

# Roadmap for local climate change mitigation

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

The publication was originally written by Matías Mesa García. It was adapted and published as part of the project Bridging European and Local Climate Action (BEACON). BEACON promotes climate action through dialogue between national governments, municipalities and schools in Central, Eastern and Southern Europe. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) commissioned the BEACON project within the framework of the European Climate Initiative (EUKI). EUKI's overarching goal is to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experiences. The information and views set out in this publication are those of the authors and do not necessarily reflect the official opinion of the BMU.

## Imprint

Author: Matías Mesa García (FC.ID - FCUL)

Co-authors: Tobias Bernstein (adelphi), Gil Penha-Lopes (FC.ID - FCUL)

Publisher: adelphi consult GmbH

Alt-Moabit 91

10559 Berlin

+49 (030) 8900068-0

office@adelphi.de

www.adelphi.de

ISBN: 978-989-99962-8-1

Editors: Tobias Bernstein (adelphi), Matías Mesa García (FC.ID - FCUL)

Design: Xiana Estévez Coronel

Status: November 2020

© 2020 adelphi | For non-commercial use only

## Contents

### Domains

Governance	7
Education and Communication	13
Land Use (Agriculture, forestry and other land use)	17
Consumption Patterns	23
Waste Management	30
Energy	35
Transportation and Mobility	40
Spatial Planning	44

### Other

Summary Table	6
Bibliography	50

## Introduction

---

The Paris Agreement intends to limit global warming to 1.5°C above pre-industrial levels.<sup>[1]</sup> The European Green Deal aims to achieve carbon neutrality in Europe by 2050.<sup>[2]</sup> The sustainable development goals (SDGs) aim to take urgent action to combat climate change and its impacts.<sup>[3]</sup> 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.<sup>[4]</sup>

## 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](mailto:mmgarcia@fc.ul.pt) or [bernstein@adelphi.de](mailto:bernstein@adelphi.de)




## Summary table



RECOs= Recommendations	Topics	SDGs + Targets
<b>Governance (7 RECOs)</b>	<ul style="list-style-type: none"> <li>• Model of governing</li> <li>• Adequate policies</li> <li>• Stakeholders Partnership</li> <li>• Municipal Structure</li> <li>• Internal Capacity Building</li> </ul>	<div> <div>  <p>TARGET 13-2 TARGET 13-3</p> </div> <div>  <p>TARGET 17-14 TARGET 17-16 TARGET 17-17</p> </div> </div>
<b>Education &amp; Communication (5 RECOs)</b>	<ul style="list-style-type: none"> <li>• Education on climate change</li> <li>• Communication on climate change</li> </ul>	<div> <div>  <p>TARGET 13-3</p> </div> <div>  <p>TARGET 4-7</p> </div> </div>
<b>Land Use (10 RECOs)</b>	<ul style="list-style-type: none"> <li>• Sustainable land management</li> <li>• Sustainable food production</li> <li>• Sustainable forest management</li> <li>• Soil fertility and permeability</li> <li>• Green Urban Spaces and Infrastructure</li> </ul>	<div> <div>  <p>TARGET 2-4</p> </div> <div>  <p>TARGET 6-6</p> </div> <div>  <p>TARGET 11-7</p> </div> <div>  <p>TARGET 15-1 TARGET 15-2 TARGET 15-3 TARGET 15-5 TARGET 15-9 TARGET 15-B</p> </div> </div>
<b>Consumption Patterns (6 RECOs)</b>	<ul style="list-style-type: none"> <li>• Carbon footprint</li> <li>• Green public procurement</li> <li>• Sustainable food consumption</li> <li>• General sustainable consumption</li> <li>• Consumerist behaviour</li> </ul>	<div>  <p>TARGET 12-2 TARGET 12-6 TARGET 12-8</p> </div>
<b>Waste Management (7 RECOs)</b>	<ul style="list-style-type: none"> <li>• Reduce, reuse and recycle municipal Waste</li> <li>• Compost and Biogas production</li> <li>• Waste treatment</li> </ul>	<div>  <p>TARGET 11-6</p> </div> <div>  <p>TARGET 12-3 TARGET 12-5</p> </div>
<b>Energy (6 RECOs)</b>	<ul style="list-style-type: none"> <li>• Energy production</li> <li>• Energy consumption &amp; efficiency</li> </ul>	<div>  <p>TARGET 7-2 TARGET 7-3</p> </div>
<b>Transportation and Mobility (7 RECOs)</b>	<ul style="list-style-type: none"> <li>• Sustainable transportation</li> </ul>	<div>  <p>TARGET 11-2</p> </div>
<b>Spatial Planning (8 RECOs)</b>	<ul style="list-style-type: none"> <li>• Spatial planning process</li> <li>• Urban form</li> <li>• Infrastructures</li> </ul>	<div>  <p>TARGET 9-1 TARGET 9-4</p> </div> <div>  <p>TARGET 11-3 TARGET 11-7</p> </div>



Recommendations for local climate change mitigation	SDGs and Targets
<p><b>A.</b> Provisioning Sustainable Services/ Green Public Procurement</p> <p><b>B.</b> Promote Information Policies</p> <p><b>C.</b> Undertake Voluntary Actions</p> <p><b>D.</b> (Re)municipalise Local Services to Foster Institutional Capacity for Climate Change Mitigation</p>	<div data-bbox="821 510 938 627">  </div> <p><b>13.2:</b> Integrate climate change measures into national policies, strategies and planning.<sup>[3]</sup></p> <div data-bbox="821 667 938 784">  </div> <p><b>17.14:</b> Enhance policy coherence for sustainable development.<sup>[3]</sup></p>
<p><b>E.</b> Establish Stakeholder Partnerships</p> <p><b>F.</b> Re-arrange Internal Structures of the Local administration</p>	<div data-bbox="821 891 938 1008">  </div> <p><b>17.16:</b> 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.<sup>[3]</sup></p> <p><b>17.17</b> Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.<sup>[3]</sup></p>
<p><b>G.</b> Capacity Building for Local Administrations in Climate Action</p>	<div data-bbox="821 1305 938 1422">  </div> <p><b>13.3:</b> Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.<sup>[3]</sup></p>



