carbon transportation alternatives can be very resource intensive (for example, increased use of rare minerals for the production of batteries for electric vehicles[5, p. 623] and water resources in both the electric vehicle production process and water usage associated with electricity production)[65]

Practical example

Providing municipal charging stations for electric vehicles could help facilitate the migration to low-carbon transportation, decreasing fossil fuel dependency.

E- Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)

It is crucial to move from individual to collective low-carbon modes of transportation for journeys within and outside municipal territory. Collective low-carbon transportation should be among the first local transport options.

Local administrations should **increase public transportation efficiency by investing in necessary infrastructure and necessary services.**[5, p. 603]

Practical examples

- Increase public transportation efficiency by increasing its frequency and reducing the commute time with other modes of transportation.
- Invest in related infrastructures and necessary services by facilitating access to collective low-carbon modes of transportation (for example, bus, train or waterborne stations) and by creating lanes exclusively designated for collective transport (e.g. carpooling, taxi, and bus lanes)

Case example

The Barcelona metropolitan transportation network offers individuals who want to decommission or scrap their old non-environmentally friendly vehicles a 3-year public transport pass for the greater Barcelona Metropolitan Area.[64]

F- Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)

Non-Motorised Transportation (NMT) has zero associated emissions and simultaneously, has important health co- benefits.

NMT could be encouraged by increasing its accessibility and safety in the municipality by re-designing urban areas.[5, p. 603]

Practical example

Increase pedestrian areas, increase cycling infrastructure and increase speed-limited areas and infrastructure to force speed reductions (for example, speed bumps).

Case example

The municipality of Pontevedra in Spain, is a front runner in sustainable mobility. They have installed more than 300 speedbumps throughout the city, set the speed limit in urban areas to 30km/h and prioritised pedestrian spaces wherever possible.[66]

G- Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising

Changes in behaviour are crucial for shifting to NMTs or collective low-carbon modes of transportation.[5, p. 603]

Practical example

Local authorities can promote sustainable transportation with specific education in municipal schools, training professional drivers in ECO-Driving and inducing behavioural changes through sustainable transportation advertising campaigns, among other solutions.

Spatial Planning

Recommendations for local climate change mitigation	SDGs and Targets
A. Spatial Planning Processes	 **11.3:** By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human planning and management in all countries.[3] **11.7:** By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.[3] **(Only for recommendations A2 and A3)**
A.1 Enable the local administration in integrating climate change mitigation perspectives into municipal spatial planning processes	
A.2 Integrate nature/ecosystem-based solutions into the spatial planning process	
A.3 Implement adequate spatial planning policies and instruments to support low-carbon fluxes in the municipality	
B. Municipal Urban Form	
B.1 Increase density	
B.2 Increase land use mix	
B.3 Increase connectivity	
B.4 Increase accessibility	
C. Prioritise Sustainable and Resilient Infrastructure while Minimising Lifecycle GHG Emissions	 **9.1:** Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.[3] **9.4:** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all the countries taking in accordance with their respective capabilities.[3]

Did you know?

Urban areas account for between 71% and 76% of CO_2 emissions from global final energy use.[5, p. 927]

Urban form and infrastructure significantly affect direct (operational) and indirect (embodied) GHG emissions and are strongly linked to the throughput of material and energy in a city, the waste that it generates, and the urban system efficiency.[5, p. 949] For that reason, the mitigation options available for local authorities, particularly in rapidly developing cities, includes shaping their urbanisation and infrastructure development trajectories.[5, p. 928]

The recommendations in this domain are divided into three main groups: the spatial planning process, municipal urban form and municipal infrastructure

Recommendations

A- Spatial Planning Processes

Spatial planning is a broad term that describes systematic and coordinated efforts to manage urban and regional growth in ways that promote well-defined societal objectives, such as land conservation, economic development, carbon sequestration and social justice.[5, p. 958]

Related SDGs:

The following recommendations for the spatial planning process are linked to SDG 11 (Sustainable Cities and Communities) and include the following concrete targets:

11.3: By 2030, enhance inclusive and sustainable urbanisation and capacity for participatory, integrated and sustainable human planning and management in all countries.[3]

11.7: By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.[3]
(Only for recommendations A2 and A3)

Related recommendations

A.1: Enable the local administration in integrating climate change mitigation perspectives into municipal spatial planning processes

Training the local administration and increasing institutional capacity for planning based on low municipal energy fluxes and sustainable urbanisation is crucial to the pursuit of climate change mitigation.[5, p. 958]

A.2: Integrate nature/ecosystem-based solutions into the spatial planning process

Due to its multiple co-benefits, integrating nature/ecosystem-based design and solutions into the spatial planning process can increase the potential for municipal climate action, in terms of increasing green spaces, urban carbon sinks and reducing municipal carbon fluxes.

Case example

City of Vienna Austria, uses NBS such as green roofs, bridges, walls and large scale nature conservation areas to minimise the urban heat island effect.[68]

Practical example

Establishing green roofs in public buildings can help regulate stormwater, lead to reduced air pollution, provide shade and cooling, facilitate rainwater interception and infiltration, increase biodiversity, and enhance well-being.[69, pp. 40–51]

The European Commission has provided a list of possible urban NBS interventions, including: inscreasing urban green spaces, planting green roofs and walls, using phytoremediation/stabilisation, encouraging the planting of appropriate resource and caterpillar food plants, and more.[69]

A.3: Implement adequate spatial planning policies and instruments to support a low-carbon fluxes in the municipality

A single path forward does not exist for municipalities in terms of spatial planning to increase climate change mitigation. Nonetheless, it is recommended that strategies be combined to ensure success and effectiveness, harmonising and integrating each level of planning, paying special attention to urban form and municipal structure.[5, p. 958]

Recommendations

Practical example

In the following table, the Intergovernmental Panel on Climate Change (IPCC) summarised matching spatial planning strategies and policy instruments carried out in different spatial contexts.

B- Municipl Urban Form

Urban form and structure are the patterns and spatial arrangements of land use, transportation systems, and urban design elements, including the physical urban extent, the layout of streets and buildings, as well as the internal configuration of settlements.[5, p. 949]
For the effective pursuit of climate change mitigation, it is important to combine the following recommendations on urban form.

Related SDGs:

The following recommendations related to urban form are linked to SDG 11 (Sustainable Cities and Communities) and include the following concrete target:

11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human planning and management in all countries.[3]

Related recommendations

B.1: Increase density

Density is the measure of an urban unit of interest (for example, population, employment, and housing) per area unit.[5, p. 952]

Density affects GHG emissions in two ways. A low density of employment, commerce and housing increases the average travel distance for both work and shopping trips (increasing the vehicle kilometres travelled).[5, p. 952] Additionally, a low density complicates the switch to less energy-intensive and alternative modes of transportation.[5, p. 952] In contrast, increasing density too much by building high-rise buildings (i.e. buildings with more than seven floors) results in inefficiency in terms of energy consumption.[5, p. 955] Thus, municipalities should aim to increase density, within reason.

Practical examples

- Prioritise **medium-rise buildings** (i.e. buildings with less than seven floors) before single-unit and high-rise buildings. Medium-rise buildings increase urban density without the need for materials associated with larger construction projects and the loss in energy efficiency that can occur in high-rise buildings.[5, p. 955]
- Renovate central abandoned buildings and other urban abandoned properties.

B.2: Increase land use mix

Land use mix to the diversity and integration of land uses at a given scale. Diverse and mixed land uses can reduce travel distances and enable walking and other Non-Motorised Transportations, thereby reducing aggregate amounts of vehicular and associated GHG emissions.[5, p. 955]

Did you know?

In cities with effective air pollution control, mixed land use can additionally have a beneficial impact on health and well-being by putting things within walking distances.[5, p. 955]

B.3: Increase connectivity

Connectivity refers to street density and design.[5, p. 956] High urban connectivity is characterised by finer grain systems with smaller blocks that allow frequent changes in direction.[5, p. 956] When connectivity is high, there is typically a positive correlation with walking and, thereby, lower GHG emissions.[5, p. 956]

B.4: Increase accessibility

Accessibility can be defined as access to jobs, housing, services, shopping, and in general, to people and places in cities.[5, p. 956] It can be viewed as a combination of proximity and travel time and is closely related to the land use mix.[5, p. 956] Communities with high accessibility are typically characterised by short commuting distances and travel times, enabled by multiple modes of transportation.[5, p. 956]

Did you know?

Metanalysis shows that a reduction in the vehicle kilometres travelled is strongly related to highly accessible job destinations.[5, p. 956]

Recommendations

C- Prioritise Sustainable and Resilient Infrastructure while minimising lifecycle GHG emissions

Infrastructure primarily affects GHG emissions during three phases of its lifecycle: construction, use or operation and decommissioning.[5, p. 951] It is relevant to analyse all the emissions associated with each phase (particularly the construction phase) of any new infrastructure project, including its transboundary emissions, in order to facilitate sustainability and resilience.[5, p. 951]

Did you know?

The manufacturing of steel and cement, two common infrastructure materials, contributed to nearly 9% and 7%, respectively, of global carbon emissions in 2006.[5, p. 951]

Practical example

Local authorities can pay special attention to the nature of materials used during infrastructure construction, their emplacement and associated energy fluxes (for example, the energy that the infrastructure is expected to consume, and so on).[5, p. 391]

Related SDGs:

This recommendation can be linked to SDG 9 (Industry, Innovation and Infrastructure) and includes the following concrete targets:

9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.[3]

9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all the countries taking in accordance with their respective capabilities.[3]

Recommendations

SPATIAL STRATEGY	POLICY INSTRUMENTS/IMPLEMENTATION TOOLS					
	Government Regulations		Government Incentives		Market-Based Strategies	
	Land Regulation/Zoning (see 12.5.2.1)	Taxation/Finance Strategies (see 12.5.2.3)	Land Management (see 12.5.2.2)	Targeted Infrastructure/Services (see 12.5.1)	Pricing (see 12.5.2.3)	Public-Private Partnerships (see 12.5.2.3)
Metropolitan/Regional						
Urban containment	Development restrictions; UGBs	Sprawl taxes	Urban Service Boundaries	Park improvements; trail improvements		
Balanced growth	Affordable housing mandates	Tax-bases sharing	Extraterritorial zoning		Farm Tax Credits[1]	
Self-contained communities/new towns	Mixed-use zoning		Greenbelts	Utilities; urban services		Joint ventures[2]
Corridor/District						
Corridor growth management	Zoning	Impact fees; Exactions[3]		Service Districts[4]		
Transit-oriented corridors	Transfer of development rights			Urban rail; Bus rapid transit investments		Joint Powers Authorities
Neighbourhood/Community						
Urban Regeneration/Infill	Mix-use zoning/small lot designations	Split-Rate Property Taxes; Tax increment finance[5]	Redevelopment districts	Highway conversions; Context-sensitive design standards	Congestion charges (see Ch. 8)	
Traditional Neighbourhood Designs; New urbanism	Zoning overlays; form-based codes			Sidewalks; cycle tracks; bike stations[6]		
Transit oriented Development	Design codes; flexible parking	Impact Fees; Betterment Taxes[7]		Station siting; station access		Joint development[2]
Eco-Communities	Mixed-use zoning			District Heating/Cooling; co-generation (see Ch. 9.4)	Peak-load pricing	Joint venture[2]
Site/Streetscape						
Pedestrian Zones/Car-Free Districts	Street code revisions[8]	Special Improvement Districts[7]		Road entry restrictions; sidewalks[8]	Parking surcharges	
Traffic Calming/Context-Sensitive Design	Street code revisions[8]	Benefit Assessment[7]				Property owner self-assessments
Complete Streets	Design standards			Bike infrastructure; Pedestrian facilities		Design competitions

Table rom IPCC, 2014: Climate Change 2014: Mitigation of Climate Change.[5, p. 959]

