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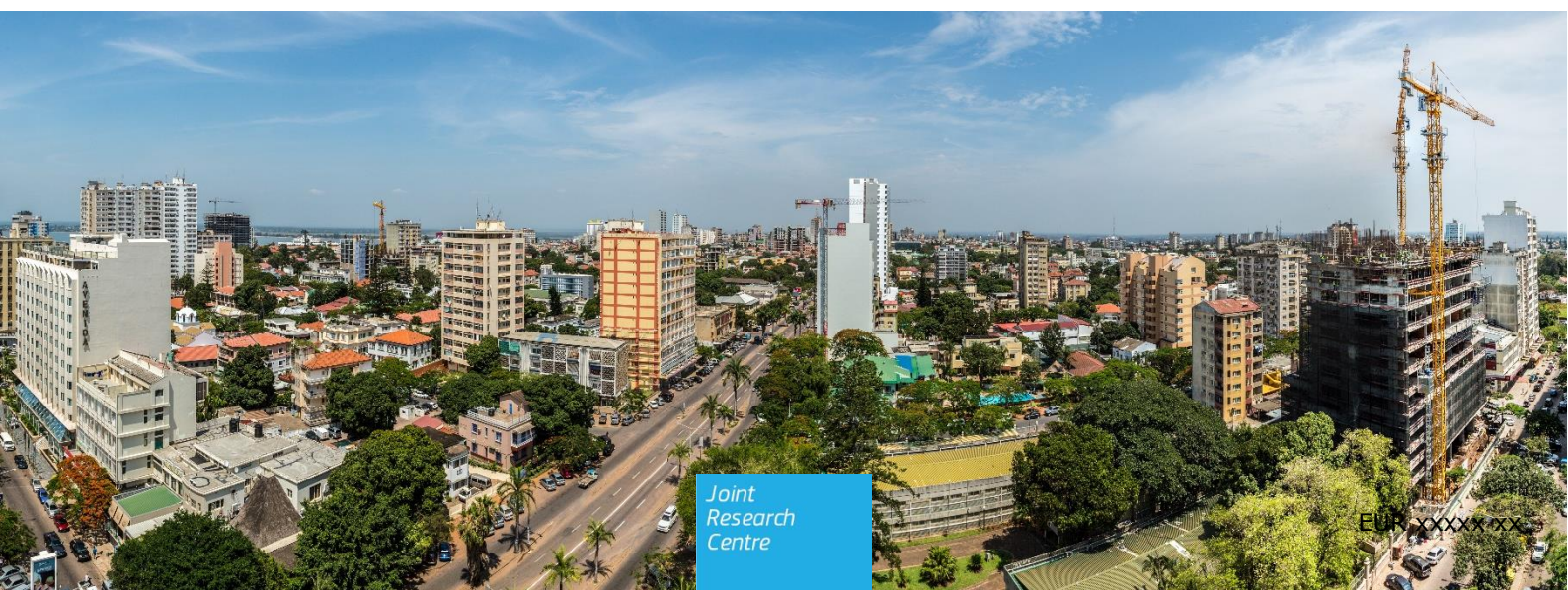
Guidebook:

"How to develop a Sustainable Energy Access and Climate Action Plan (SEACAP) in Sub-Saharan Africa"

Extended Document

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Abstract

The Covenant of Mayors in Sub-Saharan Africa (CoM SSA) supports local authorities in Sub-Saharan Africa in the climate challenge and in their efforts in ensuring access to clean energy. It is the "regional covenant" of the Global Covenant of Mayors for Climate & Energy (GCoM). Under the CoM SSA local authorities are invited to make a voluntarily political commitment to implement climate and energy actions in their communities and agree on a long-term vision to tackle 3 pillars, namely access to energy, climate mitigation and climate adaptation. In order to translate the political commitment into practical measures, CoM SSA signatories commit to elaborate and implement a Sustainable Energy Access and Climate Action Plan (SEACAP).

This document has been prepared to assist Sub-Saharan Africa local authorities in preparing a Climate Action Plan. It provides step-by-step guidance and examples of measures relevant for local authorities in Sub Saharan context. Despite being framed and definite, the process of developing a SEACAP allows flexibility. The choice and sequence of actions can vary according to the policies and measures already in place. This flexibility allows local governments to develop a SEACAP that is coherent with and effective for their local circumstances and objectives.

This document has been partly adapted from previous Joint Research Centre's (JRC) experience in Europe and other regions of the world (see for example the JRC report: JRC113188 "Guidebook: How to develop a Sustainable Energy and Climate Action Plan (SEACAP) in the MENA Region" and the JRC112986 "Guidebook - How to develop a Sustainable Energy and Climate Action Plan" released in 2018).

It should be noted that the content of this Guidebook aims to be coherent with the wider framework of the GCoM initiative. A specific Guidance document will be prepared by the GCoM Data Technical Working Group.

At the date of the preparation of the present Guidebook, three reporting platforms are accepted in the GCoM framework (My Covenant -the European reporting platform-, CDP and the Carbon Climate Registry (cCR)).

Other guidance material on climate action planning in Sub Saharan Africa is a useful complement to the present document.

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Special thanks also to C. Thiel, Head of JRC Energy Efficiency and Renewable Energies Unit.

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This CoM guidebook for SSA benefited from the input, comments, suggestions and review from a wide group of experts from:

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- GCoM Secretariat, E. Abbes, S. Mc Daniel.

Executive summary

The Covenant of Mayors in Sub-Saharan Africa (CoM SSA) supports local authorities in Sub-Saharan Africa in the climate challenge and in their efforts in ensuring access to clean energy. It is the "regional covenant" of the Global Covenant of Mayors for Climate & Energy (GCoM). Under the CoM SSA local authorities are invited to make a voluntarily political commitment to implement climate and energy actions in their communities and agree on a long-term vision to tackle 3 pillars, namely access to energy, climate mitigation and climate adaptation. In order to translate the political commitment into practical measures, CoM SSA signatories commit to elaborate and implement a Sustainable Energy Access and Climate Action Plan (SEACAP).

This document is part of the guiding materials developed to assist local governments in Sub-Saharan Africa (SSA) in preparing a climate action plan. The full set of guiding materials consists of:

- "Guidebook: How to develop a Sustainable Energy Access and Climate Action Plan (SEACAP) in Sub-Saharan Africa" - Extended version;
- Summary of the "Guidebook: How to develop a Sustainable Energy Access and Climate Action Plan (SEACAP) in Sub-Saharan Africa";
- "How to develop a SEACAP in Sub-Saharan Africa: short starting guide".

This guidebook has been adapted partly from previous Joint Research Centre's (JRC) experience in Europe and other regions of the world and **is intended to be coherent with the Global Covenant of Mayors for Climate and Energy (GCoM) approach**.

This document aims at presenting the framework for the three pillars of the initiative and provides step-by-step recommendations for the entire process of elaborating a climate action plan (SEACAP), from initial political commitment to monitoring. Climate action planning is performed in four phases (**Figure 1**):

- Initiation phase- preparing the ground: Chapter 3 provides detailed guidance throughout the initiation phase on the commitment to address climate change mitigation and adaptation and access to energy;
- Planning phase: including a Pre-assessment phase and a Development phase. Detailed guidance throughout the pre-assessment phase of elaborating a SEACAP is provided – from undertaking a Baseline Emission Inventory (BEI) (see chapter 4.2) and setting objective and targets (see chapter 5.1), undertaking a Risk and Vulnerability Assessment (RVA) (see chapter 4.3) and assessing the state of energy access and setting targets (see chapter 4.4). Detailed guidance on the elaboration of the climate action plan throughout the elaboration of the SEACAP mitigation measures (5.2); key adaptation measures (5.3); access to energy actions (5.4).
- Implementation of the actions planned in the plan and monitoring the progress towards the target setting (6 and 7).

Figure 1. The SEACAP process: main phases



Source: JRC own elaboration.

Moreover the document includes a section on financing the action plan (chapter 8) and some insights on specific issues in the annexes.

Signatories commit to preparing and implementing the plan and reporting on the status and their progresses. At the date of the preparation of this document, three reporting platforms are accepted in the GCoM framework: My Covenant- the European one-, CDP and the Carbon Climate Registry (cCR). Other guidance material on climate action planning in sub Saharan Africa is a useful complement to the present document. A specific Guidance document will be also prepared by the GCoM Data Technical Working Group ⁽¹⁾.

The CoM SSA addresses specifically the adaptation to the Sub-Saharan Africa context of the European experience. However, it is important to note that local authorities can use other equivalent reporting platform. Likewise, the climate action plan, local authorities shall develop within the initiative, can be named SEACAP or CAP, which are the most common names used by CoM SSA cities for their plans. Although, this document mainly refers to SEACAP, both terms can be equally used and are considered as equivalent in the present document.

Cities are key actors in the fight of climate change. Therefore, their contribution is crucial to reach the climate targets. For this reason, there is the need for a flexible framework, in which local authorities can develop and build their strategy according to their peculiarities and potentials.

The guidebook provides a flexible but coherent set of principles and recommendations. The flexibility will allow local authorities to develop a SEACAP in a way that suits their own circumstances, permitting those already engaged in energy and climate action to come on board of the Global Covenant of Mayors, while continuing to follow the approaches they have used before with as little adjustments as possible.

⁽¹⁾ A team of multi-disciplinary experts from GCoM partners with the aim of providing a harmonized definition of a common reporting framework

1 Introduction

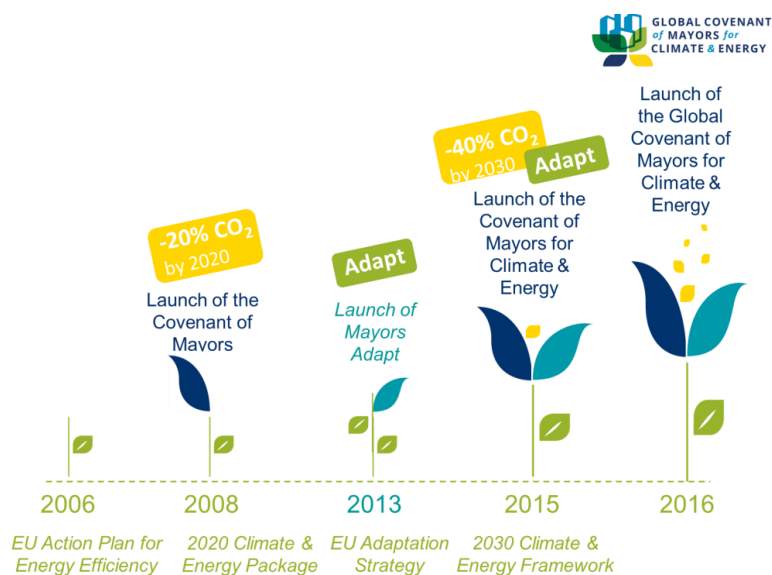
1.1 Global Covenant of Mayors for Climate & Energy evolution

The **Covenant of Mayors** (CoM) initiative is a voluntary commitment by local governments (regions, cities, towns) to implement energy access and efficiency and climate change mitigation measures to reduce their overall CO₂ emissions, which in the case of Europe was by at least 20% by 2020. The implementation of the agreed measures should take place at the local level in the territory within the competence of the local authority and, where relevant, with the consultation and participation of national authorities. The political commitment undertaken by all CoM signatories is declared in the CoM core text, which must be approved by the municipal council (or equivalent body, including national authorities).

Building on the success of the CoM, the Mayors Adapt initiative was launched in 2014, relying on the same governance model, inviting cities to make political commitments and take action to anticipate and prepare for the unavoidable impacts of climate change.