## 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.<sup>[5, p. 116]</sup> The concrete targets include the following:

**13.2:** Integrate climate change measures into national policies, strategies and planning.<sup>[3]</sup>

**17.14:** Enhance policy coherence for sustainable development.<sup>[3]</sup>

### 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.<sup>[7]</sup> Details include, *inter alia*, designing a mitigation goal, estimating base year emissions, accounting for the land sector and monitoring and verification.

Governance capacity is highly related to the effectiveness of climate policy.<sup>[5, p. 41]</sup> 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.<sup>[5, p. 92]</sup>

#### 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).<sup>[6]</sup>
- 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.<sup>[6]</sup> 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



### 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.<sup>[5, p. 116]</sup> The concrete targets include the following:

**13.2:** Integrate climate change measures into national policies, strategies and planning.<sup>[3]</sup>

**17.14:** Enhance policy coherence for sustainable development.<sup>[3]</sup>

### 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 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.<sup>[8]</sup>



### 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.<sup>[5, p. 116]</sup> The concrete targets include the following:

**13.2:** Integrate climate change measures into national policies, strategies and planning.<sup>[3]</sup>

**17.14:** Enhance policy coherence for sustainable development.<sup>[3]</sup>

### 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.<sup>[9]</sup>



#### Did you know?

Publicly managed services are generally more focused on quality, universal access, affordability and the delivery of broader social and environmental objectives.<sup>[9]</sup> Thus, (re)municipalisation could be the key to achieving local climate change mitigation goals<sup>[9]</sup>, 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.<sup>[9]</sup>



### 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.<sup>[5, p. 116]</sup> The concrete targets include the following:

**13.2:** Integrate climate change measures into national policies, strategies and planning.<sup>[3]</sup>

**17.14:** Enhance policy coherence for sustainable development.<sup>[3]</sup>

### E- Establish Stakeholder Partnerships

Partnerships are crucial. They extend the operation of the state by facilitating further action from external actors.<sup>[10]</sup> 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.<sup>[5, p. 1186]</sup>

## 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.<sup>[11]</sup> 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.<sup>[12]</sup> 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.<sup>[5, p. 116]</sup> 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.<sup>[3]</sup>

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

## F- Rearrange the Internal Structure of the Local Administration

Effective climate policy involves building institutions and the capacity for governance.<sup>[5, p. 41]</sup> 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.<sup>[13]</sup>

- **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.<sup>[5, p. 116]</sup> 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.<sup>[3]</sup>

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

## 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.<sup>[5, p. 160]</sup> 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.<sup>[3]</sup>



## 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

**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

**B.3** Invest in non-commercial advertising campaigns to increase citizen awareness about the climate change crisis and regenerative responses



**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.<sup>[3]</sup>



**13.3:** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.<sup>[3]</sup>

## 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<sup>[14]</sup>, 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.<sup>[15]</sup>

#### ! 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.<sup>[16]</sup>

#### ? 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.<sup>[3]</sup>

**13.3:** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.<sup>[3]</sup>

## 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.3- Invest in non-commercial 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.<sup>[19, 20]</sup>



#### 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.

## 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.<sup>[17, 18]</sup>

#### 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).





## Recommendations for local climate change mitigation

## SDGs and Targets

<p><b>A.</b> Promote Sustainable Land Management</p>	<div data-bbox="820 215 935 331"> </div> <p><b>15.1:</b> 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.<sup>[3]</sup></p> <p><b>15.5:</b> 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.<sup>[3]</sup></p> <p><b>15.9:</b> By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.<sup>[3]</sup></p>
<p><b>B.</b> Sustainable Food Production</p> <p><b>B.1</b> Promote organic farming systems</p> <p><b>B.2</b> Increase urban and peri-urban organic food production</p> <p><b>B.3</b> Promote an improved capacity for local organic food production with special attention to indigenous knowledge/local knowledge</p>	<div data-bbox="820 763 935 880"> </div> <p><b>2.4:</b> 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.<sup>[3]</sup></p>
<p><b>C.</b> Sustainable Forest Management</p> <p><b>C.1</b> Increase municipal forest area</p> <p><b>C.2</b> Reduce forest loss and degradation caused by forestry activity</p> <p><b>C.3</b> Avoid conversion from forest land to other land use, particularly from switching into cropland or monocultures</p> <p><b>C.4</b> Implement operational and effective wildfires management</p>	<div data-bbox="820 1104 935 1220"> </div> <p><b>15.2:</b> 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.<sup>[3]</sup></p> <p><b>15.b:</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.<sup>[3]</sup></p>
<p><b>D.</b> Increase Soil Carbon Sequestration by Increasing Soil Fertility and Groundwater Infiltrations</p>	<div data-bbox="820 1503 935 1619"> </div> <p><b>6.6:</b> By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers and lakes.<sup>[3]</sup></p> <div data-bbox="820 1637 935 1753"> </div> <p><b>15.3:</b> 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.<sup>[3]</sup></p>
<p><b>E.</b> Increase Green Urban Spaces and Infrastructure, Paying Special Attention to Local Biodiversity</p>	<div data-bbox="820 1816 935 1933"> </div> <p><b>11.7:</b> 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.<sup>[3]</sup></p> <div data-bbox="820 1977 935 2094"> </div> <p><b>15.9:</b> By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.<sup>[3]</sup></p>