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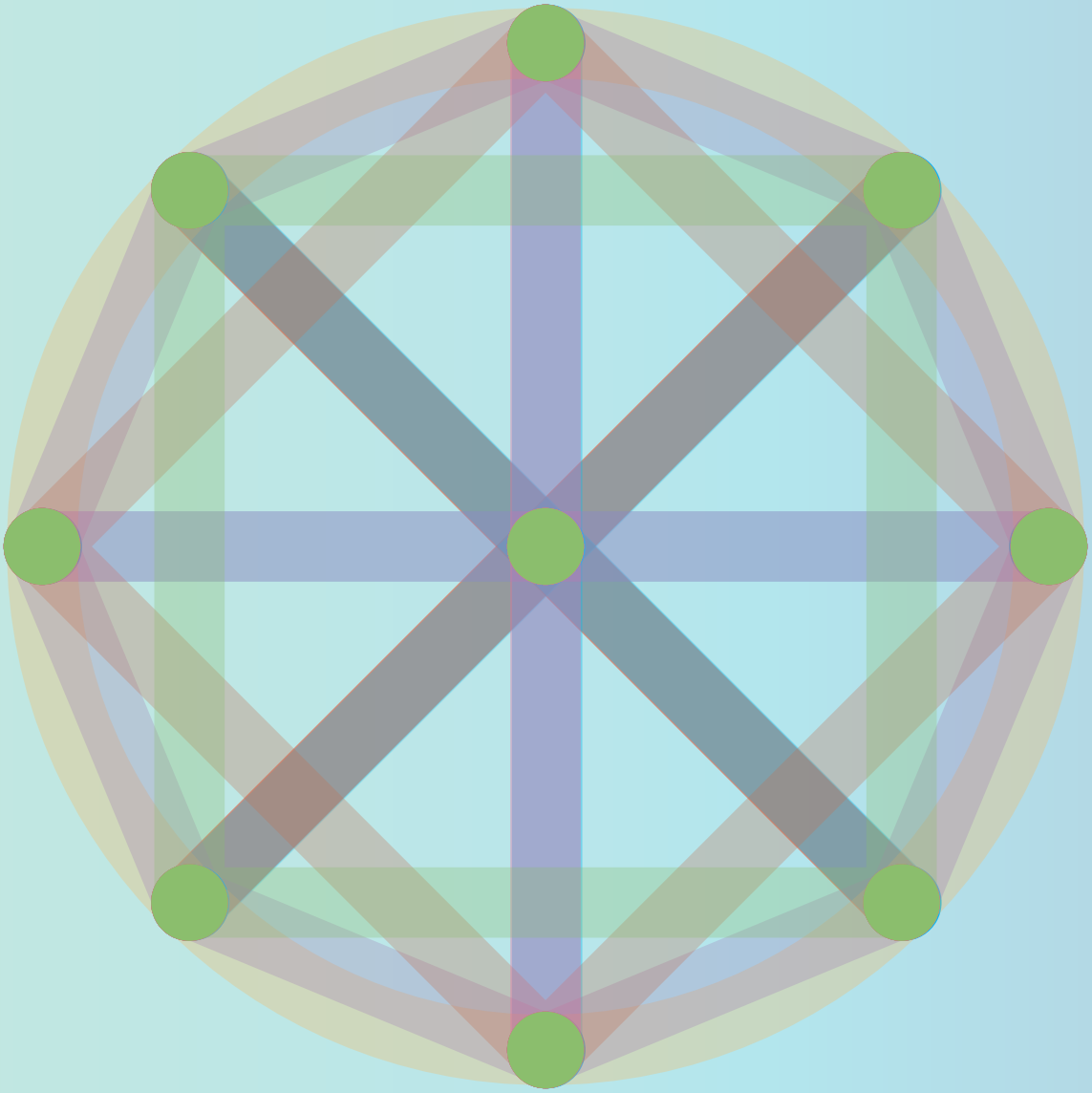

BEACON Bridging European & Local Climate Action

Annex 4: Set of Indicators Proposed per Domain and Related Definitions

GOVERNANCE RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A. Provisioning Sustainable Services/ Green Public Procurement	**G1**	**Municipal services with environmental management or other related certification**	Rate of municipal public services offered with a validated sustainable certification (for example, EMAS, ISO or others) updated every year	% certifications per year	University of Lisbon
B. Promote Information Policies	**G2**	**Territorial Greenhouse Gases (GHG) emissions**	GHG emissions emitted within the municipal territory based on the baseline emissions inventory, updated every year	CO_2 eq Tonnes per year	University of Lisbon
B. Promote Information Policies	**G3**	**Greenhouse Gases (GHG) territorial sinks**	GHG emissions captured based on vegetation cover of the municipality, updated every year	CO_2 eq tonnes per year	University of Lisbon
B. Promote Information Policies	**G4**	**Balanced municipal Greenhouse Gases (GHG)**	Balanced GHG emissions (Municipal GHG emitted - GHG emissions capture) of the municipal territory, updated every year.	CO_2 eq Tonnes per year	University of Lisbon
C. Undertake Voluntary Actions	**G5**	**Sustainable Energy and Climate Action Plan (SECAP)**	Rate of successfully implemented measures over the total measures proposed for climate change mitigation in the SECAP (Covenant of mayors), based on the SECAP's monitoring system	% of measures implemented per year	University of Lisbon
C. Undertake Voluntary Actions	**G6**	**Climate action plan's success (different from SECAP)**	Rate of successfully implemented measures over the total measures proposed for climate change mitigation in other(s) local action plan(s) (different from SECAP), based on the monitoring system of the plan, disclosed by the plan	% of measures implemented per year	University of Lisbon
D. (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation	**G7**	**Ownership of municipal services**	Rate of municipal services completely owned by the local administration over the total of municipal services, disclosed by sector, updated every year	% owned municipal services	University of Lisbon
E. Establish Stakeholders' Partnerships	**G8**	**Private Sector* Involvement in Municipal Climate Action Process**	Rate of local private sector* participating actively in the municipal climate action process disclosed by any related activity (for example, feedback to municipal action plans, supporting municipal mitigation measures, data sharing related to climate change, and so on) updated every year.	% per Activity and year	University of Lisbon

E. Establish Stakeholders' Partnerships	**G9**	**Target measures addressing municipal top Greenhouse Gases (GHG) Emitters**	Rate of climate change mitigation measures directly related to the top five highest GHG emitters in the private sector based in the municipal territory	% target measures	University of Lisbon
E. Establish Stakeholders' Partnerships	**G10**	**Climate-related NGOs or Associations Involvement**	Rate of related NGOs or associations existing in the municipal territory and participating in the climate action process of the municipality disclosed, by any related activity (for example, feedback to municipal action plans, supporting municipal mitigation measures, events organisations, and so on)	% per Activity and year	University of Lisbon
E. Establish Stakeholders' Partnerships	**G11**	**NGOs and Municipality partnerships for Climate Action**	Number of official partnerships between the municipality and related climate action NGOs and associations updated every year. For example, Partnerships for environmental sensibilisation tasks with local NGOs.	Nº Partnerships per year	University of Lisbon
E. Establish Stakeholders' Partnerships	**G12**	**Civil society participation**	Participation rate of civil society in local climate action measures disclosed per activity (for example, feedback on municipal measures, public consultation, citizens assembles, and so on) updated every year	% Civil Society participation per Activity and year	University of Lisbon
E. Establish Stakeholders' Partnerships	**G13**	**Collaboration with other/s public entities**	Number of other local public entity (for example, energy agencies, other municipalities, and so on) officially involved in the municipal climate action process (for example, collaboration in climate action plans, inter-municipal partnerships, and so on) disclosed by type of activity and public entity, updated every year.	Nº Public entities per activity and year	University of Lisbon
F. Rearrange the Internal Structure of Local Administration	**G14**	**Local administration involvement**	Human resources investment for any related climate change mitigation process per month, disclosed by department	Working Hours/month	University of Lisbon
F. Rearrange the Internal Structure of Local Administration	**G15**	**Collaboration among departments**	Internal meetings among departments to discuss climate action policies per year	Meeting Hours/year	University of Lisbon
F. Rearrange the Internal Structure of Local Administration	**G16**	**Level of department's implication**	Rate of local administration departments officially and actively involved the climate change mitigation process. For example, number of departments involved in the implementation of the SECAP Plan	% of departments	University of Lisbon
G. Capacity Building for Local Administration in Climate Action	**G17**	**Administration's General Training**	Rate of local administration staff that has successfully accomplished general training on the importance of climate change issue and good practices related, disclosed per department, updated each year	% of administration staff	Adapted from SDG Indicators[48]

G. Capacity Building for Local Administration in Climate Action	**G18**	**Administration's Specific Training**	Rate of local administration staff that has successfully accomplished specific training in their specific areas for climate change mitigation, disclosed by department, updated every year	% of administration staff	Adapted from SDG Indicators[48]

Definitions:

*Private sector: The private sector is the part of a country's economy which consists of industries and commercial companies that are not owned or controlled by the government.[141]

EDUCATION & COMMUNICATION RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A.1: Promote climate change education in schools and other educational institutions	**EC1**	**Extent of the climate change subject**	Rate of hours taught concerning the climate change issue over the total hours taught to students disclosed per educational institution	Hours/year taught	University of Lisbon
A.1: Promote climate change education in schools and other educational institutions	**EC2**	**Educational partnerships for climate action**	Rate of municipal schools or educational institutions in partnership with the municipality for disseminating climate action, updated each year	% schools and/or educational institutions per year	University of Lisbon
A.2: Promote climate change education for citizens not currently enrolled in an education	**EC3**	**Population training in climate change**	Rate of municipal citizens who attended educational events (for example, workshops, conferences, and so on) about climate change-related issues in the municipality, disclosed by type of event per year	% citizens per year	University of Lisbon
B.1: Dissemination of general information on climate change and local environmental conditions	**EC4**	**Municipal website activity**	Number of visits to the climate action section of the municipal website per year	Visits per year	University of Lisbon
B.1: Dissemination of general information on climate change and local environmental conditions	**EC5**	**Social media activity**	Number of interactions in municipal social media publications (likes, shares, comments) about climate change issues per year	Interactions per year	University of Lisbon
B.2: Dissemination of information on actions taken by the municipality to mitigate climate change	**EC6**	**Climate action press releases**	Number of municipal press release about undertaken local climate action per year	Press releases per year	University of Lisbon
B.3 - Invest in non-commercial advertising campaigns to increase citizen awareness about the climate change crisis and regenerative responses	**EC7**	**Awareness raising campaigns**	Municipal resources used to raise awareness among citizens about the climate change issue and their potential contribution to take action per year	€ per habitant or Staff working hours per year	University of Lisbon

LAND USE RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A - Promote Sustainable Land Management	**L1**	**Municipality's Biocapacity**	Biocapacity of the region over the last 10 years. Please specify the area size (ha) of each land use type present in the region in order to calculate the area's biocapacity (in global hectares)	Global hectares (ha)/habitant	UNHabitat [49]
B.1 - Promote organic farming systems	**L2**	**Local organic farming (agriculture & livelihoods)**	Rate of organic farming production activities over the total declared agriculture activities in the municipality per year	% per year	Adapted from SDG's Indicators [48]
B.1 - Promote organic farming systems	**L3**	**Area of organic farming** (agriculture & livelihoods)**	Rate of municipal land area used for organic farming over the total farming area per year	% per year	University of Lisbon
B.1 - Promote organic farming systems	**L4**	**Density of organic** (agriculture & livelihoods**	Density of organic food production in the municipality per year	ha/habitant per year	University of Lisbon
B.1 - Promote organic farming systems	**L5**	**Amount of organic** food production**	Tons of food produced in the municipal territory (disclosed by organic and non-organic) per year	Tons/year	Adapted from UN-Habitat [49]
B.1 - Promote organic farming systems	**L6**	**Synthetic fertiliser sold**	Kg of synthetic fertiliser sold in the municipality per year	Kg per year	University of Lisbon
B.2 - Increase urban and peri-urban organic food production	**L7**	**Urban farming**	Rate of households*** practicing urban farming and/or aquaculture (disclosed by tenure type) over the total households*** per year	% households per year	UnHabitat [49]
B.2 - Increase urban and peri-urban organic food production	**L8**	**Area of urban/peri-urban farming**	Rate of urban and peri-urban areas dedicated to farming over the total urban and peri-urban area per year	% m^2 per year	University of Lisbon