In 2015, the European Commission and the Covenant of Mayors Office launched a consultation process with the support of the European Committee of the Regions and with the majority of the stakeholder's and they called for a new target beyond 2020 as well as a longer-term target. The 2030 objectives called for a minimum 40% CO₂ /GHG reduction in Europe and supported the integration of mitigation and adaptation to climate change under a common umbrella. The new integrated **Covenant of Mayors for Climate & Energy** was launched by the European Commission on 15 October 2015 in Brussels. The three pillars of the strengthened Covenant: mitigation, adaptation, and secure, sustainable and affordable energy, were symbolically endorsed on this day.

Figure 2. Covenant evolution through the years.



Following and supporting the international dimension and the international principle of equality, the European Commission according to the Neighbourhood Investment policy has been funding the CoM initiatives in the EU neighbourhood to the East, to the South and to the Sub-Saharan African countries.

In January 2017, following the major changes in the international scene, and in order to incorporate all the efforts in the same direction and increase the cooperation between the international organizations working to achieve the same results in combatting climate

change, there was a very important announcement to merge the CoM 2030 with the Compact of Mayors ⁽²⁾ to become the **Global Covenant of Mayors for Climate and Energy (GCoM)**.

The Global Covenant of Mayors for Climate & Energy has, hence, become the broadest international alliance of cities and local governments with a shared long-term vision of promoting and supporting voluntary action to combat climate change and move to a low-emission resilient society. GCoM is a response by the world's cities to address the climate challenge, building on the commitment of over 9,000 cities and local governments from six continents and 127 countries representing more than 770 million residents (almost 10% of the world's population)⁽³⁾. Regional chapters of the GCoM, managed by local, regional and global city networks ⁽⁴⁾ are core partners of the GCoM, serving as the primary support for participating cities and local governments. Focusing on those sectors where cities have the greatest impact, the Global Covenant of Mayors supports ambitious, locally relevant solutions, captured through strategic action plans that are registered, implemented and monitored and publicly available. The GCoM supports cities and local governments to be active contributors to a global climate solution, mirroring the commitments their national governments have set to ensure the goals of the Paris Climate Agreement are met. Detailed information on the GCoM initiative can be found on the GCoM web site (<https://www.globalcovenantofmayors.org/>).

GCoM incorporates, under a single umbrella, the commitments of individual cities and local governments originally put forth either through the Compact of Mayors, pre-existing Regional/National Covenants, and now newly developing Regional/National Covenants operating under the shared vision of the GCoM and principles and methods that best suit each region ⁽⁵⁾.

Box 1. Global Covenant of Mayors reporting framework key principles

- The reporting framework allows flexibility to suit differentiated local circumstances and needs.
- The reporting framework allows for consistency with national and/or sub-national requirements for local governments within their own context. It is also designed specifically to consider the United Nation's Framework Convention on Climate Change's (UNFCCC's) framework for reporting under the Paris Agreement (work in progress on enhanced framework) and, as such, ensure overall consistency with the IPCC framework.
- Greenhouse gas (GHG) emissions inventories, risk and vulnerability assessments, target(s) and goal(s), identifying hazards, climate and energy access plans should be relevant to the local and regional situation, reflecting the specific activities, capacity and regulatory context of the local government.
- The reporting framework allows for the continuity of current reporting requirements.
- Local governments may develop joint GHG inventories, targets, and/or action plans with the neighbouring community(ies).
- Local governments shall report in a way that enables meaningful comparison and aggregation with other cities.

⁽²⁾ Launched in 2014 by UN Secretary General Ban Ki-moon and former New York City Mayor Michael Bloomberg (former UN Special Envoy for Cities and Climate Change), the Compact of Mayors was a global coalition of city leaders addressing Climate Change by pledging to cut greenhouse gas emissions and prepare for the future impacts of Climate Change (Barron-Lopez, Laura. "UN launches global mayors network to fight climate change". The Hill. Retrieved 2015-12-03.)

⁽³⁾ Figures updated at August 2018. For more recent updated and more information on GCoM, please refer to www.globalcovenantofmayors.org

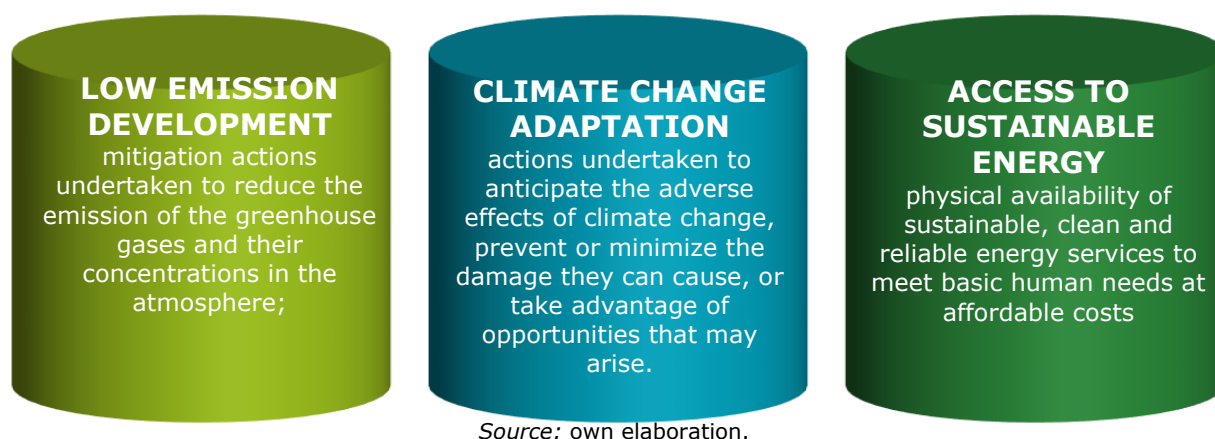
⁽⁴⁾ The terms "cities" and "local governments" are used throughout this document, understanding that the geo-political institutions of local governments may vary from country to country and terminology used may differ. In this document, a city refers to a geographical subnational jurisdiction ("territory") such as a community, a town, or a city that is governed by a local government as the legal entity of public administration. The term "city boundary" refers to a local government's administration boundary

⁽⁵⁾ <https://www.covenantofmayors.eu/>; <http://www.ces-med.eu/covenant-mayors-climate-energy>

1.2 Covenant of Mayors in Sub-Saharan Africa

The Covenant of Mayors in Sub-Saharan Africa (CoM SSA) is an initiative launched by the European Union (EU) to support local authorities in Sub-Saharan Africa in the climate challenge and in their efforts in ensuring access to clean energy. It is the "regional covenant" or chapter of the Global Covenant of Mayors for Climate & Energy. CoM SSA is delivered through a partnership of global and local city networks as well as initiatives funded by the European Commission (EC). It is a bottom-up and voluntary initiative that invites cities to define and meet ambitious and realistic energy and climate targets set by themselves, in line with GCoM requirements. This means that targets are at least as ambitious as cities' respective government's Nationally Determined Contribution (NDC) under the Paris Agreement. Furthermore, targets need to be in line with National Adaptation Plans (where these exist) and be consistent with the principles around energy access and urban sustainability embodied in the Sustainable Development Goals (SDGs). Local authorities are encouraged to voluntarily commit to the implementation of a climate and energy action plan in their area of influence. They are also encouraged to define long-term vision actions towards a sustainable future based on the pillars of climate change mitigation and adaptation, and sustainable, affordable and secure Access to Energy ⁽⁶⁾. CoM SSA is open to any city in Sub-Saharan Africa regardless the size.

Figure 3. Pillars of the Covenant of Mayors in Sub-Saharan Africa.



In order to translate the political commitment into practical measures, CoM SSA signatories commit to produce and implement a strategic and operational document called Sustainable Energy Access and Climate Action Plan (SEACAP).

⁽⁶⁾ CEMR coordinates the Covenant of Mayors Office for Sub-Saharan Africa partnering with six networks: Climate Alliance (CA), Energy Cities (ENC), United Cities of Local Governments Africa (UCLG Africa), ICLEI Africa and ICLEI World Secretariat. Three Institutional organisations: French Agency for Environment and Energy Management (ADEME), the International Association of Francophone mayors (AIMF), the Portuguese Energy Agency (ADENE); and two non-governmental organisations: Environment Development Action in the third world (ENDA) and Sustainable Energy for Africa (SEA). <http://www.ccre.org/activites/view/40>

Box 2. CoM SSA / GCoM signatories pledge to:

- Formally commit to the CoM SSA/GCoM;
- Engage with local stakeholders throughout the development and implementation of the climate strategy and action plan;
- Develop a community-scale greenhouse gas (GHG) emissions inventory and adopt ambitious, measurable and time-bound target(s) to reduce/limit GHG emissions;
- Develop a climate risk and vulnerability assessment and adopt ambitious climate change adaptation vision and goals, based on quantified scientific evidence when possible, to increase local resilience to climate change;
- Develop the status of access to energy and adopt ambitious and just goals to improve access to secure, affordable and sustainable energy;
- Develop a community strategy and integrated climate action plan to address climate change mitigation / low emission development, climate resilience and adaptation, and access to sustainable energy;
- Approve the developed climate action plan;
- Monitor the implementation of the plan and report achievements and progress on common reporting platforms, including provisions for regular progress reports.

Cities are key actors in the fight of climate change. Therefore, their contribution is crucial to reach the climate targets. For this reason, there is the need for a flexible framework, in which local authorities can develop and build their strategy according to their peculiarities and potentials.

The guidebook provides a flexible but coherent set of principles and recommendations. The flexibility will allow local authorities to develop a SEACAP in a way that suits their own circumstances, permitting those already engaged in energy and climate action to come on board of the Global Covenant of Mayors, while continuing to follow the approaches they have used before with as little adjustments as possible.

2 Sustainable Energy Access and Climate Action Plan (SEACAP)

The Sustainable Energy Access and Climate Action Plan (SEACAP) is the key document that sets the strategies, plans and actions for a sustainable and low greenhouse gas (GHG) emission development while including climate adaptation actions and ensuring access to secure, affordable and sustainable energy, in response to the current and future impacts of climate change in the territory.

The SEACAP is both a strategic and an operational document. It uses the results of the Baseline Emission Inventory (BEI) to identify the best fields of action and opportunities for reaching the local authority's greenhouse gases (GHG) emissions target. It is based on the climate change Risk and Vulnerability Assessment (RVA), which identifies the most relevant city climate hazards and vulnerabilities. It also includes an Access to Energy Assessment, which articulates a plan to improve the access to secure, sustainable, affordable and reliable energy. The SEACAP defines concrete measures for climate mitigation, adaptation and access to sustainable energy, with timeframes and assigned responsibilities, translating the long-term strategy into action. Signatories commit themselves to submitting their climate action plans by year 3 at the latest (following adhesion to the initiative).

The SEACAP can and shall be updated. It should not be regarded as a fixed and rigid document: as circumstances change and as the ongoing actions provide results and experience, it may be useful/necessary to revise the plan.

The SEACAP shall lead to climate change mitigation, adaptation and access to energy actions being integrated into development policy and planning at every level. The cities understand while preparing their SEACAP that mitigation and adaptation should complement each other, and should be mainstreamed into existing sectorial policies in order to foster synergies and optimize the use of available resources. Opportunities to make cities more climate-resilient arise with every new development project to be approved by the local authority. The impacts of missing such an opportunity can be significant and will last for a long time. This means that climate related considerations should be taken into account for all new developments, even if the SEACAP has not yet been finalised or approved.