## 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. <sup>[21]</sup>



#### 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. <sup>[24]</sup> (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. <sup>[3]</sup>

**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. <sup>[3]</sup>

Land is the main resource of ecosystem services, and its use directly affects the economy and quality of life. <sup>[5, p. 818]</sup> Not only does it provide food to feed the Earth's population, but it can affect the climate depending on its use or activity. <sup>[5, p. 818]</sup> Changes in land conditions affect global and regional climates, reducing or accentuating warming and can affect the intensity, frequency, and duration of extreme events. <sup>[22, p. 11]</sup>

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...). <sup>[5, Ch. 11]</sup>



#### Did you know?

Land use accounts for 23% of total anthropogenic greenhouse gas emissions (2007–2016), namely 13% of carbon dioxide (CO<sub>2</sub>), 44% of methane (CH<sub>4</sub>) and 82% of nitrous oxide (N<sub>2</sub>O). <sup>[22, p. 7]</sup>

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). <sup>[22]</sup>

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) <sup>[22], [23]</sup>

## Recommendations

**15.9:** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.<sup>[3]</sup>

### 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.<sup>[25, p. 143]</sup>

#### ? 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.<sup>[24]</sup>  
<sup>[25, p. 140]</sup>

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.<sup>[24]</sup>, <sup>[25, Ch. 10]</sup>, <sup>[26]</sup>

#### 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,<sup>[27]</sup> 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.<sup>[3]</sup>

### 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.<sup>[22, p. 19]</sup>

#### ! 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.<sup>[5, p. 847]</sup>

#### 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.<sup>[28]</sup>

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 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.<sup>[5, p. 964], [31]</sup> 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.<sup>[32]</sup>

#### ? 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.<sup>[22, p. 22]</sup>

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.<sup>[22], [33]</sup> (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.<sup>[3]</sup>

**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.<sup>[3]</sup>

### 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.<sup>[34]</sup>

#### ? 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<sup>[34]</sup> GI can refer to rural, peri-urban, or urban settings, covering terrestrial, coastal and marine areas.<sup>[34]</sup> 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.<sup>[34]</sup> 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.<sup>[3]</sup>

**15.9:** By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.<sup>[3]</sup>



Recommendations for local climate change mitigation	SDGs and Targets
<p><b>A.</b> Promote the Consumption-Based Accounting Methodology for GHG: The Carbon Footprint</p> <p><b>B.</b> Adopt Green Public Procurement</p>	<div data-bbox="821 510 938 629">  </div> <p><b>12.6:</b> Encourage companies, especially large and transnational companies, to adopt sustainable practises and to integrate sustainability information into their reporting cycles.<sup>[3]</sup></p> <p><b>12.7:</b> Promote public procurement practises that are sustainable, in accordance with national policies and priorities.<sup>[3]</sup> <b>(Only for B recommendation)</b></p>
<p><b>C.</b> Promote Seasonal, Organic and Local Produced Food Consumption Without Animal Products</p> <p><b>D.</b> Promote a Reduction in Consumerist Behaviour</p> <p><b>E.</b> Promote Sustainable Consumption</p> <p><b>F.</b> Facilitate Locally Produced Product Consumption</p>	<div data-bbox="821 828 938 947">  </div> <p><b>12.2:</b> By 2030, achieve the sustainable management and efficient use of natural resources.<sup>[3]</sup></p> <p><b>12.5:</b> By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.<sup>[3]</sup> <b>(Only for D recommendation)</b></p> <p><b>12.8:</b> By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.<sup>[3]</sup></p>



## 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.**<sup>[5, p. 306]</sup> 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.<sup>[5, Ch. 4.4.2]</sup> 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.<sup>[35]</sup>

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.<sup>[5, p. 288]</sup>

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.<sup>[3]</sup>

## 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<sup>[5, p. 718]</sup>, contributing to sustainable consumption and other sustainable goals, simultaneously.<sup>[36]</sup>

**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.<sup>[36]</sup> Sustainable public procurement includes both environmental and social criteria in the purchasing decisions.<sup>[36]</sup>



### 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.<sup>[36]</sup>



### 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.<sup>[5, p. 308]</sup> The EU identifies four types of useful labels:
  - 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.<sup>[36]</sup> For example, the EU Ecolabel, Nordic Swan and the Blue Angel.<sup>[36]</sup>
  - Single-use labels:** These are based on one or more pass/fail criteria linked to a specific issue.<sup>[36]</sup> For example, the EU Organic label or Energy star.
  - Sector-specific labels:** These are related to a specific sector, for instance, the forestry sector with the FSC or PEFC-related labels.<sup>[36]</sup>
  - Grade product labels:** Grading products or services according to their environmental performance, rather than using pass or fail criteria.<sup>[36]</sup> For example, the EU Energy Label grades energy-related products according to their energy efficiency.<sup>[36]</sup>
- **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.<sup>[36]</sup> 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.<sup>[36]</sup>
- **Environmental management systems and schemes certifications:** Environmental management systems are organisation-related tools aimed at improving overall environmental performance for the implementing organisation.<sup>[36]</sup> For example, the EU Eco-management and audit scheme (EMAS) or the International Standard on Environmental Systems (EN/ISO 14001) can be followed.<sup>[36]</sup>
- **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<sup>[37]</sup> 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.<sup>[38]</sup>