B.3 - Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge	**L9**	**Organic gardens in schools**	Area of organic gardens in the schools per number of students, disclosed by school, per year	m^2/scholar per year	University of Lisbon
B.3 - Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge	**L10**	**Organic farming** training in schools**	Rate of scholars who accomplished training about organic farming in the schools per year	% scholars per year	University of Lisbon
B.3 - Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge	**L11**	**Enhancing indigenous/local knowledge for organic food** production**	Rate of citizens who attended training or conferences about local or indigenous agriculture over the municipal population	% citizens per year	University of Lisbon
C.1 - Increase municipal forest areas	**L12**	**Forest**** area in the municipality**	Rate of forest**** area in the municipality over the total municipal area per year	% Forest area per total municipal area, per year	Adapted from SDG's Indicators [48]
C.1 - Increase municipal forest areas	**L13**	**Native plants planted in the municipality**	Number of native plants planted in municipal forest recovery, reforestation and afforestation activities; disclosed by type of plant, per year	Number of native plants per year	University of Lisbon
C.1 - Increase municipal forest areas	**L14**	**Resources mobilization for ecosystems conservation**	Public expenditure on conservation and sustainable use of biodiversity and ecosystems (for example, forest) updated every year	€/municipal area (m^2) per year	Adapted from SDG's Indicators [48]
C.1 - Increase municipal forest areas	**L15**	**Forest**** protected Areas**	Proportion of municipal forest area under a legal framework of protected areas, updated per year	% certified activities per year	University of Lisbon
C.2 - Reduce forest loss and degradation caused by forestry activity	**L16**	**Forestry activities with sustainable practices certification**	Percentage of forestry activities in the municipality with FSC certification20 or similar, disclosed by area, type of activity and certification, per year	% certified activities per year	University of Lisbon
C.3 - Avoid conversion from forest land to other land use, particularly when switching into cropland or monocultures	**L17**	**Area of forest monoculture**	Rate of forestry monoculture area in the municipality over the total forestry area in the municipality per year	% of monocultures' hectares per year	University of Lisbon

C.4 - Implement operational and effective wildfires management	**L18**	**Burned areas**	Burned area, disclosed by forest****, monocultures or other vegetation; per year	ha per year	Adapted from INE [140]
D - Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltration	**L19**	**Impervious area in the municipality**	Rate of impervious (impermeable) surface coverage within the urban area per year	% ha per year	UNHabitat [49]
D - Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltration	**L20**	**Herbicide sold**	Liters of herbicides sold in the municipality per year	Liters per year	University of Lisbon
E - Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	**L21**	**Natural areas & Green public spaces**	Rate of urban natural areas or urban public green spaces over the total urban area per year	% ha per year	UNHabitat [49]
E - Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	**L22**	**Urban green space cover**	Rate of urban green space cover, including vegetation canopy cover and blue areas, over the total urban area per year	% ha per year	Adapted from UN-Habitat [49]
E - Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	**L23**	**Green corridors**	Rate of areas (ha) that connect protected natural areas and urban green spaces in the total urban area, using the green infrastructure index as a measure	Ha of Green Corridors / Total urban area	Adapted from UN-Habitat [49]
E - Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity	**L24**	**Local biodiversity and green infrastructures**	Is local biodiversity compulsorily considered by the municipality in their green infrastructures, spaces and blue areas?	Yes/No	Adapted from UN-Habitat [49]

Definitions:

*Sustainable Land Management: The use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, ensuring the long-term productive potential of these resources and the maintenance of their environmental functions [73]

**Organic Farming (agriculture & livelihoods): Production system where food is nutritious and accessible for everyone and natural resources are managed in a way that maintain ecosystem functions to support current as well as future human needs. [77]

***Household(s) (OECD definition): A private household is defined as either a) a one-person household, that is a person who lives alone in a separate housing unit or who occupies, as a lodger, a separate room (or rooms) of a housing unit but does not join with any of the other occupants of the housing unit to form part of a multi-person household; or b) a multi-person household, that is a group of two or more persons who combine to occupy the whole or part of a housing unit and to provide themselves with food and possibly other essentials for living.[142]

****Forest: Areas where many of the principal characteristics and key elements of native ecosystems such as complexity, structure and diversity are present as defined by FSC, approved national and regional standards of forest management.[75]

CONSUMPTION PATTERNS INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A - Promote the Consumption-Based Accounting Methodology for GHG: The Carbon Footprint	**C1**	**Citizens carbon's footprints**	Average of municipal citizens carbon's footprint per year	Tons CO_2 equivalent per habitant and year	University of Lisbon
B - Adopt Green Public Procurement	**C2**	**Green Public Procurement**	Rate of public procurement contracts that includes green public criteria disclosed by sector and year	% green public procurement criteria per sector and year	Adapted from Buying Green Handbook [89]
B - Adopt Green Public Procurement	**C3**	**Green Public Procurement Training**	Rate of municipal staff in charge of public procurement that has accomplished a GPP training over the total municipal staff in charge of public procurement per year	% staff trained per year	Adapted from Buying Green Handbook [89]
B - Adopt Green Public Procurement	**C4**	**Public Procurement and Life Cycle Cost**	Rate of public procurement that includes Life Cycle Cost analysis over the total public procurement per year	% Life Cycle Cost analysis per year	University of Lisbon
C - Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products	**C5**	**Animal products in public canteens**	Rate of diets with non-animal products served in public canteens over the total diets served per month, disclosed per public canteen	% diets with non-animal products per month	University of Lisbon
C - Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products	**C6**	**Local products in public canteens**	Rate of local products included in diets served in public canteens over the total products served per month, disclosed per public canteen	% local products included per month	University of Lisbon
C - Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products	**C7**	**Seasonal products in public canteens**	Rate of seasonal products included in diets served in public canteens over the total products served per month, disclosed per public canteen	% seasonal products included per month	University of Lisbon
C - Promote Seasonal, Organic and Locally Produced Food Consumption Without Animal Products	**C8**	**Vegetarian/vegan restaurants in the municipality**	Number of declared vegetarian or vegan restaurants in the municipality per capita, updated every year	Nº of restaurants/100 habitants, updated every year	University of Lisbon

D - Promote a Reduction in Consumerist Behavior	**C9**	**Communication campaigns for reducing consumerism**	Municipal resources used in municipal campaigns against citizens' consumerist* behavior per year	€ per habitant or Staff's working hours per year	University of Lisbon
D - Promote a Reduction in Consumerist Behavior	**C10**	**School's training for reducing consumerism**	Rate of scholars trained to avoid consumerist behavior* per year, disclosed by educational institution	% students trained per educational institution and year	University of Lisbon
E - Promote Sustainable Consumption	**C11**	**Stores of organic products in the municipality**	Density of declared organic products stores in the municipality per 100 habitants, updated every year	Nº of organic stores per	University of Lisbon
E - Promote Sustainable Consumption	**C12**	**Sustainable labelled products availability**	Rate of sustainable labelled products commercialized per store in the municipality, updated every year	% of sustainable labelled products per store per year	University of Lisbon
E - Promote Sustainable Consumption	**C13**	**Organizations with environmental systems certifications**	Rate of organizations (including the private sector) based on the municipal territory with an EMA/ISO 14001 certification (or other sustainable certification) updated every year	Nº of sustainable certified organizations per year	University of Lisbon
F - Facilitate Locally Produced Product Consumption	**C14**	**Local products consumption**	Affluence of local products' market per month	Visitors of local markets per month	University of Lisbon
F - Facilitate Locally Produced Product Consumption	**C15**	**Municipal local organic food sellers**	Density of declared local and organic food sellers in the municipality per 100 habitants, updated every year	Local Organic food sellers per 100 habitants and year	University of Lisbon

Definitions:

*Consumerist behaviour: Behaviour that manifests when the possession and use of an increasing number and variety of goods and services is the principal aspiration and the surest perceived route to personal happiness, social status and national success. [16]

** Sustainable Consumption: Based in strategies that foster the highest quality of life, the efficient use of natural resources, and the effective satisfaction on human needs while simultaneously promoting equitable social development, economic, competitiveness and technological innovation.[16]

WASTE MANAGEMENT INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A - Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Products with Short Lifespans	**W1**	**Combusted urban solid waste**	Tons of urban solid waste (USW) that is combusted over the total waste produced per year	Tons of combusted USW per year	Adapted from UN-Habitat [49]
A - Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Products with Short Lifespans	**W2**	**Amount of municipal food loss**	Tons of food recovered before being discarded in the municipality, disclosed by food chain phase per month	Tons of food recovered per month	Adapted from UN-Habitat [49]
A - Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Products with Short Lifespans	**W3**	**Amount of single-use plastic waste produced**	Tons of single-use plastic waste produced in the municipality per month	Tons of single-use plastic per month	University of Lisbon
B – Enable the "right to repair", promote the exchange of second-hand goods and increase awareness about re-using	**W4**	**Second-hand stores in the municipality**	Density of second-hand stores in the municipality per 100 habitants, updated every year	Second-hand Stores per 100 habitants and year	University of Lisbon
B – Enable the "right to repair", promote the exchange of second-hand goods and increase awareness about re-using	**W5**	**Second-hand online platforms activity**	Affluence of second-hand online platforms in the municipal territory per month, disclosed per second-hand online platform	Active users in second-hand online platforms per month and platform	University of Lisbon
B – Enable the "right to repair", promote the exchange of second-hand goods and increase awareness about re-using	**W6**	**Reparations offices in the municipality**	Density of declared reparations offices in the municipal territory per 100 habitants disclose by sector, updated every year	Declared reparations Offices per 100 habitants and year	University of Lisbon
C – Promote Recycling	**W7**	**Municipal recycling rate**	Rate of urban solid waste (USW) that is recycled over the total waste produced per month	% recycled USW per month	Adapted from INE [140]

C – Promote Recycling	**W8**	**Selective urban solid waste disposal accessibility**	Rate of municipal households* situated at least from 200 meters from the nearest selective waste disposal over the total municipal households*, updated every year	% Households per year	University of Lisbon
D.1 - Produce compost, particularly from food or green waste	**W9**	**Amount of compost produced**	Tons of compost produced in the municipality per month	Tons of compost per month	University of Lisbon
D.1 - Produce compost, particularly from food or green waste	**W10**	**Amount of organic waste recovered**	Tons of food waste and/or green waste recovered from current waste per month	Tons of food waste and/or green waste per month	Adapted from INE [140]
D.1 - Produce compost, particularly from food or green waste	**W11**	**Training in domestic compost production**	Rate of municipal citizens who attended training in domestic compost production over the total municipal citizens per year	% attendants per year	University of Lisbon
D.2 - Biogas production: Capture methane from waste management or wastewater management	**W12**	**Biogas recuperation**	Tons of methane recovered per month, disclosed by centralized compost system and wastewater treatment	Tons of recover methane per month	University of Lisbon
D.3 - Reduce landfill waste disposal	**W13**	**Urban solid waste disposal in landfills**	Tons of urban solid waste disposed into non-controlled landfills per month	Tones of USW per month	Adapted from UN-Habitat [49]
D.4 - Reduce the amount of untreated wastewater	**W14**	**Wastewater treatment**	Proportion of treated wastewater over the total wastewater generated in the municipality updated every year	% Treated wastewater updated every year	INE [140]

Definitions:

*Household(s) (OECD definition): A private household is defined as either a) a one-person household, that is a person who lives alone in a separate housing unit or who occupies, as a lodger, a separate room (or rooms) of a housing unit but does not join with any of the other occupants of the housing unit to form part of a multi-person household; or b) a multi-person household, that is a group of two or more persons who combine to occupy the whole or part of a housing unit and to provide themselves with food and possibly other essentials for living.[142]