A well-designed SEACAP, developed in collaboration with local stakeholders and the community, provides local governments with political visibility, helps to improve the local governments' image, reduce their energy consumption costs as well as impacts related to CO₂ emissions. Moreover, citizens will benefit from the reduction of the health and safety impacts of energy consumption and its related CO₂ emissions. At the same time, the SEACAP makes the city more attractive to international donors and investors, when good financial figures are included for the implementation of the identified actions. At the same time, it makes the city more attractive to international donors and investors, when good financial figures are included for the implementation of the identified actions.

The SEACAP should consolidate and integrate existing initiatives. If a city has already developed a municipal action plan in the past, or any other development and climate related plans, it should prepare a SEACAP as a natural extension of the ongoing activities and measures.

Box 3. A SEACAP is defined by:

- Principles: the criteria defining the scope, boundaries and sector coverage of the plan (chapter 2.1).
- Elements: the components of a well-designed SEACAP, from political support to well-designed actions (chapter 2.2).
- Process: different phases to be followed to develop an integrated local climate action plan (chapter 2.3).

2.1 SEACAP principles

The principles of SEACAPs in terms of spatial and temporal boundaries, scopes, sector coverage and elaboration of the document are described in the following paragraphs. Moreover, the particular case of how those principles apply when a group of local authorities decide to elaborate a joint SEACAP is presented last.

2.1.1 Spatial and temporal scope

The SEACAP covers the geographical area under the jurisdiction of the local authority and includes actions by both public and private sectors.

The SEACAP has to contain a clear outline of the actions that the local authority intends to take in order to ensure Low Emission Development or GHG emission reduction, taking into account the country's Nationally Determined Contributions (NDCs). In some cases, there may be a non-emission instead of a reduction. The SEACAP may as well cover a longer period, in which case it is advised that the plan contains intermediate targets and goals for the year 2030, to be comparable with the NDC.

Planning in detail for such a long time span is difficult; hence, the local authority may distinguish between:

- A vision, with long-term strategy and goals until 2030 and/or beyond, including firm commitments in areas like land-use planning, transport and mobility, public procurement, standards for new/renovated buildings etc.
- Detailed measures for the next 3-5 years, which translate the long-term strategy and goals into real actions.

Both the long-term vision and the detailed measures shall be an integral part of the SEACAP. This is particularly true for adaptation targets: local decision-makers often focus on the immediate benefits of a measure that fits into their political agenda, whilst adaptation is known to have long-term benefits. A robust planning of climate action must integrate short-term needs with long-term threats and consider the full range of interactions between sectors and policies.

2.1.2 Sector coverage

Local governments shall report GHG emissions from at least three main sectors: stationary energy, transportation and waste. They should also report GHG emissions from Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU) sectors ⁽⁷⁾ where these are significant. Additionally, GHG emissions from upstream activities, such as material extraction, or other out-of-boundary sources can be reported.

The emissions target boundary shall be consistent with all emissions sources included in the GHG emissions inventory, with the possibility to exclude sources that are not controlled by the local government.

It is worth noting that the industrial sector is not a key target of the Global Covenant of Mayors, so the local government may choose or not to include actions in this sector.

The local government shall identify the most significant climate hazards faced by the community. For each identified climate hazard, the following information shall be reported:

- Current risk level (probability x consequence) of the hazard
- Description of expected future impacts

⁽⁷⁾ Please refer to 2006 IPCC Guidelines for National Greenhouse Gas Inventories for more details on these sectors.

- Expected intensity, frequency, and timescale of the hazard
- At least all relevant five sectors, assets, or services that are expected to be most impacted by the hazard in future and the magnitude of the impact for each of them

Local governments shall develop plans for both climate change mitigation and adaptation (climate resilience) and for access to energy, which may be presented in separate plans or an integrated plan. All actions of priority sectors (identified from GHG emissions inventories and risk/vulnerability assessments) shall be included in the plan.

The SEACAP should address areas where local government can influence energy consumption, land use planning and climate change resilience on the long term.

Climate change mitigation and adaptation measures should complement each other, and should be mainstreamed into existing sectorial policies, plans and programs in order to foster synergies and optimize the use of available resources. A climate lens should be applied whenever a climate change mitigation policy or action is formulated, planned and/or implemented, to see whether it works in favour of or against the adaptation goals and – if relevant - adjust it, and vice versa.

For low emission development / climate change mitigation, action in the following sectors is mandatory in the SEACAP: building subsector including: municipal, residential and tertiary buildings (belonging to stationary energy sector), and urban transport sub sector (belonging to transportation sector). The SEACAP may also include actions related to local electricity production (development of PV, wind power, CHP, improvement of local power generation), and local heating/cooling generation. In addition, the SEACAP should cover areas where local authorities can influence energy consumption on the long term (as land use planning), encourage markets for energy efficient products and services (public procurement), as well as changes in consumption patterns (working with stakeholders and citizens). Waste sector is also to be addressed.

For adaptation to the impacts of climate change, the SEACAP should include actions in the sectors and areas that are likely to be most vulnerable to climate change in a local authority (hotspots). Vulnerable sectors vary considerably within urban boundaries, from one city to another and from urban areas to more rural areas: this is why gaining a deep understanding of the hazards and vulnerabilities of the local authority is of paramount importance.

For access to energy the attributes of secure, sustainable and affordable energy shall be taken into consideration when developing an assessment, in order to catch its multi-faced characterisation. The fields to be considered to assess the energy access in Sub-Saharan Africa are: clean cooking and electricity in households and public buildings and activities.

Finally, mitigation and adaptation should complement each other, and should be mainstreamed into existing sectorial policies in order to foster synergies and optimize the use of available resources. A climate lens should be applied whenever a mitigation policy or action is formulated, planned and/or implemented, to see whether it works in favour of or against the adaptation goals and – if relevant - adjust it, and vice versa.

2.1.3 Elaboration of the document

Local authorities are advised to follow the recommended structure when preparing their SEACAPs, with the following content:

- A. SEACAP executive summary
- B. Strategy
 1. Vision
 2. Commitments for mitigation adaptation to climate change and access to energy

- a. *For mitigation, the SEACAP document should clearly indicate the emission reduction target by 2030 (and possibly beyond⁸) clearly stating the Baseline Emission Inventory (BEI) year and the reduction target type (absolute reduction / per capita reduction/ Baseline scenario target)*
 - b. *For adaptation, the SEACAP should include a certain number of adaptation goals, coherent with the identified vulnerabilities, risks and hazards.*
 - c. *For access to Energy, the document should include a set of sustainable affordable and secure access to energy goals*
3. Coordination and organizational structures created /assigned
4. Staff capacity allocated
5. Involvement of Stakeholder and citizens / Participatory processes
6. Overall budget allocated for implementation and financing sources
7. Implementation
8. Monitoring process
9. Assessment of the adaptation options
10. Strategy in case of extreme climate events
- C. BEI and related information, including data on:
 1. Inventory year
 2. Number of inhabitants in the inventory year
 3. Emission factors approach (IPCC or LCA)
 4. Emission reporting unit (CO₂ or CO₂-equivalent)
 5. Responsible body/department (main contact)
 6. Detailed BEI results in terms of final energy consumption and GHG emissions

If relevant, please also specify:

 7. Inclusion of optional sectors and sources
 8. Assumptions made, references or tools used
 9. Reference to the BEI inventory report
- D. Climate Change Risk and Vulnerability Assessment (RVA)
 1. Expected weather and climate events particularly relevant for the local authority or region
 2. Vulnerabilities of the local authority or region
 3. Expected climate impacts in the local authority or region
 4. Assets and people at risk from climate change impacts
- E. Access to Energy Assessment
 1. Percentage of population or households having access to electricity (grid/off-grid) [%]
 2. Percentage of population/households with clean cooking access [%]
 3. Sustainability, security and affordability attributes of energy access.
- F. Mitigation actions and measures for the full duration of the plan (2030). For each measure/action, please specify (whenever possible):
 1. Description,

⁽⁸⁾ in-line with the reporting guidelines of the UNFCCC, i.e. report in 5 year increments if targets go beyond 2030.

2. Department, person and/or company in charge of the implementation,
3. Timeline (start, end, major milestones),
4. Cost estimation (Investment and running costs),
5. Estimated energy savings and/or increased renewable energy production by target year (MWh/year),
6. Estimated CO₂ reduction by target year (tonnes/year)
7. Indicators for monitoring

G. Adaptation actions and measures for the full duration of the plan (2030). The actions should be coherent with outcomes of the city vulnerability and risk assessment (RVA). For each measure/action, please specify (whenever possible):

1. Sector
2. Title
3. Description
4. Responsible body/department/ and contact point
5. Timing (end-start, major milestones)
6. Action also affecting mitigation?
7. Stakeholders involved/advisory group
8. Impacts, vulnerabilities and risks tackled
9. Costs (LC) (Investment and running costs)
10. Indicators for monitoring

H. Set of Access to energy actions to be implemented

1. Sector
2. Title
3. Description
4. Responsible body/department/ and contact point
5. Field
6. Co-benefits

Box 4. Defining actions: detailed versus General

The level of detail in the description of each measure/action is to be decided by the local authority according to expected results, data availability and quality. However, bear in mind that the SEACAP is at the same time:

- A working instrument to be used during implementation (at least for the next few years);
- A communication tool towards the stakeholders;
- A document that is agreed at the political level by the various parties in charge within the local authority: the level of detail should be sufficient to avoid further discussion at the political level over the meaning and scope of the various measures.

2.1.4 SEACAPs with multiple partners: Joint SEACAPs

Since climate change has a regional scale in many sectors – e.g. water management – collaboration at regional level between municipalities and with regional agencies is needed. Cities within the same risk zone and with similar vulnerability factors can create a network which could facilitate data and good-practice exchange, better use of available resources (e.g., river basin management), and define common targets and monitoring systems by submitting joint SEACAP. Neighboring CoM SSA local authorities may choose to elaborate a joint or group SEACAP, and may choose between two approaches (**Table 1**).

Table 1. SEACAP group submission options for CoM SSA signatories

Covenant steps	Option 1	Option 2
Country's NDC CO₂ reduction target	Individual	Shared
Submission of the SEACAP template	Individual	1 for the
Submission of the SEACAP document	>> 1 joint SEACAP <<	
Publication of the accepted SEACAPs in the on-line catalogue	1 per signatory	1 for the group

Source: JRC own elaboration.

Option 1: Each signatory of the group individually commits to reducing its CO₂ emissions relative to baseline beyond the specific country's NDC by 2030. In this case, the group can submit one joint SEACAP document, but each must submit individual SEACAP templates. The goal of reducing CO₂ emissions beyond the country's NDC by 2030 is not a collective goal; it remains each signatory's commitment within its jurisdiction. The idea is to share the benefits of a given measure among participating municipalities to assist each one to reach its goal. Emissions reduction corresponding to the common measures or resilience measure proposed in the SEACAP will be divided among the cities sharing these measures. This option is particularly recommended for two or more cities willing to implement one or several joint actions, but remaining individually committed to the 2030 target.

Option 2: The group of signatories collectively commits to reducing CO₂ emissions beyond the specific country's NDC by 2030. In this case, the targets are a collective goal achieved by the measures taken by the signatories combined. The group submits one joint SEACAP and report in the platform only one SEACAP. This option fosters inter-institutional cooperation by facilitating joint approaches with neighboring authorities. It is particularly recommended for small and medium-sized municipalities lacking human and/or financial resources within the same territorial area. The joint SEACAP has to be approved by the municipal council (or equivalent body, including local authorities) of each signatory.