### Practical Example

Municipalities can promote local currencies in their territory thereby directly supporting local businesses, leading to an increase in local product consumption.<sup>[39]</sup> 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.<sup>[39]</sup>

France already has over 80 (March, 2020) local currencies circulating!<sup>[40]</sup>

### 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.<sup>[3]</sup>

**12.7:** Promote public procurement practices that are sustainable, in accordance with national policies and priorities.<sup>[3]</sup>

## 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.<sup>[5, p. 305]</sup>

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.<sup>[22]</sup> 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<sub>2</sub> eq (a 49% reduction), ocean acidification by 50%, eutrophication by 49% and (scarcity-weighted) freshwater withdrawals by 19% (reference from 2010).<sup>[41]</sup>

### 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.<sup>[3]</sup>

**12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.<sup>[3]</sup>

## 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.<sup>[5, p. 310]</sup>

**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.<sup>[5, p. 304]</sup>

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.<sup>[3]</sup>

**12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.<sup>[3]</sup>

**12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.<sup>[3]</sup>

### 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.<sup>[5, p. 307]</sup>

#### ? 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).<sup>[42]</sup> Information policies are highly relevant for facilitating choice outcomes and thus are important for promoting environmental standards and proper product labelling.<sup>[42]</sup>



#### 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.<sup>[3]</sup>

**12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.<sup>[3]</sup>

## 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.

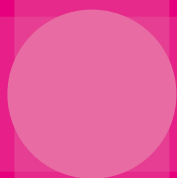


#### Related SDGs:

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.<sup>[3]</sup>

**12.8:** By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.<sup>[3]</sup>



## Recommendations for local climate change mitigation

## SDGs and Targets

<b>A.</b> Reduce Urban Solid Waste Production with Special Attention to Food Waste and Single-Use or Short-Life Products
<b>B.</b> Enable the “Right To Repair”, Promote the Exchange Of Second-Hand Goods and Increase Awareness About Re-use
<b>C.</b> Promote Recycling
<b>D.</b> Waste Treatment
<b>D.1</b> Produce compost, particularly from food or green waste
<b>D.2</b> Biogas production: Capture methane from waste management or wastewater management
<b>D.3</b> Reduce landfill waste disposal
<b>D.4</b> Reduce the amount of untreated wastewater



**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.<sup>3</sup> **(Only for A recommendation)**

**12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.<sup>[3]</sup>



**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.<sup>[3]</sup>

**Waste** is defined as an object that someone discards, intends to discard, or is required to discard.<sup>[43]</sup>

### 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.<sup>[5, p. 385]</sup>
- 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.<sup>[5, p. 786]</sup>
- 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.<sup>[5, p. 786]</sup>

In 2010, GHG emissions from waste represented 3% of total GHG emissions, mainly stemming from solid waste disposal on land and wastewater handling.<sup>[5, p. 385]</sup> 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.<sup>[5, p. 786]</sup>

Accordingly, appropriate waste management has important potential for climate change mitigation and a transition towards a circular economy.<sup>[44], [45]</sup>

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).<sup>[43]</sup>

To induce **behavioural change**, the promotion of a reduction of unnecessary consumption is suggested.<sup>[43]</sup> 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.<sup>[5, p. 310]</sup> (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.<sup>[46]</sup> For instance, single-use plastics (including plastic packaging) not only increase waste generation but contribute to an increase in oceanic pollution.<sup>[46]</sup>

### Did you know?

Annual production of plastic is about 300 million tonnes, whereof roughly 50% is disposed of after a single use.<sup>[46]</sup>

### Case example

28% of Californian Municipalities have implemented local bans on single-used plastics <sup>[46]</sup>

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.<sup>[47]</sup>

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.<sup>[45]</sup>



## 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) <sup>[22, p. 26]</sup>

### 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.<sup>[3]</sup>

**12.5:** By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.<sup>[3]</sup>

## 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** <sup>[5, p. 744]</sup> 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. <sup>[45]</sup>

### 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.<sup>[3]</sup>

## 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.<sup>[5, p. 82]</sup>

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.<sup>[3]</sup>

## D- Waste Treatment:

Before its disposal, waste can be treated, depending on its nature, to potentially increase soil fertility or produce heat and energy.<sup>[5, p. 789], [33]</sup> For climate change mitigation, municipalities should focus on solid waste disposal and untreated domestic wastewater, as they account for 90% of waste-related emissions<sup>[5, p. 791]</sup>

### 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.<sup>[3]</sup>

## 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<sup>[48]</sup> when composting is applicable (depending on the nature of the compost).<sup>[33]</sup> Increasing soil fertility reverses desertification, increasing soil carbon sequestration<sup>[22, p. 20], [49]</sup>. (See Land Use chapter, p. 17.)

Composting has a significant advantage in that it ensures a sustainable solution for waste treatment, minimising related gaseous emissions.<sup>[33]</sup> 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.<sup>[50]</sup>

- **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.<sup>[5, p. 789]</sup> During this process, methane is generated through the anaerobic digestion of organic waste (biogas), enabling its use in a gas engine to produce energy.<sup>[5, p. 789]</sup>

#### 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.<sup>[51]</sup>



	Recommendations for local climate change mitigation	SDGs and Targets
Energy production & supply	A. Promote Appropriate Renewable Energy (RE) Production	 <b>7.2:</b> By 2030, increase substantially the share of renewable energy in the global mix. <sup>[3]</sup>
	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	 <b>7.3:</b> By 2030, double the global rate of improvement in energy efficiency. <sup>[3]</sup>
	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).<sup>[5, p. 9]</sup>

## 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.<sup>[5, p. 516]</sup>

The suggested recommendations involve a deep decarbonisation of electricity generation<sup>[5, p. 516]</sup>, where distributed energy systems can play an important role.<sup>[5, p. 528], [52]–[54]</sup>

### 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.<sup>[3]</sup>

## 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.<sup>[5, p. 516]</sup>

**RE is energy derived from natural, unlimited, and replenishable sources.**<sup>[55]</sup> 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).<sup>[5, p. 517]</sup>

### B- Decentralise Energy Production (Both Social and Technological Aspects)

Distributed energy systems can help facilitate energy transitions<sup>[56]</sup> and sustainable development<sup>[52]</sup> at the local level.