ENERGY RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A - Promote Appropriate Renewable Energy (RE) Production	**E1**	**Total renewable energy* (RE) production self-sufficiency**	Rate of total RE produced in the municipal territory over the total energy municipal consumption (including all existing renewable energy communities****)	% (KWh local produced RE / total municipal KWh consumed) per year	Adapted from UN-Habitat [49]
A - Promote Appropriate Renewable Energy (RE) Production	**E2**	**Municipal administration renewable energy* (RE) production self-sufficiency**	Rate of total RE produced in the municipal territory by the municipal administration over the total energy municipal consumption (only public RE Community****)	(KWh RE produced by public REC / total municipal KWh consumed) per year	Adapted from UN-Habitat [49]
B – Decentralize Energy Production (Both Social and Technological Aspects)	**E3**	**Renewable energy* (RE) production in public infrastructures**	Percentage of RE produced in municipal public buildings or infrastructures per year	% (RE KWh) per year	University of Lisbon
B – decentralize Energy Production (Both Social and Technological Aspects)	**E4**	**Renewable energy* (RE) production by Households****	Percentage of RE Produced by households** in the municipality per year	% (RE KWh) per year	University of Lisbon
B – Decentralize Energy Production (Both Social and Technological Aspects)	**E5**	**Renewable energy* (RE) production among the private sector*****	Percentage of RE produced by the private sector*** per year	% (RE KWh) per year	University of Lisbon
C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E6**	**Household** participation in Renewable Energy Communities****(REC)**	Ratio of households** involved in existing renewable Energy Communities**** in the municipal territory, disclosed by REC, per year	(Households** participating in RECs / total municipal households**) per year	University of Lisbon
C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E7**	**Private sector*** Participation in renewable energy communities**** (REC)**	Ratio of the municipal based private sector that is participating in RECs **** in the municipal territory, disclosed by REC, per year	(Number of private sector participating in renewable energy communities/total municipal private sector***) per year	University of Lisbon
C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E8**	**Commercialization of renewable energy* (RE) produced**	Amount of RE sold or commercialized from all the RE communities**** based in the municipal territory, disclosed by REC, per year	KWh per year	University of Lisbon

C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E9**	**Ownership and management of the municipal distribution grid**	Percentage of municipal ownership and management of the power grid, updated each year	% owned and manage energy distribution grid	Adapted from BEACON Benchmarking [45]
C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E10**	**Household** renewable energy* (RE) consumption**	Percentage of RE consumed by households** per year	% RE consumed by households**/ Total energy consumed) per year	Adapted from UN-Habitat [49]
C – Facilitate Citizen and Private Sector Involvement in the Energy Supply Dimension	**E11**	**Municipal infrastructure renewable Energy* (RE) consumption**	Percentage of RE consumed by the municipal infrastructures, disclosed by infrastructure (if possible), per year	% RE consumed /Total energy consumed per year	Adapted from UN-Habitat [49]
D - Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure	**E12**	**Building sector energy consumption**	Buildings Sector (households** + services) energy consumption per capita and year	(KWh/habitants) per year	Adapted from UN-Habitat [49]
D - Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure	**E13**	**Energy Consumption of Public Spaces and Street Lighting**	Amount of energy consumed by the area of the public space, disclosed by neighborhood, per year	(KWh/m^2) per year	Adapted from UN-Habitat [49]
D - Increase Energy Efficiency in Municipal or Local Buildings and Infrastructure	**E14**	**Energy efficiency grade certification of municipal infrastructures**	Rate of municipal infrastructures with an energy efficiency certification with at least "A" grade in the EU Energy label25 or similar level in other certifications, updated each year	% of "A" or more certified municipal infrastructures	University of Lisbon
E - Facilitate Citizen and Private Sector Involvement to Increase Energy Efficiency	**E15**	**Energy efficiency regulations**	Existence of energy efficiency regulations in the related municipal plan	Yes/No	Adapted from UN-Habitat [49]
E - Facilitate Citizen and Private Sector Involvement to Increase Energy Efficiency	**E16**	**Subsidies for energy efficiency**	Number of public subsidies given to municipal based actors to increase energy efficiency in buildings, disclosed by type of subsidy, per year. Note: Not only subsides from local administration, other donors included	€ per year	University of Lisbon
F - Encourage Energy Consumption Reduction	**E17**	**Total energy consumption in the municipality**	Total energy consumption of the municipality, disclosed per appropriate sectors, per year	KWh per year	University of Lisbon

F - Encourage Energy Consumption Reduction	**E18**	**Total habitant's energy consumption**	Domestic electric energy consumed per habitant in the municipality per year	(KWh/hab) per year	Adapted from INE [140]
F - Encourage Energy Consumption Reduction	**E19**	**Real-time energy consumption data**	Does the municipality have access to real-time municipal electricity consumption data?	Yes/No	Adapted from UN-Habitat [49]
F - Encourage Energy Consumption Reduction	**E20**	**Local administration's enabling of energy efficiency**	Rate of municipal workers that accomplished an energy-use efficiency workshop, updated every year	% of workers that have accomplished the training per year	University of Lisbon
F - Encourage Energy Consumption Reduction	**E21**	**Scholar's capacitation on energy efficiency**	Rate of scholars that have attempted training about energy consumption reduction, disclosed by school, per year	% scholars that attempted the training per year	University of Lisbon
F - Encourage Energy Consumption Reduction	**E22**	**Communication campaigns to reduce energy consumption**	Municipal resources for energy consumption reduction communication campaigns	€/habitant or Staff working hours/year	University of Lisbon

Definitions:

*Renewable energy (RE): For this study we will exclude nuclear energy from renewable energy concept.

**Household(s) (OECD definition): A private household is defined as either a) a one-person household, that is a person who lives alone in a separate housing unit or who occupies, as a lodger, a separate room (or rooms) of a housing unit but does not join with any of the other occupants of the housing unit to form part of a multi-person household; or b) a multi-person household, that is a group of two or more persons who combine to occupy the whole or part of a housing unit and to provide themselves with food and possibly other essentials for living.[142]

***Private sector: The private sector is the part of a country's economy which consists of industries and commercial companies that are not owned or controlled by the government.[141]

****Renewable Energy Community (REC) (EU definition): A legal entity which in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by stakeholder or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity. The shareholders or members of which are natural persons, SMEs or local authorities, including municipalities. The primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits. RECs are entitled to produce, consume, store and sell renewable energy, including throughout renewables power purchase agreements, to share renewable energy within the community, and to access all suitable markets.[115]

TRANSPORTATION AND MOBILITY RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A - Implement Local Policies for Sustainable Transportation	**T1**	**Transportation growing rate**	Growth rate for each mode of transportation	Users per month	Adapted from UN-Habitat [49]
A - Implement Local Policies for Sustainable Transportation	**T2**	**Holders of mobility pass**	Rate of the municipal population that holds a mobility pass per year (disclosed by the pass modality: Transportation modality within the municipal territory or for outside of the municipal borders)	% pass holders per year	Adapted from UN-Habitat [49]
A - Implement Local Policies for Sustainable Transportation	**T3**	**Telework for local administration**	Average number of telework days offered per municipal employee and month	Days per employee and month	University of Lisbon
B - (Re)municipalization of Transportation Services	**T4**	**Transportation services ownership or management**	Rate of municipal ownership or management for all modes of transportation's services in the municipal, disclosed by type of transportation, updated every year	% owned or managed transportation's services updated every year	Adapted from UN-Habitat [49]
C - Reduce Automobile Dependency, Especially Dependency on Light-Duty Vehicles	**T5**	**LDV's*** fleet in the municipal territory**	Percentage of municipal households** that owns a car (disclosed by number of cars per household: None, One, Two or more and, disclosed by car engine: electric, hybrid, gasoline, gas, and so on) per year	% households that do not own a car, % Households that own one car, % Households that own two or more cars, per year	UnHabitat [49]
D - Promote the Reduction of Fossil Fuel Dependency in Transportation	**T6**	**Liquefied petroleum gas (LPG) consumption**	Fuel sold in the municipality territory for vehicle consume (LPG) per month	L per month	Adapted from INE [140]
D - Promote the Reduction of Fossil Fuel Dependency in Transportation	**T7**	**Gasoline 98 consumption**	Fuel sold in the municipal territory for vehicle consume (Gasoline 98) per month	L per month	Adapted from INE [140]

D - Promote the Reduction of Fossil Fuel Dependency in Transportation	**T8**	**Diesel consumption**	Fuel sold in the municipal territory for vehicle consume (Diesel) per month	L per month	Adapted from INE [140]
D - Promote the Reduction of Fossil Fuel Dependency in Transportation	**T9**	**Infrastructure for low-carbon Light Duty Vehicles (LDVs)*****	Density of charging spots for electric vehicles per electric vehicles registered in the municipality, disclosed by every municipal district, per year	Number of charges stations / electric vehicles registered in the municipality per year	University of Lisbon
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T10**	**Commuting timing by public transportation**	Average commuting travel time among the different modes of transportation, updated every year	Minutes per year	UNHabitat [49]
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T11**	**Public transportation accessibility**	Rate of urban population within a maximum of 500m distance to the nearest public transport stop, updated every year	% of urban population	UNHabitat [49]
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T12**	**Public transportation frequency**	Average frequency of public transportations towards the main urban area by buffer (every 2, 5, 10, 20 and 50 km buffer from the centre of the main urban area) updated every year	Times/hour	University of Lisbon
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T13**	**Public transportation efficiency**	Travel timing by public transportation and non-motorised transportation (NMT) from the centre of the urban area to the closest regional transportations station (e.g. rail station, bus station, and so on.) compared to the travel timing of LDVs, updated every year	Public transportation and/or NMT timing / LDV timing updated every year	University of Lisbon
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T14**	**Users of non-owned low-carbon or non-motorised transportations (NMT)**	Users rate of use of rental low-carbon transportation or NMT per month , disclosed by type of transportation	Users per month	University of Lisbon
E - Promote Low-Carbon Collective Transportation (Trains, Waterborne and Low-Carbon Buses)	**T15**	**Exclusive lanes for public transportation**	Road density dedicated for public transport only, updated each year	m per 100 habitant and year	Adapted from UN-Habitat [49]
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T16**	**Speed-limited areas**	Extent of municipal roads with speed limits up to 30km/h for LDVs***, updated by year	m^2 of speed limit areas (30km/h) per total road's area per year	University of Lisbon

F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T17**	**Speed limitation infrastructures**	Rate of municipal zebra crossings with speed humps or speed bumps, updated each year	% of zebra crossings with speed humps or speed bumps per year	University of Lisbon
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T18**	**Urban center closed for private LDVs*** **	Hours per month where the main urban area's center is closed to private LDVs***	Hours per month	University of Lisbon
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T19**	**Parking regulations**	Extent of parking areas regulated by the municipality updated each year	m^2 with regulated parking areas per total parking areas updated every year	University of Lisbon
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T20**	**Bicycle lanes status**	Bicycle lanes density updated per year	m per 100 habitant and year	Adapted from UN-Habitat [49]
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T21**	**Sidewalks status**	Density of sidewalks and pedestrian paths updated per year	m per 100 habitant and year	Adapted from UN-Habitat [49]
F - Promote and Increase Accessibility and Safety for Non-Motorised Transportation (for Example, Cycling or Walking)	**T22**	**Exclusive areas for pedestrians or non-motorised transportation (NMT)**	Density of pedestrian specific or NMT areas, updated every year	m per 100 habitant and year	University of Lisbon
G - Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	**T23**	**ECO-Driving training**	Rate of professional road drivers that have successfully completed a complete ECO-driving course, per year	% trained road drivers per year	Adapted from IPCC [16]
G - Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	**T24**	**Sustainable transportation training for scholars**	Rate of scholars that have attempted a course in sustainable transportation provided in schools, disclosed by school, per year	% trained scholars per year	University of Lisbon
G - Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	**T25**	**Sustainable transportation communication campaigns**	Municipal resources used in communication campaigns to promote sustainable transportation	€/habitant or Staff's working hours/year	University of Lisbon

G - Promote Sustainable Transportation Through Awareness-Raising Campaigns, Education, and Advertising	**T26**	**Affluence of car-sharing**	Affluence of car-sharing online platforms in the municipal territory per month, disclosed per platform	Users who travelled per month	University of Lisbon

Definitions:

*The Sustainable Transportation defends the accessibility for all to help meet the basic daily mobility needs consistent with human and ecosystem health, but to constrain GHG emissions by [16]
**Household(s) (OECD definition): A private household is defined as either a) a one-person household, that is a person who lives alone in a separate housing unit or who occupies, as a lodger, a separate room (or rooms) of a housing unit but does not join with any of the other occupants of the housing unit to form part of a multi-person household; or b) a multi-person household, that is a group of two or more persons who combine to occupy the whole or part of a housing unit and to provide themselves with food and possibly other essentials for living.[142]
***Light Duty vehicles (LDVs): Vehicles from the M and N European category, concretely the passenger cars and vans.[143]