2.2 SEACAP elements

The following elements are presented to guide signatories in the elaboration of their SEACAPs. These steps are linked to the commitments taken by the Covenant signatories and constitute key ingredients of success.

2.2.1 Strong political support

Strong political support by municipal council or equivalent decision-making body is a prerequisite for the successful design, implementation and monitoring of a SEACAP. Local authorities must ensure that the vision and actions proposed in the approved SEACAP are aligned with and integrated into relevant national and/or regional plans, strategic development plans or land-use plans. The SEACAP should therefore be approved by the municipal council (or equivalent body, including national authorities).

2.2.2 Commitment to ambitious targets

The principle behind the chapter on mitigation of the SEACAP is a meaningful, actionable commitment by local authorities to implement low emission development strategies to ensure that local authorities develop in a way that limits the GHG emissions in their jurisdictions. For CoM SSA signatories, the SEACAP must include the signatory's statement of commitment to reduce emissions beyond the country's NDCs by 2030 within the geographical area under its responsibility for the areas of activity, relevant to its mandate.

The commitment should be based on the quantification of associated GHG emitted in the baseline year. The base year shall be the same as the base year used in the NDC. Where the base year is different from the NDC (e.g. due to a lack of data availability), this shall be justified. Targets on the other hand should be based on a reference scenario called the Business-as-Usual (BAU) scenario, as explained in chapter 5.

In addition to the mitigation commitment, adaptation goals have to be specified coherently with the main outcomes of the RVA, and levels of improvement in access to energy services based on the outcomes of the assessment.

2.2.3 Suitable assessment of the current situation

The SEACAP should be elaborated based on a sound knowledge of the local situation in terms of energy and GHG emissions, as well as of climate hazards, vulnerabilities and access to energy. Therefore, an assessment of the current framework should be carried out. This includes calculating a Baseline Emission Inventory (BEI), preparing a Climate Change Risk and Vulnerability Assessment (RVA), and an Access to Energy Assessment (AEA). The three assessments, BEI RVA and AEA have to be included in the SEACAP document.

2.2.4 Development and prioritization of actions

Local authorities should identify and prioritize the required and/or most effective sectors in which to implement mitigation actions. Local authority should establish a long-term vision with clear objectives for each sector. The SEACAP must include a coherent set of measures covering the selected activity sectors. Those measures should be aligned with identified priorities and measurable in terms of energy consumption and GHG emissions reduction.

Adaptation to Climate Change requires a multilevel approach involving local, regional, national levels. In particular, adaptation to Climate Change is a shared competence between local and regional authorities and should be defined according to a city's peculiarities and needs, which might be neglected by a solely large-scale national framework.

Local authorities can identify the most suitable measures to their conditions. Medium and long term visions allow prioritization and keeping the track of the progresses. **Measures can be selected according to the needs identified in the assessment.** LAs can target specific renewable energy resource that best suits their conditions; a major focus can be given on providing access to electricity and to clean cooking.

Suggestions for measures and actions in various sectors are provided in the Section 5.

The mitigation, adaptation and Access to Energy strategies could be part of the SEACAP and/or developed or mainstreamed in separate documents. Based on recognized local risks and vulnerabilities, the local authority should identify actions aimed at enhancing local adaptive capacity ⁽³³⁾ to respond to climate change impact or/and reducing city sensitivity to climate extremes.

2.2.5 Strategies and actions

The SEACAP must provide a clear outline of the specific actions the local authority intends to take to reach its commitments. It should include:

- Long-term strategy and goals in selected and/or mandatory sectors, as well as public procurement, standards for new/renovated buildings
- Detailed actions for the next three to five years that will advance towards the long-term strategy and goals. For each action, include the department and persons in charge of implementation and monitoring, a timeline (start, end, and major milestones), a cost estimate and potential financing source(s), the estimated energy saving/increased renewable energy production, and the associated estimated GHG

reduction i.e. for instance, fuel switching from charcoal to biomass pellets for cooking. For the key adaptation actions, the stakeholders involved, the risk and/or vulnerability tackled and the outcome reached should also be specified.

Box 5. Key principles for a successful SEACAP

- Document approved by the municipal council;
- Build strong political support; secure a long-term commitment;
- Commit to concrete and ambitious emission reduction targets under the municipal jurisdiction;
- Based the plan on assessments: Baseline Emission Inventory (BEI), Risks And Vulnerabilities Assessment (RVA) and Access to Energy Assessment (AEA);
- Develop comprehensive measures covering key municipal sectors;
- Define concrete actions to 2030 but strategies beyond;
- Mobilization of all municipal departments involved;
- Engagement of all relevant stakeholders and empowerment of citizens;
- Ensure adequate financial resources;
- Ensure proper management, including monitoring and reporting, during implementation.

2.2.6 Governance

An appropriate governance structure is fundamental to the successful implementation of the SEACAP. The SEACAP should outline which structures are in place or how they will be organized to implement the proposed actions successfully. Local authorities should ensure that the SEACAP is taken into account at different levels and by different departments, including those at a national level. The SEACAP should also specify the human resources required and how they will be made available, as well as the implementation and monitoring strategy. A coordinated interaction and cooperation between mitigation and adaptation through the mobilization of all municipal departments involved should be ensured.

Furthermore, the local authority should consider training and capacity-building to avoid delays in implementation. Municipalities with limited autonomy or opportunity for recruiting staff should draft recommendations to national authorities, including a request for suitable technicians and administrators to carry out some actions foreseen in the SEACAP.

2.2.7 Engagement of citizens and stakeholders

The involvement of relevant stakeholders, in particular Civil Society Organizations, throughout drafting and implementing the SEACAP is crucial in order to develop successful mitigation and adaptation coherence. The SEACAP should describe how each stakeholder was and will be involved during the preparation of the SEACAP document since the very first steps of the planning process until the end of the whole process, and how each will participate in the implementation and monitoring of the planned actions. Moreover, advisory groups should be created to ensure an exhaustive understanding of city specificities and problems, meet end-user expectations, guarantee a common agreement about selected indicators, and ensure a full uptake of the main outcomes and their inclusion into decision-making.

2.2.8 Financing

The SEACAP should identify the potential financing resources for each step of its development, implementation and monitoring. It should take into consideration the

financial resources needed to build capacity within the municipality and to compensate external stakeholders such as architects, consultants, banks, developers and facility management involved in elaborating the SEACAP. More details can be found in chapter 8.

2.2.9 Document submission

The covenant signatories commit to submitting their SECAPs within three years following adhesion.

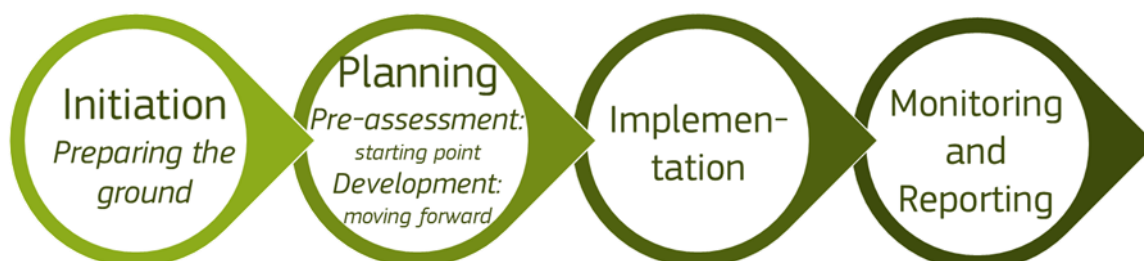
2.2.10 Monitoring and reporting

Regular monitoring using relevant indicators, followed by adequate revisions of the SEACAP allows local authorities to evaluate progress towards targets over time and adopt corrective measures if necessary. The SEACAP should briefly outline how the local authority (or relevant decision-making body) intends to ensure the follow up and monitoring throughout implementation of the planned actions. CoM SSA signatories must submit a monitoring Report every two years following the submission of the SEACAP.

2.3 SEACAP process

Figure 4 illustrates the main phases within the Sustainable Energy Access and Climate Action Plan elaboration process, while **Figure 5** includes, for each of the phases, milestones and time frame ⁽⁹⁾.

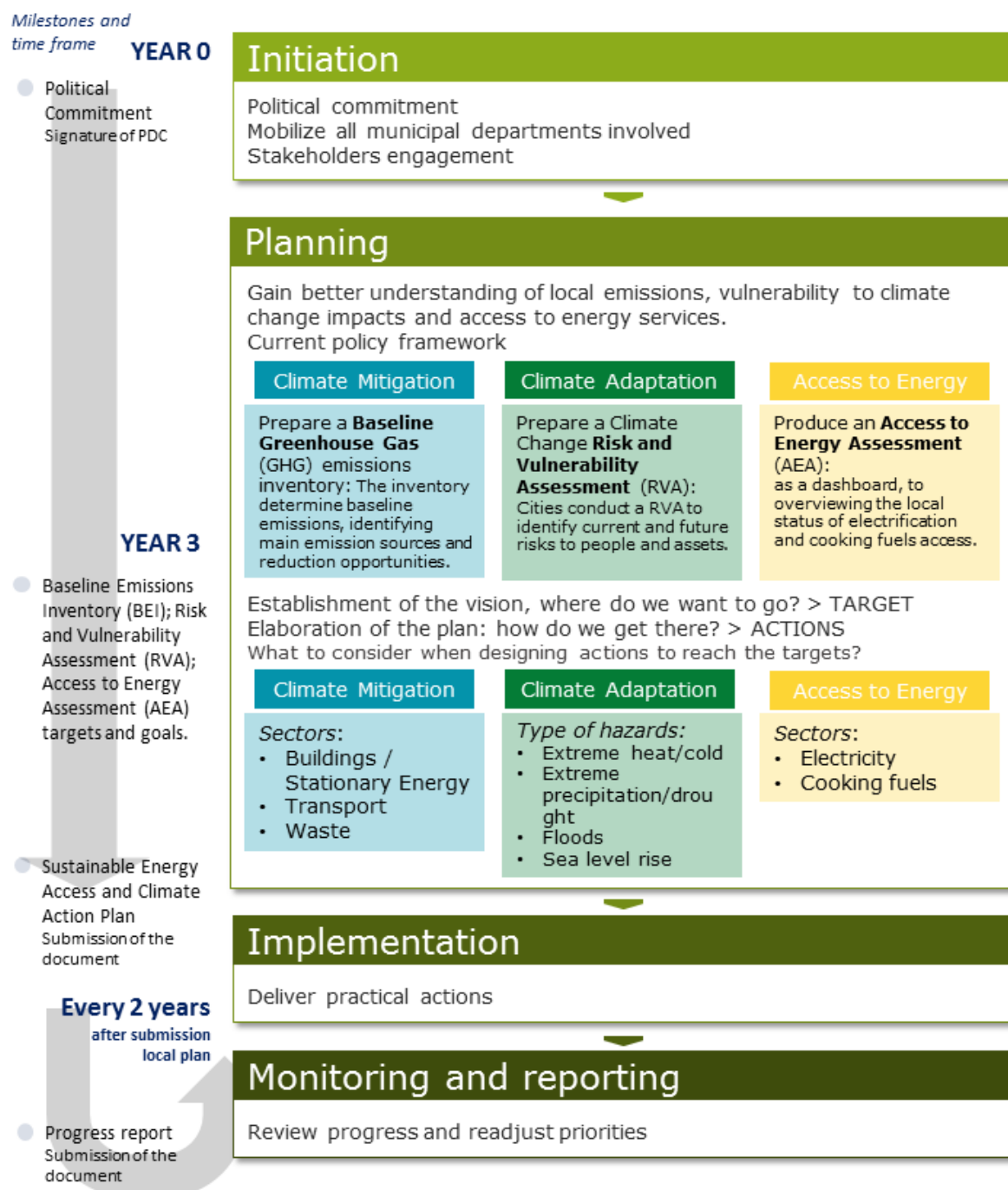
Figure 4. The SEACAP process: main phases



Source: JRC own elaboration.