### Did you know?

Depending on the context, distributed energy systems can be cost-efficient, reliable and environmentally friendly.<sup>[52], [53]</sup> Technological decentralisation of energy supply can lead to an appropriate and diverse use of local resources.<sup>[52]</sup>

### 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.<sup>[57]</sup>

### Case example

In Ostrów Wielkopolski, Poland, energy from locally produced biomass is distributed to citizens via a newly constructed 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 blocks to 50% for the institutional and industry buildings.<sup>[58]</sup>

## 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.<sup>[54]</sup>

#### 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.<sup>[58], [59]</sup>

#### 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.<sup>[60]</sup>

### 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.<sup>[5, pp. 22, 678]</sup>



#### 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.<sup>[3]</sup>

### 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.<sup>[61]</sup>

## 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 3<sup>rd</sup> of all municipal buildings).<sup>[16]</sup>

### 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.<sup>[5, p. 23]</sup>

#### 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	
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)	 <p><b>11.2:</b> 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.<sup>[3]</sup></p>
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<sub>2</sub>) of global greenhouse gas emissions, with this number expected to double by 2050.<sup>[5, p. 21,72], [63]</sup>



### 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.<sup>[3]</sup>

## 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.<sup>[5, p. 603]</sup>

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).<sup>[62]</sup> 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.<sup>[9]</sup>

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.<sup>[9, p. 31]</sup> (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.<sup>[5, p. 606]</sup>

### ? 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).<sup>[5, p. 611]</sup>

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<sup>[5, p. 623]</sup> and water resources in both the electric vehicle production process and water usage associated with electricity production)<sup>[65]</sup>



#### 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.**<sup>[5, p. 603]</sup>



#### 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.<sup>[64]</sup>

### 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.<sup>[5, p. 603]</sup>



#### 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.<sup>[66]</sup>

### 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.<sup>[5, p. 603]</sup>



#### 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.



Recommendations for local climate change mitigation	SDGs and Targets
<p><b>A. Spatial Planning Processes</b></p> <p><b>A.1</b> Enable the local administration in integrating climate change mitigation perspectives into municipal spatial planning processes</p> <p><b>A.2</b> Integrate nature/ecosystem-based solutions into the spatial planning process</p> <p><b>A.3</b> Implement adequate spatial planning policies and instruments to support low-carbon fluxes in the municipality</p> <p><b>B. Municipal Urban Form</b></p> <p><b>B.1</b> Increase density</p> <p><b>B.2</b> Increase land use mix</p> <p><b>B.3</b> Increase connectivity</p> <p><b>B.4</b> Increase accessibility</p>	<div data-bbox="820 703 935 815">  </div> <p><b>11.3:</b> By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human planning and management in all countries.<sup>[3]</sup></p> <p><b>11.7:</b> 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.<sup>[3]</sup>  <b>(Only for recommendations A2 and A3)</b></p>
<p><b>C. Prioritise Sustainable and Resilient Infrastructure while Minimising Lifecycle GHG Emissions</b></p>	<div data-bbox="820 1267 935 1379">  </div> <p><b>9.1:</b> 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.<sup>[3]</sup></p> <p><b>9.4:</b> 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.<sup>[3]</sup></p>

## Did you know?

Urban areas account for between 71% and 76% of CO<sub>2</sub> emissions from global final energy use.<sup>[5, p. 927]</sup>

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.<sup>[5, p. 949]</sup> For that reason, the mitigation options available for local authorities, particularly in rapidly developing cities, includes shaping their urbanisation and infrastructure development trajectories.<sup>[5, p. 928]</sup>

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.<sup>[5, p. 958]</sup>



#### 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.<sup>[3]</sup>

**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.<sup>[3]</sup>  
(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.<sup>[5, p. 958]</sup>

#### 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.<sup>[68]</sup>



#### 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.<sup>[69, pp. 40–51]</sup>

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.<sup>[69]</sup>

#### 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.<sup>[5, p. 958]</sup>

## 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.<sup>[5, p. 949]</sup>

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.<sup>[3]</sup>

### 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.<sup>[5, p. 952]</sup>

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).<sup>[5, p. 952]</sup> Additionally, a low density complicates the switch to less energy-intensive and alternative modes of transportation.<sup>[5, p. 952]</sup> 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.<sup>[5, p. 955]</sup> 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.<sup>[5, p. 955]</sup>
- 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.<sup>[5, p. 955]</sup>



### 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.<sup>[5, p. 955]</sup>

#### B.3: Increase connectivity

**Connectivity** refers to street density and design.<sup>[5, p. 956]</sup> High urban connectivity is characterised by finer grain systems with smaller blocks that allow frequent changes in direction.<sup>[5, p. 956]</sup> When connectivity is high, there is typically a positive correlation with walking and, thereby, lower GHG emissions.<sup>[5, p. 956]</sup>