SPATIAL PLANNING RELATED INDICATORS

RECOs	Nº	Indicator	Description	Units	Source
A.1- Enable the local administration in integrating climate change mitigation perspectives into municipal spatial planning processes	**SP1**	**Enabling of climate change mitigation involving spatial planning**	Rate of local administration staff involved in the municipal spatial planning process that have accomplished climate change mitigation training, updated every year	% related trained staff per year	University of Lisbon
A.2 - Integrate nature/ecosystem-based solutions into the spatial planning process	**SP2**	**Enabling of nature/ecosystem-based solutions**	Rate of local administration staff involved in the spatial planning process that has accomplished a related ecosystem-based solution training updated every year	% related trained staff per year	University of Lisbon
A.2 - Integrate nature/ecosystem-based solutions into the spatial planning process	**SP3**	**Integration of nature/ecosystem-based solutions* into the spatial planning process**	Does the local government take the ecosystems-based solutions into mandatory consideration in the spatial planning process?	Yes/No	Adapted from UN-Habitat [49]
A.3 - Implement adequate spatial planning policies and instruments to support low-carbon fluxes in the municipality	**SP4**	**Success of local policies towards low-carbon-fluxes**	Rate of successful policies to transit into low-carbon fluxes in the spatial planning process, disclosed by policy, updated every three years	% successful policies targeting municipal low-carbon fluxes, per 3 years	University of Lisbon
B.1 - Increase density	**SP5**	**Municipal Density**	Population per area in the municipality, disclosed by urban, peri-urban and rural area	Hab. per m^2	Adapted from IPCC [16]
B.1 - Increase density	**SP6**	**Abandon spaces in the urban area**	Rate of abandon buildings and/or other abandon spaces area over the total urban area, updated every year	% of Abandon urban area per year	University of Lisbon
B.1 - Increase density	**SP7**	**Building Height**	Percentage of medium-rise buildings (between 3 to 7 floors) in the municipality	% medium-rise buildings	University of Lisbon
B.2 - Increase land use mix	**SP8**	**Land use mix among residencies and jobs**	Ratio of jobs to residents, disclosed by municipal neighborhood	Jobs per residents	Adapted from IPCC [16]

B.2 - Increase land use mix	**SP9**	**General land use mix**	Relative proportion of retail, housing and green areas in the municipality, disclosed by neighborhood	Proportion of retail, housing and green areas	Adapted from IPCC [16]
B.3 - Increase connectivity	**SP10**	**Municipal connectivity**	Intersection's density, disclosed by neighborhood	Intersections per Km^2	Adapted from IPCC [16]
B.4 - Increase accessibility	**SP11**	**Population centrality**	Population centrality, disclosed by neighborhood	Depending on the methodology	Adapted from IPCC [16]
B.4 - Increase accessibility	**SP12**	**Jobs accessibility**	Average job accessibility by road or transit, disclosed by neighborhood	m/m^2	Adapted from IPCC [16]
B.4 - Increase accessibility	**SP13**	**Retail accessibility**	Average of Retail accessibility, disclosed by neighborhood	m/m^2	Adapted from IPCC [16]
B.4 - Increase accessibility	**SP14**	**Distance to the urban center**	Distance to the urban center, disclosed by neighborhood	m	Adapted from IPCC [16]
C - Prioritise Sustainable and Resilient Infrastructures while minimising lifecycle GHG emissions	**SP15**	**Integration in infrastructures of nature/ecosystem-based solutions**	Rate of municipal infrastructures that have been based in nature/ecosystem-based solutions*, updated every 3 years	% infrastructures per 3 years	University of Lisbon
C - Prioritise Sustainable and Resilient Infrastructures while minimising lifecycle GHG emissions	**SP16**	**Lifecycle assessment of GHG emissions for infrastructures**	Rate of municipal Infrastructures with an integrated lifecycle assessment of GHG emissions, updated every 3 years	% infrastructures per 3 years	University of Lisbon
C - Prioritise Sustainable and Resilient Infrastructures while minimising lifecycle GHG emissions	**SP17**	**Balance between value-added and GHG emissions**	GHG emissions per unit of value added of each municipal infrastructure	CO_2 eq /Infrastructure contribution to GDP	Adapted from SDG Tier Classification [48]

Definitions:

*Nature/Ecosystem-Based Solutions: Strategies based on natural processes and cycles that use natural flows of matter and energy, taking advantage of the local solutions, following the seasonal and temporal changes of the ecosystems. [79]

Annex 5: Survey Example:
Governance Indicators Survey

Governance Indicators for Local Climate Change Mitigation

1. Welcome! Governance Indicators Survey

We are grateful to introduce to you this survey to co-create together a universal methodology for monitoring climate change mitigation at the local level in the Governance domain.

Context:
Climate Change (CC) Mitigation has increased in importance across all European countries since the Paris Agreement entered into force in 2016. The mitigation of CC has been considered an important method for pursuing sustainable development and is integrated with CC adaptation in the United Nation's Sustainable Development Goal (SDG) 13, Climate Action.
Recently, with the approval of the New Green Deal in the European Union (EU), that pursues the achievement of carbon neutrality in 2050 in all EU member states, mitigation has become a crucial topic to be addressed at all levels of governance.

Did you know? CC mitigation goes beyond the reduction of greenhouse gas (GHG) emissions. It needs to be complemented with enhancing, restoring and protecting the existing GHG sinks (for example, forests).

Why local? Local authorities play a fundamental role in achieving the desired objectives. CC mitigation requires deep transformation, requiring the selection of appropriate measures for the transition, attending to the needs and reality of each territory. Municipalities are the perfect scope to adjust measures for each territory's characteristics, finding synergies to potentiate practical results.
What are the advantages of this methodology?
Municipalities are key actors for CC mitigation. The next EU funding schemes are pointing to monitoring climate action and sustainable development in all municipalities. In this way, this monitoring framework is fundamental for not only increasing the effectiveness of the process but additionally, increasing the opportunity of municipalities to apply for funding.

Each recommendation and its indicators associated are linked to their related SDGs and concrete targets in order to increase synergies for monitoring CC mitigation and sustainable development simultaneously.

Let's cocreate together a methodology to monitor CC Mitigation at the local level!
Monitoring the local process for CC mitigation seems to be a challenge for the majority of municipalities in the EU. This survey is the first step to finding a solution!
The survey is prepared to collect all the knowledge in local EU administrations in order to understand which practical indicators could be used to monitor the municipal CC mitigation process. The aim is to build up a global methodology to support each EU municipality and measure the progress of their mitigation pathway.

The proposed indicators are associated with different science-based recommendations that local authorities should tackle to mitigate CC. Recommendations are divided into the following domains to facilitate the allocation of the information in each respective department: Governance, Education & Communication, Land Use, Consumption Patterns, Waste Management, Energy, Mobility & Transportation and Spatial Planning. A survey has been prepared for each domain of action.

The path is settled! The recommendations have been collected in the Roadmap for local climate change mitigation, created by the research team of Lisbon University to support local communities with different contexts and realities for fulfilling the required CC mitigation process.

(Are you missing the Roadmap? Download the document here!)

The challenge: A global methodology that represents each municipal reality
Unifying all EU municipalities into the same mitigation pathway monitoring is the main challenge of this methodology. Thus, some of the recommendations and their associated indicators may not perfectly match with the reality of your municipality at the present moment.
Don't worry! Municipal realities may be different, but their objectives are the same: CC mitigation is the common focus and strength of this methodology.
For that reason, this methodology does not focus on how suitable the indicators are for the current status of your municipality but on how suitable they could be for the general EU local administration. It is important to keep in mind that, for instance, if your municipality has not yet started to approach some of the recommendations, they could be included in the planning for the near future, approaching the recommendations in accordance with each territory's reality.

Switching from peer pressure to self-improvement motivation
This methodology will not be used to compare the status of different municipalities, as they have different strengths and weaknesses depending on their natural and socioeconomic characteristics and context. Nonetheless, it will be useful for comparing the evolution of the same municipality through time, where each municipality can set its own goals and priorities in pursuit of CC mitigation, according to each municipal's characteristics. No municipality will be left behind!

Who will ideally answer this survey? An opportunity to engage with your colleagues!
We encourage the dissemination of the survey among the different departments specialised in each relevant area in order to collect accurate information (for example, surveys related to mobility and transportation would ideally be answered by colleagues from the mobility [or related] department). In the case that an area does not match with any defined department in your municipality, we propose having the questionnaire section completed by personnel responsible for local climate action.

How I answer to the survey?
- Freely: The answers will be anonymous and confidential. The personal information asked is the minimum required to analyse the collected data. It includes your municipality's country, your position and general expertise area (for example, your department) and, optionally, your email for sharing the results with you.

- With your Expertise: Contributing your knowledge and practical experience is crucial for alignment with what academia proposes for dealing with this situation.
- Envisioning: As explained before, if you know or feel that some recommendations do not currently match with your municipal reality, let us know if they could be suitable in the near or long-term future.

In the survey, two questions (one mandatory and one optional) are asked for each proposed indicator in order to understand whether the indicator is suitable for the global methodology:
Mandatory: Do you find the indicator adequate for the local administration? If not, you have the opportunity to share with us why (including an option to propose alternatives).
Optional: Do you already use the indicator or similar alternative? (with an option to describe your current indicator)

Completing the survey takes no longer than 1 hour. You can save your answers and get back to them when ready (for example, when waiting to get feedback from a colleague).

About the information collected in the questionnaire and outlines the steps of the methodology:
The information collected will be under the care of the Lisbon University and the BEACON project. The data will be used to build a monitoring methodology for local CC mitigation to be applied in European countries.

For any clarification regarding the questionnaire, please do not hesitate to contact us via email at mmgarcia@fc.ul.pt

Thanks for your collaboration! Answering this questionnaire could be the needed catalyst for a transition to occur.

1. Please, check the tick box if you have read and aknowledge how to proceed with the survey *

☐ I am willing to collaborate to CC Mitigation answering this survey

2. The Basics:

2. Country: *

3. Your municipality: *

4. How many years of experience do you have working in the local administration (approximately)? Please, answer only with numbers *

5. Which is the area(s) related to the municipal department/unit that you belong? *

- [ ] Climate Action
- [ ] Consumption (Public Procurement, Local Markets...)
- [ ] Education and/or Communication
- [ ] Energy
- [ ] Governance
- [ ] Land Use (Agriculture, Forestry and Other Land Use)
- [ ] Mobility & Transportation
- [ ] Spatial Planning
- [ ] Waste Management
- [ ] Other (please specify):

6. Your position in the municipality:

7. Your email address (just if you are interested in the results, the global consensus of indicators):

3. Governance Recommendations for Local Climate Change Mitigation:

This survey will be focus on the governance domain for municipal climate change mitigation. A total of 7 science-based recommendations are proposed with 18 indicators associated (some recommendations are associated to more than one indicator)

The recomendations are based by the following model of governing: Governing by provisioning sustainable services and using all available politic instruments for climate change mitigation, specifically the information policies and voluntary actions, increasing (re)municipalisation of municipal services, enhancing the collaboration and participating through stakeholder-partnership.

A. Provisioning Sustainable Services/ Green Public Procurement (Indicator associated: G1)
B. Promote Information Policies (Indicators associated: G2, G3, G4)
C. Undertake Voluntary Actions (Indicators associated: G5, G6)
D. (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation (Indicator associated: G7)
E. Stablish Stakeholders' Partnerships (Indicators associated: G8, G9, G10. G11, G12, G13)
F. Rearrange the Internal Structure of Local Administration (Indicators associated: G14, G15, G16)
G. Capacity Building for Local Administration in Climate Action (Indicators associated: G17, G18)

If you would like to better understand the nature of the recommendations, please follow up the Roadmap for Local Climate Change Mitigation (please, download it here).

If you have any inquiries, please, do not hesitate to contact us via email to mmgarcia@fc.ul.pt

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Definitions:
*Private sector: The private sector is the part of a country's economy which consists of industries and commercial companies that are not owned or controlled by the government.