⁽⁹⁾ CoM SSA reporting scheme follows the GCoM recommendations. See Annex 3.

Figure 5. The SEACAP process: main phases, milestones and timeframe.



Source: JRC own elaboration.

3 Sustainable Energy Access and Climate Action Plan (SEACAP) process:

initiation phase / preparing the ground

The SEACAP process includes several phases: initiation, planning (pre-assessment, elaboration of the plan), implementation and monitoring and reporting. Outlined below are steps and recommended measures involved in each phase. Note that some steps repeat or overlap among phases and/or may already be established or underway in a municipality. Local authorities will select and sequence the steps as appropriate to their situations.

3.1 Secure political commitment

Sufficient empowerment and support for the municipal staff in charge of the SEACAP from the highest political level is essential to its success.

Political commitment and leadership should be sought early, as they are driving forces of the overall process. The formal approval of the SEACAP by the municipal council (or equivalent body, including national authorities), along with budgets for the first year(s) of implementation, are crucial to ensure successful implementation.

The local authority is best situated to know who to contact and how to raise the political commitment needed (mayor, municipal council, ministries, national agencies, future partners, specialized committees, etc.). Before seeking this political commitment and support, ensure proposed SEACAP actions are aligned with, and even help to achieve, relevant approved regional and national plans. Doing so promotes buy-in and approval of the necessary resources from higher levels during implementation.

Establishing broad political consensus at all levels for SEACAP actions is highly recommended. It provides long-term support and stability, regardless of changes in political leadership, especially in countries where local and regional authorities depend heavily on national policies and budget.

3.2 Municipal support

The municipal council and local authority should further support the process by ensuring adequate human resources are in place to prepare and implement the SEACAP (this may require identifying, engaging and allocating, or recommending and requesting support from other levels of government to ensure the plan feasibility and success), including providing a clear mandate and sufficient time and budget. They should also involve relevant technical departments from the local authority in the SEACAP elaboration process to gain their acceptance and backing.

Other support activities within the municipal council and local authority's purview include taking steps to:

- Integrate the SEACAP vision with the actions and initiatives undertaken at the national and/or regional level;
- Make the SEACAP a part of the municipality's overall planning;
- Solicit the long-term commitment of relevant authorities and departments to implementation and monitoring;
- Foster the participation of different stakeholders, including citizens;
- Reinforce the local authority and citizen "ownership" of the SEACAP process.

Network with other GCoM signatories to share experiences and best practices, through peer to peer learning, webinars, workshops etc.

As the responsible entity and authority, the municipal council must follow the implementation process closely. For CoM signatories, municipal council approval is required. The SEACAP should be updated as necessary and the updates circulated to relevant bodies for visibility and/or approval.

3.3 Establish governance structure

Developing and implementing a SEACAP is a challenging and time-consuming process. It requires well-planned and continuous collaboration and coordination among local and higher authorities and administrative departments, such as environmental protection, land use and urban planning, economics and social affairs, buildings and infrastructure management, mobility and transport, budget and finance, procurement, internal and external communications, etc. The SEACAP process should be integrated in the everyday work of each department.

3.3.1 Local resource coordination

Having gained political commitment to the vision and approval of the planned actions, and ensured the allocation of required human and financial resources, local authorities should coordinate with the relevant authorities to adjust or develop a clear organisational structure and assignment of responsibilities. If appropriate, they can use organisational structures established for related policies in the context of the SEACAP's development and monitoring.

Sustainable energy and climate management should be integrated into other actions and initiatives of relevant municipal departments, and become part of the local authority's overall planning. Multi-departmental and cross-sector involvement is required, and their organisational targets need to be aligned with and integrated into the SEACAP.

Whenever required in the SEACAP elaboration process, adequate training should be planned for and provided in different fields, including technical competencies (energy efficiency, renewable energies, energy management, etc.), project management, data management, financial management, investment project development, and communication (how to promote behavioral changes, etc.). Lack of skills in data management can be a particular barrier to SEACAP elaboration.

3.3.2 SEACAP coordinator

Local authorities can appoint a SEACAP Coordinator at the outset of the process. If this is not possible, they may seek equivalent support through a National Coordination Group (NCG). One or more NCG member could appoint a counsellor as focal point or SEACAP Coordinator who is given the full support of local authorities and higher levels, as well as the necessary time and budget to carry out the role. In large cities, the role may require a dedicated unit of staff at its disposal (to be coordinated with the NCG). Furthermore, Covenant Territorial Coordinators (CTCs) can be appointed. CTCs are decentralized authorities, those public administrations which provide strategic guidance, financial and technical support to municipalities signing up to the Covenant of Mayors.

3.3.3 SEACAP organisational structure

Past experience recommends establishing two SEACAP groups: a steering committee (including politicians and senior managers at the city/municipality level if necessary) and a project committee (comprising people from various municipal departments, representatives of public agencies if relevant, etc.). The first will provide strategic direction and political support, while the last undertakes the actual SEACAP elaboration and follow-through to ensure stakeholder participation, organize monitoring, report progress, etc. Larger municipalities may need a core group member dedicated to data collection and BEI. The project committee may establish additional working groups, to which non-municipal stakeholders directly involved in SEACAP actions could be invited to join. Both the steering and project committees require distinct and specific objectives, functions and leaders, as well as a well-defined meeting schedule/agenda and a project-reporting strategy.

The project committee should assign responsibilities to important municipal actors to ensure strong ownership. A specific communication campaign may help to reach and

convince municipal workers in different departments. The campaign should include a citizens’ awareness promotion plan at the municipal and/or national level.

The project committee should approach government coordination bodies for further organisation/coordination assistance. Territorial coordinators are sub-national decentralised authorities, including provinces, regions and public groupings of municipalities. National coordinators are national public bodies, including national energy agencies and ministries of energy. Such organisations may be able to mobilise technical expertise for preparing the BEI, the RVA, the AEA and SEACAP, provide strategic guidance on identifying appropriate financial support, train local officials on SEACAP methodologies, link the SEACAP to regional and national policies and initiatives, and facilitate approval when necessary.

3.3.4 External support

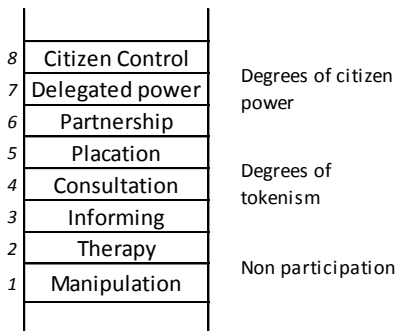
Depending on their size and human resources availability, local authorities may benefit from the assistance of local or regional energy agencies, city networks, CSOs etc. It is even possible for them to subcontract some specific tasks (e.g. compilation of a BEI or of a RVA) or to use interns (Masters or PhD students can do much of the work associated with the collection of data and entry into a GHG calculation tool to produce the BEI or to develop a RVA). Local authorities, which do not have sufficient skills or resources to draft and implement their own SEACAP, should be supported by public administrations with such capacities.

3.4 Stakeholders engagement

Citizens and other stakeholders should be invited to take part at important stages of the SEACAP elaboration process: building the vision, defining the objectives and targets, setting the priorities and defining the necessary human and financial resources. Such stakeholder involvement constitutes a formal commitment by local actors to a future vision. Whenever possible, local authorities and significant actors should define together the paths to transform the vision into action.

The level to which the citizens are engaged can be defined following the Arnstein’s ladder of citizen participation as per **Figure 6**. It helps to illustrate the point that there are significant gradations of citizen participation. Seeking the highest level of participation by stakeholders and citizens in the process is therefore highly recommended. The degree of involvement of citizen may hence vary from “informing” to “empowering”.

Figure 6. Eight Rungs on a Ladder of Citizen Participation.



Source: (Arnstein, 1969)

Simply, as can be seen from the ladder above, “*Informing*” is the stage where citizens may indeed hear and be heard, but they will still lack the power to ensure that their views will be heard and applied by the decision makers and hence there exists no

guarantee changing the actual situation. On the other hand, the envisaged level of participation, which is “*empowering*” or “*citizen control*” is the stage where citizens obtain the majority of decision-making seats and/or the full managerial power enabling them to assure the change of the current situation to their favour.

Nevertheless, and since it is not always possible to secure the highest level of participation and involvement between the citizens and the different stakeholders, it is hence recommended to achieve at least level 6 of the above mentioned ladder which is “*Partnership*” enabling them to negotiate and engage in trade-offs with the decision makers.

Box 6. Stakeholder engagement is key

- Decision-making transparency;
- A decision taken among various stakeholders is usually based on more extensive knowledge;
- Participation in planning and broad consensus on vision, strategies, goals and actions ensures their long-term acceptance, legitimacy, support, quality, viability and effectiveness;
- SEACAPs may sometimes get stronger support from external stakeholders than from the internal management or staff of the local authority.

3.4.1 Identifying the stakeholders

It is important to involve in the SEACAP process stakeholders whose interests are affected or whose activities affect the issue at stake, those who possess or control information, resources or expertise needed for strategy and/or implementation, and/or whose involvement is needed for successful implementation. Therefore, stakeholders from the following divisions should be considered:

- Local administration, relevant municipal departments and companies (e.g. municipal energy utilities, transport companies, etc.);
- Relevant representatives of national or regional administrations and/or neighbouring municipalities, to ensure coordination and consistency with plans and actions that take place at the regional and national level;
- Institutional stakeholders such as chambers of commerce, professional organizations (e.g. architects, engineers), universities, professionals and research centres, observatories, experts;
- Local and regional energy agencies, suppliers, utilities, facilities management companies, Energy Services Companies (ESCOs), supporting structures, national energy agencies;
- Financial partners, banks, private funders (including international);
- Transport/mobility actors (e.g. private/public transportation companies);
- Construction sector (e.g. building companies, developers);
- Businesses and industries, including tourism where it represents a large share of the local Authority’s CO₂ emissions;
- NGOs and other civil society representatives, including students, trade unions and consumer associations;
- Small Scale businesses and community service organisations (e.g. waste collectors);
- Informal businesses;
- Youth and women organisations.

3.4.2 Approaches and tools for stakeholders' involvement

Local authorities use various methods to involve different stakeholders (**Table 2**) according to the different levels of participation in the municipality as mentioned in **Figure 6**. Past experiences show that involving a neutral moderator during stakeholder's meetings can be useful for reaching consensus.

The roles of local authorities and potential stakeholders are summarized in **Table 3**. Many indicate long-term partnerships and require ongoing communications about SEACAP implementation to motivate and maintain the necessary stakeholder involvement. Such requirements should factor into a SEACAP communications strategy.

Table 2. Approaches and tools for stakeholders' involvement

Approach	Option 1	Option 2
Provide information and education	Informing	Brochures, newsletters, advertisement, exhibitions, site visits
Provide information and elicit feedback	Consultation	Telephone hotline, website, public meetings, teleconferences, surveys and questionnaires, staffed
Elicit involvement	Partnership	Workshops, focus groups, forums, open house
Elicit extended involvement	Delegated	Community advisory committees

Source: JRC Own elaboration.