#### B.4: Increase accessibility

**Accessibility** can be defined as access to jobs, housing, services, shopping, and in general, to people and places in cities.<sup>[5, p. 956]</sup> It can be viewed as a combination of proximity and travel time and is closely related to the land use mix.<sup>[5, p. 956]</sup> Communities with high accessibility are typically characterised by short commuting distances and travel times, enabled by multiple modes of transportation.<sup>[5, p. 956]</sup>



### Did you know?

Metanalysis shows that a reduction in the vehicle kilometres travelled is strongly related to highly accessible job destinations.<sup>[5, p. 956]</sup>

## 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.<sup>[5, p. 951]</sup> 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.<sup>[5, p. 951]</sup>



#### 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.<sup>[5, p. 951]</sup>



#### 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).<sup>[5, p. 391]</sup>



#### 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.<sup>[3]</sup>

**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.<sup>[3]</sup>



## 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)
<b>Metropolitan/Regional</b>						
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 <sup>1</sup>	
Self-contained communities/new towns	Mixed-use zoning		Greenbelts	Utilities; urban services		Joint ventures <sup>2</sup>
<b>Corridor/District</b>						
Corridor growth management	Zoning	Impact fees; Exactions <sup>3</sup>		Service Districts <sup>4</sup>		
Transit-oriented corridors	Transfer of development rights			Urban rail; Bus rapid transit investments		Joint Powers Authorities
<b>Neighbourhood/Community</b>						
Urban Regeneration/Infill	Mix-use zoning/small lot designations	Split-Rate Property Taxes; Tax increment finance <sup>5</sup>	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 <sup>6</sup>		
Transit oriented Development	Design codes; flexible parking	Impact Fees; Betterment Taxes <sup>7</sup>		Station siting; station access		Joint development <sup>2</sup>
Eco-Communities	Mixed-use zoning			District Heating/Cooling; co-generation (see Ch. 9.4)	Peak-load pricing	Joint venture <sup>2</sup>
<b>Site/Streetscape</b>						
Pedestrian Zones/Car-Free Districts	Street code revisions <sup>8</sup>	Special Improvement Districts <sup>7</sup>		Road entry restrictions; sidewalks <sup>8</sup>	Parking surcharges	
Traffic Calming/Context-Sensitive Design	Street code revisions <sup>8</sup>	Benefit Assessment <sup>7</sup>				Property owner self-assessments
Complete Streets	Design standards			Bike infrastructure; Pedestrian facilities		Design competitions

Table from IPCC, 2014: Climate Change 2014: Mitigation of Climate Change.<sup>[5, p. 959]</sup>

## Bibliography

---

1. COP 21, UNFCCC, 'Paris Agreement'. 2015.
2. 'A European Green Deal', European Commission - European Commission. [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en) (accessed Jan. 22, 2020).
3. W. Rosa, Ed., 'Transforming Our World: The 2030 Agenda for Sustainable Development', in A New Era in Global Health, New York, NY: Springer Publishing Company, 2017.
4. UN HABITAT, 'ROADMAP FOR LOCALIZING THE SDGs: IMPLEMENTATION AND MONITORING AT SUBNATIONAL LEVEL'. 2015.
5. Intergovernmental Panel on Climate Change and O. Edenhofer, Eds., Climate change 2014: mitigation of climate change: Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. New York, NY: Cambridge University Press, 2014.
6. R. F. Boehnke, T. Hoppe, H. Brezet, and K. Blok, 'Good practices in local climate mitigation action by small and medium-sized cities; exploring meaning, implementation and linkage to actual lowering of carbon emissions in thirteen municipalities in The Netherlands', *Journal of Cleaner Production*, vol. 207, pp. 630–644, Jan. 2019, doi: 10.1016/j.jclepro.2018.09.264.
7. S. Greenhalgh et al., The greenhouse gas protocol: the GHG protocol for project accounting. Geneva, Switzerland : Washington, DC: World Business Council for Sustainable Development ; World Resources Institute, 2005.
8. 'Covenant of Mayors - Home'. <https://www.covenantofmayors.eu/en/> (accessed Mar. 29, 2019).
9. S. Kishimoto and O. Petitjean, Reclaiming public services: how cities and citizens are turning back privatisation. 2017.
10. V. Castán Broto, 'Urban Governance and the Politics of Climate change', *World Development*, vol. 93, pp. 1–15, May 2017, doi: 10.1016/j.worlddev.2016.12.031.
11. 'Proklimatyczna sesja Rady Miasta w Sztumie', EUKI, Oct. 04, 2019. <https://www.euki.de/en/proklimatyczna-sesja-rady-miasta-w-sztumie/> (accessed Oct. 07, 2020).
12. L. Devaney, D. Torney, P. Brereton, and M. Coleman, 'Ireland's Citizens' Assembly on Climate Change: Lessons for Deliberative Public Engagement and Communication', *Environmental Communication*, vol. 14, no. 2, pp. 141–146, Feb. 2020, doi: 10.1080/17524032.2019.1708429.
13. BEACON, 'Enhancing Internal Structures for Climate Action: Recommendations for municipal decision-makers from the BEACON Workshop in Syros, Greece', 2019. [Online]. Available: <https://www.euki.de/en/euki-projects/bridging-european-and-local-climate-action-beacon/>.
14. N. Giangrande et al., 'A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge', *Sustainability*, vol. 11, no. 10, p. 2832, May 2019, doi: 10.3390/su11102832.
15. 'www.ekocentra.cz – Portál Ministerstva životního prostředí'. <https://www.ekocentra.cz/> (accessed Oct. 07, 2020).
16. 'Bridging European and Local Climate Action (BEACON)', EUKI. <https://www.euki.de/en/euki-projects/bridging-european-and-local-climate-action-beacon/> (accessed May 31, 2019).
17. 'Projeto QualAR', Setúbal em Bom Ambiente, Sep. 03, 2019. <https://www.setubalambiente.pt/projeto-qualar/> (accessed Oct. 07, 2020).
18. 'QualAR - Qualidade do AR'. <https://qualar.apambiente.pt/indices> (accessed Oct. 07, 2020).
19. Harris, Ciorciari, and Gountas, 'Consumer Neuroscience and Digital/Social Media Health/Social Cause Advertisement Effectiveness', *Behavioral Sciences*, vol. 9, no. 4, p. 42, Apr. 2019, doi: 10.3390/bs9040042.
20. R. Pozharliev, W. J. M. I. Verbeke, and R. P. Bagozzi, 'Social Consumer Neuroscience: Neurophysiological Measures of Advertising Effectiveness in a Social Context', *Journal of Advertising*, vol. 46, no. 3, pp. 351–362, Jul. 2017, doi: 10.1080/00913367.2017.1343162.