4. G1 - Municipal services with environmental management or other related certification

A) Provisioning Sustainable Services/ Green Public Procurement (Indicator G1)

Indicator: G1 - Municipal services with environmental management or other related certification

Description: Rate of municipal public services offered with a validated sustainable certification (for example, EMAS, ISO or others) updated every year

Units: % certifications per year

Suggestion for data collection: Internal Information

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

8. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

9. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

5. G2 - Territorial Greenhouse Gases (GHG) emissions

B) Promote Information Policies (Indicator G2, G3, G4)

Indicator: G2 - Territorial Greenhouse Gases (GHG) emissions

Description: GHG emissions emitted within the municipal territory based on the baseline emissions inventory, updated every year

Units: CO2 eq Tonnes per year

Suggestion for data collection: Baseline GHG emissions inventory

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

10. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

11. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

6. G3 - Greenhouse Gases (GHG) territorial sinks

B) Promote Information Policies (Indicator G2, G3, G4)

Indicator: G3 - Greenhouse Gases (GHG) territorial sinks

Description: GHG emissions captured based on vegetation cover of the municipality, updated every year

Units: CO2 eq Tonnes per year

Suggestion for data collection: Geographic Information Systems (GIS)

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

12. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

13. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

7. G4 - Balanced municipal Greenhouse Gases (GHG)

B) Promote Information Policies (Indicator G2, G3, G4)

Indicator: G4 - Balanced municipal Greenhouse Gases (GHG)

Description: Balanced GHG emissions (Municipal GHG emitted - GHG emissions capture) of the municipal territory, updated every year

Units: CO2 eq Tonnes per year

Suggestion for data collection: Geographic Information Systems (GIS)

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

14. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree

☐ 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

15. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

☐ No, neither this nor similar

☐ Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

8. G5 - Sustainable Energy and Climate Action Plan (SECAP) success

C) Undertake Voluntary Actions (Indicators G5, G6)

Indicator: G5 - Sustainable Energy and Climate Action Plan (SECAP) success

Description: Rate of successfully implemented measures over the total measures proposed for climate change mitigation in the SECAP (Covenant of mayors), based on the SECAP's monitoring system

Units: % of measures implemented per year

Suggestion for data collection: SECAP's Monitoring system

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

16. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

17. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

9. G6 - Climate action plan's success (different from SECAP)

C) Undertake Voluntary Actions (Indicators G5, G6)

Indicator: G6 - Climate action plan's success (different from SECAP)

Description: Rate of successfully implemented measures over the total measures proposed for climate change mitigation in other(s) local action plan(s) (different from SECAP), based on the monitoring system of the plan, disclosed by the plan

Units: % of measures implemented per year

Suggestion for data collection: Monitoring system of Local Climate Action Plan(s)

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

18. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

19. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

10. G7 - Ownership of municipal services

D) (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation (Indicator G7)

Indicator: G7 - Ownership of municipal services

Description: Rate of municipal services completely owned by the local administration over the total of municipal services, disclosed by sector, updated every year

Units: % owned municipal services

Suggestion for data collection: Internal Information

SDG related (concrete target): 13 Climate Action (13.2) & 17 Partnerships for the Goals (17.4)

20. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

21. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

11. G8 - Private Sector* Involvement in Municipal Climate Action Process

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G8 - Private Sector* Involvement in Municipal Climate Action Process

Description: Rate of local private sector* participating actively in the municipal climate action process disclosed by any related activity (for example, feedback to municipal action plans, supporting municipal mitigation measures, data sharing related to climate change, and so on) updated every year

Units: % per Activity and year

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

Definitions:
*Private sector: The private sector is the part of a country's economy which consists of industries and commercial companies that are not owned or controlled by the government.

22. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

23. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

12. G9 - Target measures addressing municipal top Greenhouse Gases (GHG) Emitters

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G9 - Target measures addressing municipal top Greenhouse Gases (GHG) Emitters

Description: Rate of climate change mitigation measures directly related to the top five highest GHG emitters in the private sector based in the municipal territory

Units: % target measures

Suggestion for data collection: Climate action plan measures

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

24. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

25. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

13. G10 - Climate-related NGOs or Associations Involvement

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G10 - Climate-related NGOs or Associations Involvement

Description: Rate of related NGOs or associations existing in the municipal territory and participating in the climate action process of the municipality disclosed, by any related activity (for example, feedback to municipal action plans, supporting municipal mitigation measures, events organisations, and so on)

Units: % per Activity and year

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

26. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

27. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar

- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

14. G11 - NGOs and Municipality partnerships for Climate Action

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G11 - NGOs and Municipality partnerships for Climate Action

Description: Number of official partnerships between the municipality and related climate action NGOs and associations updated every year.
For example, Partnerships for environmental sensibilisation tasks with local NGOs

Units: Nº Partnerships per year

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

28. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

29. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

15. G12 - Civil society participation

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G12 - Civil society participation

Description: Participation rate of civil society in local climate action measures disclosed per activity (for example, feedback on municipal measures, public consultation, citizens assembles, and so on) updated every year

Units: % Civil Society participation per Activity and year

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

30. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

31. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

16. G13 - Collaboration with other/s public entities

E) Stablish Stakeholders' Partnerships (Indicator G8, G9, G10, G11, G12, G13)

Indicator: G13 - Collaboration with other/s public entities

Description: Number of other local public entity (for example, energy agencies, other municipalities, and so on) officially involved in the municipal climate action process (for example, collaboration in climate action plans, inter-municipal partnerships, and so on) disclosed by type of activity and public entity, updated every year

Units: Nº Public entities per activity and year

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

32. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

33. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

17. G14 - Local administration involvement

F) Rearrange the Internal Structure of Local Administration (Indicator G14, G15, G16)

Indicator: G14 - Local administration involvement

Description: Human resources investment for any related climate change mitigation process per month, disclosed by department

Units: Working Hours/month

Suggestion for data collection: Local Administration rooster

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

34. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

35. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

18. G15 - Collaboration among departments

F) Rearrange the Internal Structure of Local Administration (Indicator G14, G15, G16)

Indicator: G15 - Collaboration among departments

Description: Internal meetings among departments to discuss climate action policies per year

Units: Meeting Hours/year

Suggestion for data collection: Local Administration rooster

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

36. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

37. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

19. G16 - Level of department's implication

F) Rearrange the Internal Structure of Local Administration (Indicator G14, G15, G16)

Indicator: G16 - Level of department's implication

Description: Rate of local administration departments officially and actively involved the climate change mitigation process.
For example, number of departments involved in the implementation of the SECAP Plan

Units: % of departments

Suggestion for data collection: Internal Information

SDG related (concrete target): 17 Partnerships for the Goals (17.16 & 17.17)

38. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

39. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

20. G17 - Administration's General Training

G) Capacity Building for Local Administration in Climate Action (Indicator G17, G18)

Indicator: G17 - Administration's General Training

Description: Rate of local administration staff that has successfully accomplished general training on the importance of climate change issue and good practices related, disclosed per department, updated each year

Units: % of administration staff

Suggestion for data collection: Attendants' list

SDG related (concrete target): 13 Climate Action (13.3)

40. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

41. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

21. G18 - Administration's Specific Training

G) Capacity Building for Local Administration in Climate Action (Indicator G17, G18)

Indicator: G18 - Administration's Specific Training

Description: Rate of local administration staff that has successfully accomplished specific training in their specific areas for climate change mitigation, disclosed by department, updated every year

Units: % of administration staff

Suggestion for data collection: Attendants' list

SDG related (concrete target): 13 Climate Action (13.3)

42. Based on your experience, do you find the indicator adequate for the local administration/municipality? *

- [ ] 1 - No, I Strongly Disagree
- [ ] 2 - No, I Disagree
- [ ] 3 - Yes, I Agree
- [ ] 4 - Yes, I Strongly Agree

If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative

43. Is this indicator (or a similar one) used for monitoring purposes in your municipality?

- [ ] No, neither this nor similar
- [ ] Yes, the same or similar indicator

If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using:

Annex 6: Survey Comments from Participants

Governance Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
G1	- EMAS or ISO certifications are extremely complex and so far not very suitable for local government. Simplified certification systems should be used, e.g. Kom.ems (https://www.komems.de/)	- iso 9001:2015, on the road to certify for iso 50001 - Kom.ems und european Energy award(https://www.komems.de/)
G2		- tone equivalent CO2 - Evaluation of CO2 emissions within the audits MA21 - Healthy City
G3	- The effort for smaller communities is immense compared to the benefits	
G4		- So monitored at the voivodeship level
G5	- The Municipality of Loulé is still developing its Sustainable Energy and Climate Action Plan (SECAP). - But the actions have very different difficulties (money, time...) - Taxa de concretização da EMAAC (Estratégia Municipal de Adaptação às Alterações Climáticas) - it depends on how much CO2 savings each measure will bring, so a rating by% of measure is not the most appropriate in my opinion. So I do not agree with the way this indicator is evaluated. I would agree with the indicator as such - I think it is more appropriate to monitor this for a larger whole, our city is too small to monitor the% of measures implemented per year.	
G6	- see previous point. Rather than the share of measures, I would monitor the emission savings caused by the implemented measures	- we evaluate the implementation of the strategic plan of the city and related action plans
G7	- What added value should this information bring in relation to climate protection?	
G8	- How should this proportion be determined? An absolute value may be more useful than a percentage. - A second indicator should be introduced, as a percentage of the total private sector participating in the activity, in order to have a clearer record, to see how many private companies provide such information to the local administration. Most of the time the private sector does not provide such data to the local administration, and then this indicator will have to be correlated with national and possibly local legislation (local council decisions), and in order to be significant in monitoring the climate action process at the municipal level, the	- We are preparing within SECAP

	percentage of the private sector that participates in this monitoring must also be highlighted. - it is difficult to calculate such an indicator. What data would it contain?	
G9	- For privacy reasons, it is likely difficult or impossible to get the emissions data of the top 5 consumers. - I can't agree, because at the moment from the data I have, it does not result that a monitoring is done on GHG / company, and then it would be difficult to say which are the 5 most important GHG emitters, and implicitly It is difficult to highlight the percentage of measures aimed at mitigating climate change, correlated with the five most important GHG emitters in the private sector. - - The largest emitters are large or medium-sized enterprises. It is difficult for me to imagine what these actions could be. ADDITIONALLY, there is an aspect of social perception (political) of working with large companies (negative). On the third hand, state aid.	- I don't know
G10	- We are a small town and I do not have such an organization in our territory	
G11	- Partnership, even if official, does not necessarily mean active cooperation ... It can be misleading. - For smaller municipalities, finding a partner can be a problem	- Cooperation with Danfoss
G12		- The Municipality of Loulé monitors the number of participants in all formal, mandatory, and non-mandatory participation mechanisms, not just those directly related to climate action. - SMART city strategy - The following indicators are used in the annual monitoring report on the implementation of Law no. 52/2003 (decisional transparency): Total number of recommendations received (for HCL projects, other municipal documents); The total number of recommendations included in the draft normative acts. Number of meetings organized at the request of legally constituted associations. The total number of observations and recommendations expressed during public meetings. The total number of recommendations included in the decisions taken. - Participation in the civic budget and residents' meetings - The city is a member of the Network of Healthy Cities of the Czech Republic. Every year, the so-called Public Forum of the Healthy City of Přeštice takes place, which describes the main problems of the city, but also goals or projects with a positive impact. Among them, topics related to climate protection often appear. Area and maintenance of greenery, transport, nature protection. Subsequently, a survey is compiled, which is presented by all available communication channels. The evaluation is then published and becomes the basis for the following forum. - MA21, public involvement campaigns