3.5 Communication

Communication, both to expedite SEACAP actions and promote their adoption, is an essential mean of keeping external and internal stakeholders motivated and supportive. The SEACAP should include a clear communication strategy that is feasible, efficient and adapted to local needs and cultural context as well as using accessible language. Good communication is particularly essential during the implementation phase, both internally among different departments of the local authority, the associated public authorities and all those involved (e.g. local building managers), and externally with relevant stakeholders, including citizens.

A good communication plan will promote visibility, investment, awareness, behavioral change and broad support throughout implementation (an example of dissemination see **Figure 7**).

Lack of communication channels at all levels can be a major challenge. Local authorities may need to invent the necessary strategy, channels and tools and/or enlist a dedicated communications officer or external partner (schools, private sector, NGOs, etc.). Consider creating a "Citizen Awareness Promotion Plan" as part of the SEACAP communications strategy to ensure effective implementation.

Networking with other local authorities, especially CoM signatories, to exchange experiences and best practices is highly recommended. It accelerates learning and highlights the actions taken by each local authority, which may also attract investors and additional funding to support pilot and/or demonstration projects.

Box 7. Effective communication.

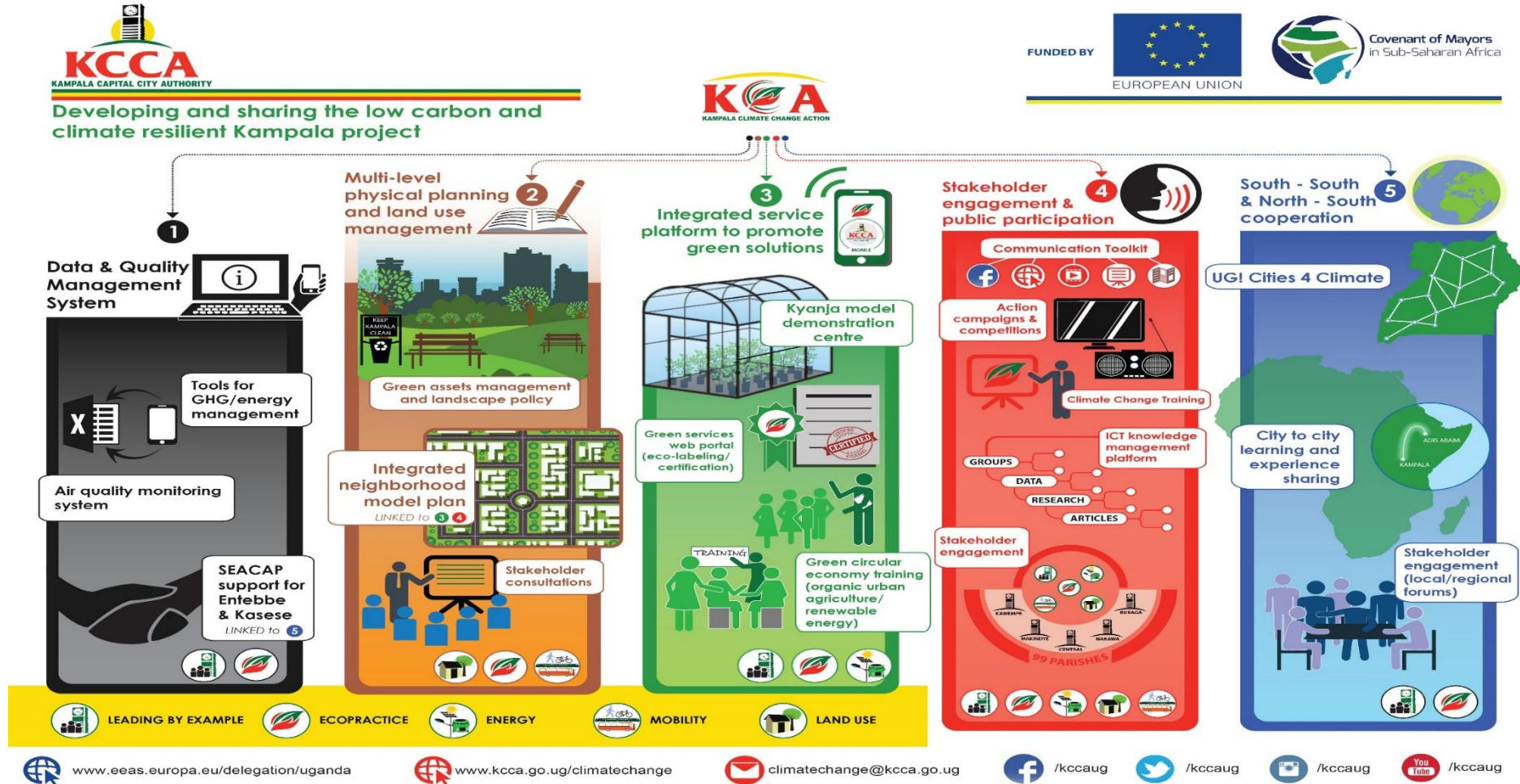
- Have a clear message to produce the desired outcome;
- Identify the audience for each message;
- Establish indicators to evaluate the impacts of the communication (Head count at a seminar, quantitative/qualitative surveys, hits on website, feedback via e-mails, etc.);
- Specify the most appropriate communication channel(s) (i.e. the most accessible and the easiest to implement and finance): face-to-face (most effective), advertising, mail, e-mail, internet, blogs, talks/meetings, brochures, posters, newsletters, printed publications, media releases, sponsorship, etc.
- Specify planning and budget;
- Set up internal communication to improve collaboration among departments.

Table 3. SEACAP process: the main steps – role of key actors (*Source:* Adapted from Guidebook CoM EU, 2018)

PHASE	STEP	ROLE OF THE ACTORS		
		Municipal council or equivalent body	Local administration	Stakeholders
Initiation	Political commitment and signing of the Covenant	Make the initial commitment. Sign the Covenant of Mayors SSA. Provide the necessary impulse to the local administration to start the process.	Encourage the political authorities to take action. Inform them about the multiple benefits (and about the necessary resources).	Awareness raising among political authorities to take action (if necessary).
	Mobilize all municipal departments involved	Allocate sufficient human resources and make sure adequate administrative structures are in place (e.g. horizontal offices ensuring collaboration amongst different departments of the administration) to ensure a coordinated action between mitigation and adaptation.		
	Build support from stakeholders and establishing a governance structure	Provide the necessary impulse for stakeholders' participation. Show that you consider their participation and support as important.	Prepare an inventory of the relevant stakeholders, decide what channels of communication/participation you want to use, establish collaboration practices. Inform them about the process that is going to start, and collect their views.	Express their views, explain their potential role in SEACAPs development and implementation.
Planning phase (Pre-assessment and development)	Assessment of the current framework: Where are we?	Make sure the necessary resources are in place for the planning phase.	Conduct the initial assessment, collect the necessary data, and elaborate the CO ₂ baseline emission inventory, the climate risks and vulnerabilities assessment and the access to energy assessment. Make sure the stakeholders are properly involved.	Provide valuable inputs and data, share the knowledge.
	Establishment of the vision: Where do we want to go?	Support the elaboration of the vision. Make sure it is ambitious enough. Approve the vision (if applicable).	Establish a long-term vision and objectives that support the vision. Make sure it is shared by the main stakeholders and endorsed by the political authorities.	Participate in the definition of the vision, express their view on the city's future.
	Elaboration of the plan: How do we get there?	Support the elaboration of the plan. Define the priorities, in line with the vision previously defined.	Elaborate the plan: define policies and measures in line with the vision and the objectives, establish budget and financing sources and mechanisms, timing, indicators, responsibilities. Keep the political authorities informed, and involve stakeholders. Make partnerships with key stakeholders.	Participate in the elaboration of the plan. Provide input, feedback. Contribute to initiating and designing the processes.
	Plan approval and submission	Approve the plan and the necessary budgets, at least for the first year(s).	Submit the SEACAP and Communicate the plan.	Put pressure on political authorities to approve the plan (if necessary)
Implementation and monitoring of the SEACAP	Implementation	Provide long-term political support to the SEACAP process.	Coordinate the implementation. Make sure each stakeholder is aware of its role in the implementation.	Each stakeholder implements the measures that are under its responsibility and shares the results.
		Make sure that the energy and climate policy is integrated in the everyday life of the local administration.	Implement the measures that are under responsibility of the local authority. Be exemplary. Communicate the actions.	Put pressure / encourage the local administration to implement the measures under its responsibility (if necessary).
		Show interest in the plan implementation, encourage stakeholders to act, show the example.	Motivate the stakeholders to act (information campaigns). Inform them properly about the resources available for EE, RES and adaptation.	Changes in behaviour, EE, RES and adaptation action, general support to SEACAP implementation.
		Networking with other CoM signatories, exchanging experience and best practices, establishing synergies and encouraging their involvement in the Covenant of Mayors in Sub-Saharan Africa.		Encourage other stakeholders to act
	Monitoring	Ask to be informed regularly about the advancement of the plan.	Proceed to a regular monitoring of the plan: advancement of the actions and evaluation of their impact.	Provide the necessary inputs and data.
	Reporting and submission of the report	Approve the report (if applicable).	Report periodically to the political authorities and to the stakeholders about the advancement of the plan. Communicate about the results. Every second year, submit a report.	Provide comments on the report and report on the measures under their responsibility.
	Review	Ensure that plan updates occur at regular intervals.	Periodically update the plan according to the experience and the results obtained and based on new opportunities. Involve political authorities and stakeholders.	Participate in plan update.

Source: adapted from: Bertoldi P. (editor), 2018. Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 1 - The SECAP process, step-by-step towards low carbon and climate resilient cities by 2030.

Figure 7. Kampala Climate Change Action



4 Sustainable Energy Access and Climate Action Plan (SEACAP) process

Planning phase : pre-assessment

This chapter provides detailed guidance throughout the pre-assessment phase of the elaboration of a SEACAP: Baseline Emission Inventory (BEI) (see sub-chapter 4.2), Risk and Vulnerability Assessment (RVA) (see sub-chapter 4.3) and Access to Energy Assessment (see sub-chapter 4.4).

4.1 Assess current policy framework on mitigation, adaptation and access to energy

Before starting the detailed planning process at the municipal level, it is recommended to review the policy framework in which the plan will be established – taking into consideration relevant international frameworks, national policies and regulations as well as existing strategies and plans at the regional and local level.

A review of the existing policy and regulatory framework is a good starting point towards better policy integration and makes sure that potential synergies or conflicting policies and procedures are addressed early on in the planning process.

A first step is to identify the existing municipal, regional and national policies, plans, procedures and regulations that affect energy and climate issues within the local authority. For example, National Adaptation Strategies serve as a good entry point for existing information on adaptation at country level. Cities sometimes can also draw on existing national RVAs and available climate projections, and may come across adaptation-related instruments, but also ongoing actions at the city level (i.e. disaster risk reduction, biodiversity protection, land use planning, existing regional or sectoral plans). Similarly, National Low Emission Development Strategies (LEDS) may provide a good overview on existing national policies, legislation, programmes and data availability related to climate change mitigation.

The next step is to go through, check and compare the objectives and goals in the identified documents with the ones for a sustainable energy policy and resilient sectoral development. The aim is to establish whether these objectives and goals are supporting or conflicting. If such conflicts are detected in policy goals, ideally they should be amended and aligned with the SEACAP goals. In order to do so, the local authority should, where possible, invite all the relevant actors and stakeholders to discuss the conflicts identified, trying to reach an agreement on the changes that are necessary to update policies and plans.