21. 'Sustainable Land Management | Land & Water | Food and Agriculture Organisation of the United Nations | Land & Water | Food and Agriculture Organisation of the United Nations'. <http://www.fao.org/land-water/land/sustainable-land-management/en/> (accessed Aug. 29, 2019).
22. IPCC, 'Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Summary for Policymakers', IPCC, 2019. [Online]. Available: <https://www.ipcc.ch/srccl/>.
23. T. Endreny, R. Santagata, A. Perna, C. D. Stefano, R. F. Rallo, and S. Ulgiati, 'Implementing and managing urban forests: A much needed conservation strategy to increase ecosystem services and urban wellbeing', *Ecological Modelling*, vol. 360, pp. 328–335, Sep. 2017, doi: 10.1016/j.ecolmodel.2017.07.016.
24. S. Keesstra et al., 'The superior effect of nature based solutions in land management for enhancing ecosystem services', *Science of The Total Environment*, vol. 610–611, pp. 997–1009, Jan. 2018, doi: 10.1016/j.scitotenv.2017.08.077.
25. Graziano da Silva J., Dahlet G., Takagi M., DelGrossi M., de Lima P., and Ceolin S., 'From Fome Zero to Zero Hunger: A global perspective', FAO, Rome, 2019.
26. K. G. Turner et al., 'A review of methods, data, and models to assess changes in the value of ecosystem services from land degradation and restoration', *Ecological Modelling*, vol. 319, pp. 190–207, Jan. 2016, doi: 10.1016/j.ecolmodel.2015.07.017.
27. Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, vol. 189. 2007.
28. 'Industrial Agriculture | Global Forest Atlas'. <https://globalforestatlas.yale.edu/land-use/industrial-agriculture> (accessed Sep. 06, 2019).
29. 'Home Page | Forest Stewardship Council'. <https://fsc.org/en> (accessed Sep. 20, 2019).
30. IUCN, 'Glossary Definitions'. [https://www.iucn.org/downloads/en\\_iucn\\_\\_glossary\\_definitions.pdf](https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf) (accessed Sep. 20, 2019).
31. UNCCD/Interface Science-Policy, 'Tools for Soil Organic Carbon Estimation and Management', United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany, Science-Policy Brief No.4, 2019.
32. C. Saraswat, P. Kumar, and B. K. Mishra, 'Assessment of stormwater runoff management practices and governance under climate change and urbanisation: An analysis of Bangkok, Hanoi and Tokyo', *Environmental Science & Policy*, vol. 64, pp. 101–117, Oct. 2016, doi: 10.1016/j.envsci.2016.06.018.
33. A. Cerda, A. Artola, X. Font, R. Barrena, T. Gea, and A. Sánchez, 'Composting of food wastes: Status and challenges', *Bioresource Technology*, vol. 248, pp. 57–67, Jan. 2018, doi: 10.1016/j.biortech.2017.06.133.
34. A. Chatzimentor, E. Apostolopoulou, and A. D. Mazaris, 'A review of green infrastructure research in Europe: Challenges and opportunities', *Landscape and Urban Planning*, vol. 198, p. 103775, Jun. 2020, doi: 10.1016/j.landurbplan.2020.103775.
35. P.-P. Pichler, T. Zwickel, A. Chavez, T. Kretschmer, J. Seddon, and H. Weisz, 'Reducing Urban Greenhouse Gas Footprints', *Sci Rep*, vol. 7, no. 1, p. 14659, Dec. 2017, doi: 10.1038/s41598-017-15303-x.
36. Publications Office of the European Union, *Buying Green! A handbook on green public procurement*, 3rd Edition. 2016.
37. Ward, F., Tompt, J. & Northrop, F., 'Totnes and District Local Economic Blueprint.', (Transition Town Totnes), 2013.
38. ECOLISE, 'A community-led transition in Europe: Local action towards a sustainable, resilient, low-carbon future', ECOLISE, Brussels, 2017. Accessed: Jan. 18, 2018. [Online]. Available: <http://www.ecolise.eu/wp-content/uploads/2017/06/ECOLISE-European-Day-of-Sustainable-Communities-booklet-Sept-2017.pdf>.
39. G. Seyfang and N. Longhurst, 'Growing green money? Mapping community currencies for sustainable development', *Ecological Economics*, vol. 86, pp. 65–77, Feb. 2013, doi: 10.1016/j.ecolecon.2012.11.003.
40. 'Les monnaies locales en France et plus – Monnaies Locales Complémentaires Citoyennes'. <http://monnaie-locale-complementaire-citoyenne.net/france/> (accessed Mar. 20, 2020).