G13		- Universities, Universities, Associations of Municipalities, Transregional Cooperation (City of Písek) - Membership in the association - MA21, events and campaigns in cooperation of 3 sectors, public administration, business sector, non-profit sector
G14		- The Municipality of Loulé monitors the following indicators: Existence of a technical team or organic unit in the Internal Structure directly allocated to climate action (Y / N) Number of municipal technicians directly allocated to climate action Annual budget directly allocated to climate action; No. (or %) of municipal services directly involved in the implementation of adaptation options / climate action measures. - A similar indicator is used to timeline people working on European-funded projects, which aim to mitigate the effects of climate change (eg energy efficiency projects) and would be useful for people not working on such projects (with European funds) but are involved in climate change mitigation actions.
G15		- difficult to implement
G16		- similar - Unfortunately, the services are not involved in the new measures. - It was implemented as a measure for the implementation and monitoring of the Climate Change Mitigation Plan (SEAP) by identifying the departments involved in the City Hall. A similar measure was taken for the Urban Mobility Plan (PMU).
G17		- The Department of the Environment regularly undergoes training. - There is a general indicator on the number of people in the specialized apparatus who have benefited from training courses, but a statistic dedicated exclusively to training in the field of climate change would be welcome. - MA21, regular training on individual goals of sustainable development for various target groups (office staff, public, children and youth)
G18	- At present there are quite a few specializations at national level (university courses, postgraduate courses, forms of long and / or short-term education) that concern the field of climate change mitigation. On the other hand, they should be encouraged and should be	- As part of SMART activities - MA21, training for sustainable development

Education & Communication Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
EC1		- We don´t use it because it is Education Ministry responsibility and not Municipal Council. We just want to find out how many hours we make presentations or other activities. We count the number of hours we make presentations about CC and we have the total hours of presentations we make in schools (about environment, including CC). - I don't know
EC2	- We have a Eco-Schools (which work that subject) percentage but other schools can work about CC subject and not be Eco-Schools. - A second indicator should be included, percentage of schools or educational institutions in case of a partnership with public environmental institutions (dissemination of information on climate actions is done by the local authority - Ramnicu Valcea City Hall, but can also be done by Environmental Agency, Environmental Guard, ROMSILVA (forest management agency).	- I don't know. 100% is not updated annually. - MA21, 1x in approx. 3-4 years we organize education for elementary school students focused on various goals of sustainable development - SDG
EC3	- In addition to the indicator presented above, the Municipality of Loulé also uses the following indicators: Annual number of (in) training, awareness and environmental education projects and initiatives developed with a focus on CA Number of elements / awareness materials / information on CA edited / published per year. - The results would be very low and probably most of the time would be the same people. But I don´t find another way to be proportional to population.	- We just count the number of people. - It is quite difficult to quantify the number of people participating in such actions, they can be organized by NGOs, not just the municipality. That is, the municipality can have data from the events it organizes, but it will be quite difficult to have a statistic of all the events organized in the municipality. - MA21, 1x in approx. 3-4 years we organize education for elementary school students focused on various goals of sustainable development – SDG - Přeštice is a member of the Network of Healthy Cities of the Czech Republic.
EC4	- But sometimes is the same person visiting it.	
EC5	- But probably is the same person over and over again. - In the area of social media, the way some people communicate (e.g., "permanent commentators") lead to distortions that do not allow any meaningful indication. The indicator might fluctuate annually by orders of magnitude, which does not allow a meaningful evaluation. - It is quite difficult to have such a statistic, there should be at least one person to monitor such interactions. On the other hand, there are situations in which false accounts are used,	- The problem is usually the language barrier

	and such interactions cannot give an overview of citizens' views on the issue of climate change.	
EC6	- A bigger city would have more press releases I imagine.	
EC7	- Both units of measurement should be used, respectively euro / inhabitant and number of hours worked by staff / annually.	- Number of elements / awareness materials / information on CA edited / published annually. - Just count the campaigns/activities. - MA 21, we regularly organize campaigns such as European Mobility Week

Land Use Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
L1	- The number of inhabitants is only known every 10 years (national censuses from the National Statistics Institute)	- We use the indicator: Land occupation and land use, which provides the quantification of classes of occupation and land use - We have a calculation of the ecological footprint of the village performed about ten years ago. We plan to repeat and compare this calculation. This is a demanding calculation, in terms of data collection, we are looking for a suitable grant title, which we would include together with a survey of the satisfaction of the population with life and living conditions in the village
L2	- These activities are not licensed by the municipality	
L3	- We don't have this data	- During the audit of sustainable development, we determined the acreage of land that is organically farmed. It is very difficult to find this information.
L4	- The number of inhabitants is only known every 10 years	
L5	- It is very difficult to obtain this information. Gardeners also sell their surpluses at farmers' markets, producing food for their own use and selling surpluses. They are not entrepreneurs. - The previous indicator is more useful because it relates production to demand (inhabitants)	
L6	- This indicator is relevant for soil quality but we do not have these data. I think it would be a more reliable indicator by soil sampling - The local administration does not have data on potential suppliers of synthetic fertilizers within the city. Also, the suppliers can be from other cities in the country, maybe even from other countries, so these data are difficult, if not impossible to centralize. - the data cannot be ascertained objectively	
L7	- Ramnicu Valcea is inhabited by a very high percentage of people who live in multifamily homes (blocks of flats), so there are quite a few households in which urban agriculture or aquaculture could be practiced. - the data cannot be ascertained objectively	- At this moment, we quantify the "Area of Urban Gardens in the Municipality", the "Number of plots available in the Urban Urban Gardens" and the "% of plots allocated"
L8	- It requires the criterion for the classification of municipal soil, which does not exist. It requires the existence of aerial photography updated every year - As referred in L7	

L9	- Some schools work on the theme with all students and others only with a specific class or level of education - No information	- I agree to the extent that the schools will adopt the ecological garden system, which does not currently exist in Ramnicu Valcea. - Just the number of student which work in teh vegetable garden
L10	- No information	- We have the number of student which work in the garden and the total of students in that school.
L11	- In our experience it is always the same people who attend sessions on environment, agriculture and related topic - It is difficult to make such statistics because citizens can participate in training courses organized throughout the country, or even abroad, courses organized by people / institutions / NGOs that the municipality can not identify, not having access to a database data with such trainers.	- Only the number of participants
L12	- There is currently no such data with an annual update. I propose to replace it annually for 5 in 5 years.	- we have an overview of the forest area
L13	- We do not have this information, almost all land is private - No information	- can be objectively determined only for municipal property, not for property of other entities
L14		
L15		
L16	- can be objectively monitored only on the property of the municipality	
L17	- There is currently no such data with an annual update. I propose to replace it annually for 5 in 5 years.	
L18		- Every year, the burned area is delimited and recorded in a Geografic Information System. - It´s the same indicator
L19	- Elaboration of the Index of Land Occupation biannually by photointerpretation	
L20	- But we don´t have these data - It is difficult to make such statistics, because there is no database with potential suppliers of herbicides in the municipality and / or nationally. - cannot be determined objectively	
L21		- there are as indicators the area of green spaces in the total area of the municipality.
L22	- The previous indicator seems to be sufficient	- total green areas of the total city area

L23		- The territorial system of ecological stability registers biocorridors and bio-centres
L24		

Consumption Patterns Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
C1	- Is the average value of the carbon footprint taken into account from the total tons of CO2 equivalent of residential consumption or from the total municipal emissions?	- the tonne CO2 equivalent residential consumption indicator is used - Based on the collection of waste and its transfer to an authorized person, we obtain data on how much CO2 has been reduced
C2		- similar
C3		
C4		
C5	- Not useful for our municipality - Only applicable in municipalities with their own canteen - There aren't public canteens - very difficult to ascertain	
C6	- see last question - difficult to identify	
C7	- Not useful for our municipality - see last question - difficult to identify	
C8	- In my opinion a restaurant dont't have to be exclusively vegetarian/vegan to be sustainable. For example, in our municipality we have a restaurant that is known for serve vegetarian food but also serves meat dishes. For me makes more sense to know how many restaurants promote the use of all the remaining confectioned food goods, distributing them to people with food deficiencies, under controlled conditions of hygiene and food security, thus avoiding waste. - Does not necessarily have a meaningful value, because you do not find out anything about size and frequency of use. - The city, whose name bears the breed of black-spotted pig, can not do otherwise!	
C9		- Fairtrade Breakfast - Campaign
C10	- I agree, it is more accurate but it doesn´t mean they really learnt and act like they saw/heard.	- Just the number os students per activity and number of activities.

	- only applicable in municipalities with a university	- Our ecological education center has several programs for pupils and students on this topic.
C11	- see answer to vegetarian restaurants. - this statistic is useful, but it will be difficult to achieve, the first step being to declare the store owners as "ecological", so a classification / reclassification of stores will have to be made (at least at local level, possibly by local council decision) in this sense.	
C12	- It is very difficult to aggregate the data. - How should that be recorded? - It is difficult to make such a statistic, firstly because stores cannot be forced to provide such data, and secondly the statistic would be incomplete because even if such information were obtained from store chains. (hyper and supermarkets), they will be difficult to obtain from family stores. - difficult to identify	
C13	- It is just possible to know the organizations that work with the Municipality. - It is very difficult to make such statistics, usually the municipality does not have such information about the NGO and private sectors and I do not know if they are found in the data of other public institutions (eg Chamber of Commerce).	
C14	- I imagine a visitor count to be extremely complex in relation to the benefit. - It is difficult to make such a statistic, at present there is no system for counting visitors in local markets in the city. Also, the city has 3 permanent local markets, with daily schedule, to which is added another location arranged as a "fair". - Support for the organization of markets is also important	
C15	- I agree with the indicator, but it is a difficult statistic to make, because the local administration should obtain such data from other public institutions (in addition, I do not know that such data should be mapped), - is not an easily ascertainable figure	

Waste Management Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
W1	- This indicator is not applicable to the municipal reality. In the Algarve region (where Loulé is included) solid urban waste, which are not sent for recycling, are deposited in a sanitary landfill - But it doesn´t apply to Braga - not useful for our municipality - The Municipality does not manage its waste through incineration. - is not current in our area, there is no incinerator	- As the combusted / incineration of waste is not applicable to all municipalities, you should consider the alternative indicator: Tonnes of urban solid waste (USW) that is deposited in a sanitary landfill over the total waste produced per year - We deal with strategic partners. vision ready
W2	- I do not think that such data can be obtained from those involved (suppliers, producers, consumers) in such a way that the information obtained can be quantified and can be relevant for such statistics. - very difficult to ascertain	
W3	- This indicator is difficult to measure. Single-use plastic waste are disposed of within general waste, and their production cannot be counted separately. - It is not easy to separate because it arrives mixed with other kind of plastic and some mixed with other waste which goes to landfill. - difficult to identify	- At present, the amount of plastic waste (separately collected waste) from municipal waste is quantified locally.
W4	- not useful to our municipality - it is difficult to make such a statistic.	
W5	- Not useful for our municipality - I do not think that such an indicator is relevant; In addition, it is difficult to quantify such statistics on online platforms, primarily because you need to identify not only dedicated platforms, but also ads on social platforms.	
W6	- Not useful for our municipality	
W7		- We already use this indicator. - we are monitoring this indicator
W8		- This indicator has been used for a long time, as ERSAR obliges us to use this same indicator. - Internal monitoring - we keep an overview of the collection points for sorted waste. - One of the parameters for obtaining a reward for sorting waste.