Box 8. Relevant international policy framework for SEACAP development

SUSTAINABLE DEVELOPMENT GOALS:

In 2015, more than 150 world leaders pledged common action to protect the planet and ensure prosperity for all. They adopted the new 2030 Agenda for Sustainable Development, including the Sustainable Development Goals (SDGs). Each goal has specific targets to be achieved over the next 15 years. The SDGs recognize the massive role of energy access (SDG 7) and the interdependency with other SDGs, including economic growth (SDG 8), infrastructure (SDG 9), making cities and communities more resilient and sustainable (SDG 11) and climate change (SDG 13).

SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all. Universal access to affordable, reliable and sustainable energy services requires expanding access to electricity and clean cooking fuels and technologies, as well as improving energy efficiency and increasing the use of renewable energy.

SUSTAINABLE ENERGY FOR ALL:

The Sustainable Energy for All (SE4All) is the global initiative, led by former UN Secretary General Ban Ki-moon. It is the instrumental partnership that accelerates action toward achievement of SDG7, universal access to sustainable energy by 2030, and the Paris Climate Agreement, reducing greenhouse gas emissions to limit climate warming to below 2 degrees Celsius.

Sub-Saharan African countries are members of SE4All. Around 20 of them have finalized national assessments to identify opportunities for renewable energy development, improved energy efficiency and energy access.

PARIS AGREEMENT AND NATIONALLY DETERMINED CONTRIBUTIONS:

All 54 African countries signed the Paris Agreement. Almost all (53 out of 54, Libya being the exception) submitted an INDC, covering approximately 7.5% of global emissions. Since then, 42 have ratified their Nationally Determined Contributions (NDCs)¹⁰. 34 countries mention energy access as a key enabler for development, and 15 define specific targets and measures (International Energy Agency, 2017). According to the World Bank NDC Platform, the same 53 African countries' INDCs include adaptation as economy-wide concern. 51 countries have foreseen actions in the agriculture sector, 45 countries in the water sector. 22 countries have included specific adaptation actions concerning urban areas, including on sustainable urban planning, buildings and waste management (¹¹).

In Africa, the Paris Agreement in 2015 marked a new era not only for the national governments submitting climate commitments, but also for sub-national governments since two thirds of the Nationally Determined Contributions (NDCs) submitted envisage climate action in cities and regions (Escudero et al., 2017).

NEW URBAN AGENDA:

The UN-HABITAT III conference held in Quito in late 2016 revolved around the first Sustainable Development Goal (SDG) with an exclusively urban focus. SDG 11 aims to make cities more inclusive, safe, resilient and sustainable through a range of metrics, indicators, and evaluation systems. It also became part of a post-Quito 'New Urban Agenda' (NUA). The NUA aligns with many of the SDGs: in its preamble, the NUA sets out aims to end poverty and hunger (SDG 1 and 2), reduce inequalities (SDG 10), promote sustained, inclusive and sustainable economic growth (SDG 8), achieve gender equality (SDG 5), improve human health and wellbeing (SDG 4), foster resilience (SDGs 11 and 13), and protect the environment (SDG 6, 9, 13, 14 and 15). The Agenda promotes a vision for cities that is grounded in human rights.

AGENDA 2063:

The vision of the Agenda 2063 of the African Union is "*An integrated, prosperous and peaceful Africa, an Africa driven and managed by its own citizens and representing a dynamic force in the international arena*". The call for action of the Agenda 2063 with regards to energy refers to "*harnessing all African energy resources to ensure modern, efficient, reliable, cost effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids*". Related to climate change adaptation the vision outlines that 'Africa shall have environmentally sustainable and climate resilient economies and communities.'

⁽¹⁰⁾ <https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-ndc-hub/> (accessed 12/02/2018)

⁽¹¹⁾ <http://www.worldbank.org/en/topic/climatechange/brief/the-ndc-platform-a-comprehensive-resource-on-national-climate-targets-and-action> (accessed 22/10/2018)

AFRICAN URBAN AGENDA:

There is now a growing understanding that it is impossible to deal with Africa's growth and poverty challenges without managing urbanization. Inspired by the strategy document "*Optimizing the Urban Advantage*", which emerged from the fourth edition of the African Ministerial Conference on Housing and Urban Development (AMCHUD4) in 2012, and guided by the African Union's Agenda 2063, the Africa Urban Agenda Programme (AUA) aims to raise the profile of urbanization as a force for the structural transformation of Africa.

NATIONAL URBAN POLICIES (NUPs):

An increasing number of African Governments have either adopted National Urban Policies (NUPs), or have initiated policy processes to this end. Where those exist it is recommended to include them in the policy framework review, specifically where these NUPs not only focus on socio-economic imperatives, but also address the challenges of decarbonisation, ecosystem restoration and resource efficiency (Swilling, 2015). This could make the spatial context available for green industrialization and sustainable structural transformation – the twin policy goals advocated by the 2016 Annual Report of UNECA (United Nations Economic Commission for Africa 2016) (Swilling, 2015).

4.2 Baseline Emission Inventory (BEI)

4.2.1 Principles and requirements for emission accounting

By developing a Baseline Emission Inventory (BEI) a local authority is measuring its GHG emission level in a base year, according to a common methodological approach. It identifies the principal anthropogenic sources of CO₂ (and other GHGs) emissions and prioritises the reduction measures accordingly. In these guidelines, the requirements for emission inventories and reporting outlined in the common reporting framework under the Global Covenant of Mayors for Climate & Energy (GCoM) ⁽¹²⁾ are explained, and advice and recommendations for compiling the BEI and successive monitoring emission inventories (MEIs) under the GCoM are provided.

The BEI will show where the local authority (LA) was at the beginning (in its baseline year), and the successive MEIs will show the progress towards the target set by the LA. Elaborating these reference emission inventories is of critical importance, as they will be the instrument allowing the LA to measure the impact of its Sustainable Energy Access and Climate Action Plan (SEACAP) and adjust it over time. They are also very important elements to maintain the motivation of all parties willing to contribute to the local authority's emissions reduction objective, allowing them to see the results of their efforts.

Box 9. Tips on language used

To indicate which provisions are requirements and which are optional, language is used as follows:

The term "shall" is used to indicate what is required (indicated as "mandatory").

The term "should" is used to indicate a recommendation, so is not a requirement (indicated as "recommended").

The term "may" is used to indicate an option that is permissible or allowable that local governments may choose to follow (indicated as "optional").

⁽¹²⁾ In order to ensure robust climate action planning, implementation and monitoring phases, as well as streamline measurement and reporting procedures, a set of new global recommendations have been developed by the GCoM in consultation with partners, cities and local governments around the world, with the intention of providing flexibility to meet specific local or regional circumstances. The common reporting framework can be found at: <https://www.globalcovenantofmayors.org/common-global-reporting-framework/>.

Box 10. Notation keys

Notation keys may be used to accommodate limitations in data availability and differences in emission sources between local governments. Where notation keys are used, an accompanying explanation shall be provided.

“NO” (not occurring): An activity or process does not occur or exist within the city. This notation key may also be used for insignificant sources.

“IE” (included elsewhere): GHG emissions for this activity are estimated and presented in another category in the same inventory, stating where it is added. This notation key may be used where it is difficult to disaggregate data into multiple sub-sectors.

“NE” (not estimated): GHG emissions occur but have not been estimated or reported, with a justification why.

“C” (confidential): GHG emissions which could lead to the disclosure of confidential information, and as such are not reported publicly.

The GCoM principles, concepts and methodologies to elaborate an emissions inventory are presented in 4.2.1.1, followed by recommendations and tips on the data collection of energy-related activity sectors (see 4.2.2.1.1).

4.2.1.1 Principles for emission accounting

The emission inventory should conform to the following principles:

- *Relevance*: The Emission Inventory data should allow assessing final energy consumption and CO₂ emissions by energy carrier and by activity sector. They should be relevant to the particular situation of the local authority. Signatories are encouraged to prefer local data over national estimates – whenever relevant and available – as it allows reflecting the efforts made by LAs to reach its CO₂ reduction targets.
- *Flexibility*: The methodology is based on the principles of simplicity of use and flexibility to suit various regional and local situations, and accommodate cities of various sizes and resource, reflecting the specific activities and policy-making needs of the city by taking into account its capacity and regulatory context.
- *Completeness*: The GCoM emission inventories are not meant to be exhaustive GHG inventories but to focus on emissions from final energy consumption in GCoM key sectors (see details below). In order to be complete, the emission inventories shall cover all emission sources included in the GCoM framework in these sectors.
- *Availability*: The data should allow building emission inventories until the target year. Therefore the sources of data used should be available in the future: it is important to identify from the beginning all the data sources, including departments and external stakeholders that will be able to provide data over such a long time period.
- *Accuracy*: Within the limits of possibility, the emission inventories should be accurate, or at least represent a vision of the reality. This requires, in particular, using reliable local activity data and robust methodologies, based on internationally agreed definitions, standards and emission factors, including those presented in this guidebook.
- *Consistency*: The methodology, data sources and emission factors should be in line with GCoM specifications and consistent through the years. When defining the methodology it is important to ensure a consistent choice of the different options.
- *Documentation*: The data collection process, data sources and methodology for calculating the emission inventory should be well documented, if not in the SEACAP

official document ⁽¹³⁾, then at least in the local authorities records. The methodological choices and the main aggregated results of the emission inventories used to report should be included in the SEACAP document.

4.2.1.2 Reporting requirements

The emission inventory should be elaborated based on a sound knowledge of the local situation in terms of energy and greenhouse gas emissions. The requirements for accounting the emissions in the inventory are based on the sources, the type of gases and boundary of the inventory to be reported. Each of these elements will be defined in further detail in the following sections.

Acquiring this sound knowledge may require some initial efforts by the local authority and a close collaboration with local expertise like universities, consultants and NGOs and in some cases external technical assistance. However, it should be stressed that the picture acquired is extremely useful both for the SEACAP and service delivery planning in the local government. In this respect, the SEACAP process can be complementary to existing activities and goals, particularly where capacity is constrained.

Local authorities should use **activity-based emission factors** (also referred to as IPCC emission factors), though may use **lifecycle analysis (LCA)** based emission factors where this is required for GHG emissions reporting at the national level. The emission reporting unit to be chosen is **"tonnes CO₂ equivalent"**. The emissions of other greenhouse gases than CO₂ are converted to CO₂-equivalents by using the Global Warming Potential (GWP) values (see Box 11), which shall be kept constant all along the SEACAP implementation period. At the date of the preparation of this document, **three reporting platforms are accepted in the GCoM framework**: My Covenant- the European one-, CDP and the Carbon Climate Registry (cCR).

Box 11.

Life cycle assessment

A widely used technique defined by ISO 14040 as a "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle". The results of LCA studies are strongly dependent on the system boundaries within which they are conducted. The technique is intended for relative comparison of two similar means to complete a product. The approach considers the overall life cycle of the fuels/electricity. This includes all emissions of the energy chain that also take place outside the territory (such as transport losses, refinery emissions or energy conversion losses). It is particularly suitable for assessing potential trade-offs between different types of environmental impacts associated with specific policy and management decisions, as it includes the emissions from the whole supply chain and not only from the final combustion. This is of special relevance for biofuels and biomass ⁽¹⁴⁾.