41. J. Poore and T. Nemecek, 'Reducing food's environmental impacts through producers and consumers', *Science*, vol. 360, no. 6392, pp. 987–992, Jun. 2018, doi: 10.1126/science.aag0216.
42. OECD, 'Promoting Sustainable Consumption: Good practices in OECD Countries', OECD, France, 2008.
43. European Commission Directorate-General Environment, 'Preparing a Waste Prevention Programme: Guidance document', European Commission Directorate-General Environment, Paris, 2012.
44. European Commission, 'European Commission Report on the implementation of the Circular Economy Action Plan', 2019.
45. European Commission, 'A new Circular Economy Action Plan for a cleaner and more competitive Europe', p. 20, 2020.
46. D. Xanthos and T. R. Walker, 'International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review', *Marine Pollution Bulletin*, p. 10, 2017.
47. 'I Fruta Feia'. <https://frutafeia.pt/en/the-project> (accessed Oct. 15, 2019).
48. N. Soobhany, 'Insight into the recovery of nutrients from organic solid waste through biochemical conversion processes for fertilizer production: A review', *Journal of Cleaner Production*, vol. 241, p. 118413, Dec. 2019, doi: 10.1016/j.jclepro.2019.118413.
49. B. Shrestha, S. Chang, E. Bork, and C. Carlyle, 'Enrichment Planting and Soil Amendments Enhance Carbon Sequestration and Reduce Greenhouse Gas Emissions in Agroforestry Systems: A Review', *Forests*, vol. 9, no. 6, p. 369, Jun. 2018, doi: 10.3390/f9060369.
50. 'Câmara Municipal de Lisboa - Lisboa a Compostar | Registo'. <https://lisboaacompostar.cm-lisboa.pt/pls/OKUL/f?p=178:2> (accessed Oct. 28, 2019).
51. 'Marselisborg WWTP - turning wastewater into green energy - Aarhus Vand'. <https://www.aarhusvand.dk/en/international/solutions/marselisborg-wwtp---turning-wastewater-into-green-energy2/#:~:text=Marselisborg%20Wastewater%20Treatment%20Plant%20has,based%20on%20normal%20household%20wastewater.> (accessed Oct. 07, 2020).
52. K. Alanne and A. Saari, 'Distributed energy generation and sustainable development', *Renewable and Sustainable Energy Reviews*, vol. 10, no. 6, pp. 539–558, Dec. 2006, doi: 10.1016/j.rser.2004.11.004.
53. P. Khetrapal, 'Distributed Generation: A Critical Review of Technologies, Grid Integration Issues, Growth Drivers and Potential Benefits', *IJRED*, vol. 9, no. 2, pp. 189–205, Jul. 2020, doi: 10.14710/ijred.9.2.189-205.
54. D. Bauknecht, J. Bracker, F. Flachsbarth, C. Heinemann, D. Seebach, and M. Vogel, 'Customer Stratification and Different Concepts of Decentralisation', in *Consumer, Prosumer, Prosumer*, Elsevier, 2019, pp. 331–353.
55. A. Myers, 'Renewable energy', *Salem Press Encyclopedia of Science*. Salem Press, 2018.
56. A. Caramisaru, A. Uihlein, Europäische Kommission, and Gemeinsame Forschungsstelle, *Energy communities an overview of energy and social innovation*. 2020.
57. 'Sobre la comercialisadora de energía pública', *Barcelona Energia*. <https://www.barcelonaenergia.cat/es/faqs/> (accessed Jan. 07, 2020).
58. J. Jeriha, 'Energy Community Definitions', p. 13.
59. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Text with EEA relevance.), vol. OJ L. 2018.
60. 'Hyperion" the first community solar investment in Greece, Powered By Citizens – Electra Energy'. <https://electraenergy.coop/here-comes-the-sun-first-community-solar-farm-in-greece/> (accessed Oct. 09, 2020).
61. H. L. M. do Amaral, A. N. de Souza, D. S. Gastaldello, F. Fernandes, and Z. Vale, 'Smart meters as a tool for energy efficiency', in *2014 11th IEEE/IAS International Conference on Industry Applications*, Juiz de Fora, Dec. 2014, pp. 1–6, doi: 10.1109/INDUSCON.2014.7059413.
62. Rupprecht Consult, 'Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan', 2019.

- 
63. 'Global CO2 emissions by sector, 2018 – Charts – Data & Statistics', IEA. <https://www.iea.org/data-and-statistics/charts/global-co2-emissions-by-sector-2018> (accessed Oct. 07, 2020).
  64. 'Free travel card, T-verda metro bus Barcelona | Transports Metropolitans de Barcelona'. <https://www.tmb.cat/en/barcelona-fares-metro-bus/single-and-integrated/t-verda> (accessed Oct. 07, 2020).
  65. M. Noori, S. Gardner, and O. Tatari, 'Electric vehicle cost, emissions, and water footprint in the United States: Development of a regional optimisation model', *Energy*, vol. 89, pp. 610–625, Sep. 2015, doi: 10.1016/j.energy.2015.05.152.
  66. 'Menos coches, más cidade'. <http://www.pontevedra.gal/publicacions/menos-coches-gal/#20> (accessed Oct. 07, 2020).
  67. 'ECO-Driving | IRU'. <https://www.iru.org/iru-academy/programmes/eco-driving> (accessed Oct. 07, 2020).
  68. 'Eclipse mechanism'. [http://www.eclipse-mechanism.eu/eclipse\\_outputs\\_reports](http://www.eclipse-mechanism.eu/eclipse_outputs_reports) (accessed Sep. 07, 2020).
  69. European Commission and Directorate-General for Research and Innovation, Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities: final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' : (full version). Luxembourg: Publications Office of the European Union, 2015.