W9	- Regional indicator. With regard to organic waste, municipal competence involves the management of waste disposal equipment (placement and maintenance) and respective collection. The subsequent routing and final destination of organic waste (landfill or composting) is the responsibility of the company ALGAR - Valorisation and Treatment of Sólidos Solid, SA, which does not allow to assess the percentage of organic waste produced in the municipal territory that is sent. for composting. - It should be proporcionally to pol«pulation or total of waste. - Not useful for our municipality	- we keep an overview of the compost produced per year - tons of vegetable waste recovered monthly - Regular reporting of waste by law
W10	- Regional indicator. - It should be proporcionally to populatation or to quantity to waste. - difficult to identify for food waste	
W11	- Not useful for our municipality - it is difficult to quantify such an indicator, because such training activities can be organized throughout the country, not only in the municipality, by different institutions / NGOs.	- In addition to the referenced indicator, the municipality also monitors. Number of awareness campaigns carried out annually - We just count the number of students or citizens in activities about composting. - We have a project that contemplates the distribution of homemade composters in a residential area of Coruche - we raise awareness to support composting
W12	- Indicator with regional character. - not usefull for our municipality - conditions for biogas plants are not everywhere, there is no biogas plant in the Czech Republic that would process municipal waste,	
W13	- The local landfill is controlled and not "No-controlled landfill". Sometimes lots of waste appear along roadsides or in forests but it is not possible to quantify monthly, but annually. - I didn't understand what the term "uncontrolled landfills" meant.	- Annually. - INISOFT - we monitor how the waste is used
W14		- Accessibility to the wastewater treatment system. Contract with the wastewater treatment company. - We already use this indicator - I don't know - we monitor in connection with the UR audit - In Přeštice, 100% of wastewater is treated

Energy Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
E1	- At the moment we cannot talk about energy communities in Ramnicu Valcea. Also, the national legislation is not yet adapted to the European legislative framework, as the notion of "energy community" does not exist yet. The production of energy from renewable sources is in its infancy, referring here strictly to individuals. - difficult to identify	- As data on renewable production at the scale of the entire municipality are not available or access is not easy, we only count the renewable production of the municipality's renewable plants. - We are preparing the energy management of the city
E2	- The buildings are old, of historic interest, so it is not easy. It would be if they were new buildings.	- At present, the Municipality of Ramnicu Valcea does not produce energy from renewable sources. We have 4 ongoing projects for the rehabilitation of public buildings (schools) which also provide for the endowment with photovoltaic panels, but it is premature to consider such an indicator. - difficult to identify - Přeštice is 100% owned by a company engaged in the production, distribution and sale of heat. About 90% of the heat is produced in cogenerations using biogas
E3	- See previos observation. - At the moment, the local administration does not produce energy from renewable sources in the buildings or public infrastructure of the municipality. We have ongoing projects for the rehabilitation of public buildings (schools) which also include the endowment with photovoltaic panels. - difficult to identify	
E4	- RE relates only to electricity or also to heat. With electricity, data acquisition is difficult, with heat it becomes almost impossible. - At the moment there are no data on potential citizens who produce energy on the territory of Ramnicu Valcea Municipality. - difficult to identify	- We don't have the data or it isn't easibly acessible.
E5	- It is not controllable by the Municipality. It may eventually be encouraged but the biggest incentive is economic - see last answer - At the moment we do not have data regarding a possible production of energy from renewable sources made in the private sector on the territory of Ramnicu Valcea. - difficult to identify	- Same as E4.
E6	- But we have no data - at the moment there are no energy communities on the territory of Ramnicu Valcea municipality.	

	- This indicator may be useful at a later stage. To date, Energy Communities have not gone far enough with larger users, let alone households. It will be an indicator that will only confirm this fact - difficult to identify	
E7	- at the moment there are no energy communities on the territory of Ramnicu Valcea municipality. - difficult to identify	
E8	- But the Municipality has no data. - At the moment there are no energy communities on the territory of Ramnicu Valcea municipality. - difficult to identify	
E9	- The distribution network, for the most part, does not belong to the Municipality but to HEDNO. - too much investment for the commune - irrelevant	- Registration and assessment of consumption in municipal buildings
E10	- For this, all energy suppliers potentially available in the municipality would have to be queried. That's utopian. - There are currently no data on the production of energy from renewable sources (household, private environment), so we cannot talk about consumption from renewable sources. - difficult to identify	- The Municipality has no data.
E11	- Municipal renewable energy infrastructures are very limited. - At the moment, the municipal infrastructure does not consume energy from renewable sources. - difficult to identify	
E12		- An EPC project has been developed - energy consumption (Mwh) for total residential sector - Pumping stations, Shared areas, Street lighting, Buildings located in the wider area of the Municipality of Kalamata
E13	- It is a good indicator, but it cannot be quantified locally, because we do not have data on consumption / neighborhood. The amount of energy consumed on the surface of public spaces in the total area of the municipality could be used.	- We use the DIC index. DIK = electricity consumption index (KWh / year) As defined is the total electricity consumption of the following, expressed as Primary Energy, in kilowatt hours per year (KWh / year).
E14	- The incentives are too low in terms of the investment required for municipal buildings. It reveals little on-site understanding of the current energy reality Vs the correct adaptation of buildings to energy certification. - Annual certification is a burdensome process. The issued certification and its control according to the parameters is sufficient. which become more stringent over time, eg after 5 years.	- We are preparing ISO 50001 - Passport of public buildings

E15	- The number of certified buildings is small - The regulations are well known in the field of engineering, which is the most competent.	
E16	- Grants exist but in practice they are not applied because the criteria are inappropriate to reality and applications are rejected - Previously made investments were effective at that time, it is difficult to find resources for new efficiency gains. The amount of the subsidy is not a parameter that would convince the owner to increase efficiency. - Data difficult to aggregate	- EFEKT
E17	- The municipality does not have the capacity of persons to monitor such indicators. This should be the responsibility of the state in cooperation with energy producers, suppliers and consumers. Then the information obtained can be communicated to the municipalities. - difficult to identify	- We have a similar indicator but it's not updated early - DIK _ electricity consumption index (KWh / year); DUTH_heating oil consumption index / Heating days (Ddayθ) (KWh / Ddayθ); CPI: motor oil index (KWh / year)
E18	- difficult to identify	
E19	- It is not possible to have consumption data in real time. - Technical equipment of transformer stations, difficult negotiations with energy suppliers and distributors, their reluctance to cooperate. High to exaggerated financial costs. At present, according to the law, it is the duty of the distributor within 7 years to equip the consumption points with a smart electric meter.	- We have acess to the Energy supplier platform that shows us real time consuption, but its very slow and not practical at all.
E20	- I think there are not enough trained technicians	- Irregularly and chaotically
E21		
E22		- Just count the campaigns

Transportation & Mobility Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
T1	- not an urban municipality - The "users per month" unit is difficult to measure. Maybe if it was "percentage of users per year" it could be measured by research (questionnaires).	- AML and INE each year mobility profile - SUMP-UP - not suitable for small villages
T2	- not an urban municipality	- difficult to determine data for small and medium-sized municipalities where public transport is not owned by the municipality - AML
T3	- not useful for our municipality	- Our city council doesn't consider telework an option in our line of work
T4	- I think that who owns the operation is not relevant as an indicator. - The Municipality cannot carry out this activity (except for the collection of waste).	- not suitable for small villages - Our public Operator is a private company, and the on going tender is not for public management
T5	- not an urban municipality	- difficult to identify in a way that is accurate - We know how many cars we have in a household but we don´t konw the kind - SUMP
T6	- I don't think it's relevant. There may also be situations in which someone is passing through Ramnicu Valcea and refueling from one of the local gas stations. - As for the unit "liters per month", it may be better "liters per year", due to easier data collection.	- difficult to identify - DITEM
T7	- I don't think it's relevant. There may be situations of people who do not live in Ramnicu Valcea, are in transit and refueling to move on. It will also be difficult to obtain such data from fuel suppliers. - As for the unit "liters per month". It is better to be "liters per year", due to easier data collection. - difficult to identify	- DITEM - Our fleet major fuel is diesel
T8	- The motivation is the same as in the previous question (20). - As for the unit "liters per month". It is better to be "liters per year", due to easier data collection. - difficult to identify	
T9	- Vehicle registration is not internal information. It belongs to the Region and not to the Municipality. Alternatively, the indicator could be the "number of charging points" unrelated to vehicle registrations. Besides, in the relevant JMC (Government Gazette B'4380 / 2020)	- Number of charging spots and parking lots for that purpose

	there is at least 1 charging station per 1000 inhabitants and it is not connected to the vehicles.	- The density of charging spots for electric vehicles per electric vehicles is registered not by the municipality but by MOBI.E
T10	- not an urban municipality - difficult to ascertain, qualified estimate required - Public transport in our Municipality is operated by a Private Company and the fleet is small (only 12 diesel buses), it does not make sense to monitor this indicator.	- Public transportation is manage by a private company - AML does this kind of data - Part of SUMP
T11	- I think this indicator is more suitable for municipalities with high population ratios. - It is difficult to find the percentage of the population. However, alternatively the percentage of the area of the Municipality could be found, ie the unit was "% of the urban area"	- AML in the new public transportation tender applys this kind of indicator - SUMP
T12	- not an urban municipality - The information can be collected only by the executing body of the project (Urban KTEL - Individuals). However, the index is useful. - irrelevant for small communities	- AML in the new public transportation tender applys this kind of indicator - SUMP
T13	- not an urban municipality - This would not be relevant for cities like Bielefeld, because all regional and national traffic stations are in the center	- AML in the new public transportation tender applys this kind of indicator
T14	- It is likely that it will not be possible to collect complete data on the private providers, which is why the question of informative value arises. - There is only a small fleet of electric rental bikes (about 25 bikes), so there is no reason to monitor this indicator at this time. - difficult to identify, irrelevant for small municipalities	
T15	- This indicator makes more sense in big cities with high traffic. - not an urban municipality - We do not have many roads with two lanes in each direction, so that one becomes exclusively for buses. This indicator cannot be applied. - irrelevant for small communities - We do not have reserved lanes for public transport	- We don´t have exclusive lanes for public transportation
T16	- not useful for our municipality	- SUMP
T17	- I don't think the amount or percentage of speed bumps or humps is a indicator of accessibility or safety. It could be in some cases,but not in all of them. - not an urban municipality	- SUMP - passport data
T18	- not an urban municipality - In the center there is a wide network of sidewalks, which are constantly closed to vehicles. The unit of measurement for sidewalks could be the "length" or "% of the road network in the center". - the city is without restrictions	
T19	- not an urban municipality - The unit of measurement in sq.m. is difficult to calculate. It could be "% of seats with settings on total seats".	

T20		- SUMP
T21		- passport data
T22	- Speaking of areas, the unit of measurement should be "square meters" and not "meters".	- SUMP - passport data
T23	- I really think that ECO-driving will push people to drive and not to change. - not very meaningful - We are not responsible for the driving schools.	
T24		
T25		- This indicator is used only for people involved in European funded projects for sustainable transport. - European Mobility Week campaign
T26	- Data availability difficult with private providers - It is difficult to make such statistics, there are no dedicated platforms, possibly only ads on social platforms. - At present there is no such platform in the territory of the municipality. - difficult to identify, irrelevant for small municipalities	- We are preparing a project - becomes difficult to get the data from private providers

Spatial Planning Survey's Comments

Indicator	Q1 Comments: If your answer was "1 – No, I Strongly Disagree" or "2 – No, I Disagree", please, feel free to share with us why and/or propose an alternative	Q2 Comments: If your answer was "Yes" regarding a similar indicator, please feel free to share with us the similar indicator that your municipality is currently using
SP1		
SP2	- A team external to the municipality can be hired.	- I hope so
SP3		- Number of projects that enhance the Municipal Ecological Structure - There are projects already implemented but we have no specific indicator - Territorial system of ecological stability
SP4	- I can't judge	- Some projects take more than 3 years to have effects. - Execution of the Municipal Plan for adaptation to climate change and implementation of the measures recommended therein (number of projects)
SP5	- What would be the periodicity? - The scope of the indicator is not understood	- We use population density per parish every 10 years
SP6		- Area affects uses foreseen by master plan
SP7		- There is a document indicating the number of floors of the buildings, updated every 10 years
SP8		- We do not currently have a statistic of the number of residents on the districts of the municipality, all the more so we do not have data about employees and / or number of jobs per district. - data from the zoning plan
SP9	- It implies definition of the concept of "neighborhood". We don't have this survey or the means to update it. - It is difficult to make such statistics at the neighborhood level. I think it should start with the relative proportion of commercial, residential and green spaces in relation to the total area of the municipality.	- Area affects the uses foreseen by the master plan
SP10		
SP11	- In medium-sized cities, peri-urban areas have easy access to goods and services - This indicator is not very reliable for small cities like ours.	

	- I agree with such statistics at the neighborhood level, stating (it is maintained for all indicators at the neighborhood level) that at present we do not have information (we do not have centralized data) at the neighborhood level.	
SP12		
SP13		
SP14	- It is necessary to define the concept of "neighborhood"	
SP15		- Projects that enhance the Municipal Ecological Structure
SP16		- I can't judge
SP17		- I can't judge - CO2 emissions (tons) per total public buildings, respectively GHG emissions per total residential buildings, CO2 emissions (t) generated by public lighting, CO2 emissions (tons) generated by waste management.