Activity based approach

In the activity-based approach, all the direct GHG emissions or indirect emissions (due to consumption of grid supplied energy) are included. The GHG emissions are directly estimated from the carbon content of the fuel, though a small amount of carbon is un-oxidized (less than 1 %). It is the approach used for the national reporting in the frame of UNFCCC. Most of the GHG emissions are CO₂ emissions, whereas emissions of CH₄ and N₂O are of secondary importance for the combustion processes in the residential and transport sectors.

The **geographical boundaries** of the "local territory" are the administrative boundaries of the entity (municipality, region) governed by the local authority which is a signatory to

⁽¹³⁾ See chapter 5 of this guidebook for further details on how to elaborate a SEACAP.

⁽¹⁴⁾ In these guidelines, biofuel refers to all liquid/gaseous biofuels and biomass to solid biomass.

the GCoM, and shall remain the same boundary for consistent inventory comparison over time.

4.2.1.2.1 Type of emissions to be included

Local authorities shall account for emissions of the following gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)⁽¹⁵⁾. The three main sources of GHG emissions to be potentially included in the emission inventory are ⁽¹⁶⁾:

- 1) **Direct emissions** due to fuel combustion in the buildings, equipment/facilities and transportation sectors within the city boundary. These emissions physically occur inside the city boundary ⁽¹⁷⁾.
- 2) **non-energy related:** Other direct emissions that are not related to fuel combustion, including: fugitive emissions from disposal and treatment of waste (including wastewater) generated within the city boundary, which may occur inside or outside the city boundary ⁽¹⁸⁾, and; fugitive emissions from natural gas distribution systems (such as equipment or pipeline leaks).
- 3) **Indirect emissions** due to consumption of grid-supplied energy (electricity, heat or cold) within the geographic boundary ⁽¹⁹⁾. Depending on where energy is generated, these emissions may occur inside or outside the city boundary.

The points 1) and 2) refer to emissions that physically occur in the local territory. Inclusion of these emissions follows the principles of the IPCC used in the reporting of the national GHG inventories to the United Nations Framework Convention on Climate Change (UNFCCC, 2017).

4.2.1.2.2 Emission sources

Under the GCoM, **LAs shall consider all categories of emission sources and report all emissions that are significant**. Exclusion of emission sources shall be disclosed and justified, using notation keys. Local authorities shall report activity data ⁽²⁰⁾ and emission factors for all sources of emissions, disaggregated by activity / fuel type. Based on these principles, **LAs shall report GHG emissions from main sectors reported in the following (Table 4)**.

LAs should also report GHG emissions from Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU) sectors where these are significant ⁽²¹⁾.

⁽¹⁵⁾ When reporting IPPU, it will include hydro fluoro carbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆), and nitrogen trifluoride (NF₃).

⁽¹⁶⁾ Emissions from biogenic carbon are not required to be reported

⁽¹⁷⁾ These are often referred to as Scope 1 emissions in some other commonly used GHG inventory standards

⁽¹⁸⁾ Emissions occurring outside the city boundary as a result of city activities, such as emissions from waste generated by the city but treated outside the city boundary, are often referred to as Scope 3 emissions in some other commonly used GHG inventory standards.

⁽¹⁹⁾ These are often referred to as Scope 2 emissions in some other commonly used GHG inventory standards

⁽²⁰⁾ Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time (e.g., volume of gas used, kilometres driven, tons of solid waste sent to landfill, etc.).

⁽²¹⁾ Guidance note accompanying the Global Covenant of Mayors Common Reporting Framework

Table 4. Emission sources to be included in the emission inventory

Type of Emission sources	
Stationary energy	All GHG emissions (direct emission from fuel combustion and indirect emission due to consumption of grid-supplied energy) occurring in stationary sources within the local authority boundary shall be reported. These emissions come from final energy consumption in residential, commercial and institutional buildings and facilities, as well as from industrial buildings and facilities ⁽²²⁾ and agriculture/forestry/fisheries. GHG emissions from sources covered by a regional or national emissions trading scheme (ETS), or similar, should be identified. GHG emissions from "energy generation" industries should not be reported under this sector to avoid double counting of emissions. All fugitive emissions within the city boundary shall be reported.
Transportation	All GHG emissions (direct emission from fuel combustion and indirect emission due to consumption of grid-supplied energy) occurring for transportation purposes within the local authority boundary shall be reported. In addition, local authorities shall where possible further disaggregate by mode: on-road, rail, waterborne navigation and off-road and it is recommended to disaggregate road and rail travel by fleet type: municipal, public, private and commercial transport. Local authorities may use the "fuel sales", "geographic (territorial)", "resident activity" and "city-induced" methodologies to estimate activity data in the transport sector (see section 4.2.2.2 for further details).
Waste / Other non - energy related	All GHG emissions non-energy related from disposal and treatment of waste and wastewater generated within the city boundary shall be reported and disaggregated by treatment type. Where waste/wastewater is used for energy generation, emissions should not be reported under this sector to avoid double counting of indirect emission (instead the notation key IE should be used).
Energy Supply	All GHG emissions from generation of grid-supplied energy within the local authority boundary, and all GHG emissions from generation of grid-supplied energy by facilities owned (full or partial) by the local authority outside the local authority boundary shall be reported, disaggregated by electricity-only, CHP and heat/cold production plants. <i>To avoid double counting, these emissions will not be part of the total direct emissions, but accounted through the local emission factor for indirect emissions.</i> In addition, local authorities are recommended to report all activity data for distributed renewable energy generation.

Source: JRC own elaboration.

4.2.2 Emissions inventories

For some activities, local governments may be able to use direct measurements of GHG emissions (e.g., through use of continuous emissions monitoring systems at power stations). However, for most emission sources, local governments will need to estimate GHG emissions. To build the emission inventories, the GHG emissions from final energy consumption are calculated for each energy related activity sector, by multiplying the activity data by the emission factor per energy carrier (electricity, heat/cold, fuels).

Box 12. How to calculate the GHG emissions from the activity data?

(Equation 1)
$$\text{GHG Emissions} = \text{Activity data} \times \text{Emission factor}$$

⁽²²⁾ This includes all emissions from energy use in industrial facilities, construction activities, and energy industries, except emissions from the generation of energy for grid-distributed electricity, steam, heat and cooling.

Activity data quantifies the human activity occurring in the local territory.

Examples of activity data are: amount of natural gas used for space heating in residential buildings, measured in MWh; distance travelled by private car journeys, measured in vehicle kilometres travelled (VKM); amount of waste sent to landfill, measured in Tonnes. The main activity data in the GCoM key sectors are related to final energy consumption, disaggregated per type of energy carrier. The energy carrier refers to the form of energy input (electricity, heat/cold, fossil fuels, municipal waste or renewable energy) required by the energy-related activity sectors of the society to perform their functions.

Emission factors are coefficients which quantify the emissions associated with each unit of activity, for example: amount of CO₂ emitted per litre of petrol combusted, amount of CH₄ emitted per tonne of waste sent to landfill. The local authority can either use local emission factors (based on the detailed properties of the fuels used) or default (national/global) emissions factors, such as the IPCC (2006).

In order to ensure the consistency of the time-series, the local authorities using national/global EFs shall apply the same emission factors to all inventories (base year and monitoring years), in order to identify the changes in local emissions that are due to local mitigation actions. Only when local emission factors reflecting changes in the fuel properties are used, may different emission factors be used in the emission inventories.

The carbon content may vary considerably both among and within primary fuel types on a per mass or per volume basis. Converting the amount of consumed fuel to energy units using Net Calorific Values ⁽²³⁾ (NCV) allows aggregating all the data. NCV values for different types of fuels are available as default (IPCC, 2006) and country specific (e.g., IEA, 2017) values. All the energy related activity data shall be reported in MWh. The conversion factor from the other commonly used energy units is provided in **Table 5**.

Table 5. Conversion table of basic energy units

To	TJ	Mtoe	GWh	MWh
From	Multiply by:			
TJ	1	2.388×10^{-5}	0.2778	277.8
Mtoe	4.1868×10^4	1	11630	11630000
GWh	3.6	8.6×10^{-5}	1	1000
MWh	0.0036	8.6×10^{-8}	0.001	1

Source: JRC Own elaboration.

The following sections provide recommendations and tips, based on GCoM key concepts and guiding principles for building an emission inventory for the data collection regarding local sources of GHG in the GCoM activity sectors.

4.2.2.1 Buildings/ stationary energy

The stationary energy sources are among the largest contributors to energy consumption in urban areas and also the sectors on which local authority has generally a large degree of influence. The focus of the GCoM is to reduce direct and indirect emissions in these sectors. The following subsectors are mandatory and thus shall be covered in the emission inventory (**Table 6**).

⁽²³⁾ A calorific value is a conversion factor (e.g. in MWh/t, MJ/l) used to convert a fuel quantity between natural units (mass or volume) and energy units (energy content).

Table 6. Buildings/stationary sources accounted in the emission inventory.

Buildings/Stationary energy Sector	
Subsector	Description
Institutional / Municipal buildings and facilities	All final energy consumption and related GHG emissions occurring in buildings and facilities public or owned by the local authority for cooking, heating & cooling, lighting and appliances usage; e.g. government offices, schools, police stations, hospitals, public lighting. All final energy consumption (and related GHG emissions) due to operation (ex. electricity for pumping, natural gas for heating, etc.) of municipal water supply system, solid waste and wastewater treatment and disposal facilities are also included here. All non-energy related emissions (e.g. methane) produced in these facilities shall be reported under Waste sector.
Commercial/ Tertiary buildings and facilities	All final energy consumption and GHG emissions occurring in buildings and facilities of the tertiary sector (services) cooking, heating & cooling, lighting and appliances usage; e.g. offices of private companies, banks, commercial and retail activities, private schools, hospitals, etc. All final energy consumption (and related GHG emissions) due to operation (ex. electricity for pumping, natural gas for heating, etc.) of private water supply system, solid waste and wastewater treatment and disposal facilities are also included here.
Residential buildings	All final energy consumption and GHG emissions occurring in buildings (including informal settlements and social housing) that are primarily used as residential buildings for cooking, heating & cooling, lighting and appliances.
Industrial Buildings and facilities	All energy consumption and GHG emissions occurring in industrial (manufacturing and construction industries) buildings and facilities. Also GHG emissions from sources covered by a regional or national emissions trading scheme (ETS), or similar (e.g. above 20 MW as thermal energy input), should be identified. Energy generation industries should not be reported here (to avoid double counting).
Agriculture/Forestry /Fisheries	Emissions from energy use in agriculture, forestry and fishing activities, including energy use associated with plant and animal cultivation, afforestation and reforestation activities, and fishery activities. This could include for example the on-site operation of farm vehicles and machinery, generators to power lighting, pumps and heaters.
Fugitive emissions ⁽²⁴⁾	All fugitive emissions from the extraction, transformation and transportation of primary fossil fuels within the city boundary, including: 1)Fugitive emission from mining, processing, storage and transportation of coal 2)Fugitive emissions from oil and natural gas systems, such as equipment or pipeline leaks, evaporation and flashing losses, venting, flaring, incineration, and accidental releases etc.

4.2.2.1.1 Activity data collection

Collecting information from every individual energy consumer within the local territory is not always possible or practical. Therefore, a variety of approaches are likely to be needed to develop an estimate of energy consumption. Several options are available, and often a combination of them is necessary to have an overall picture of the energy consumption within the local territory (**Table 7**). Before starting the data collection process, it is recommended to investigate if there are already national or regional mechanisms, which could help to collect relevant data for the building of the local GHG inventory (see **Figure 8**).

⁽²⁴⁾ This is usually a small emission source in a city. Emissions data may be directly measured at facility level, or cities can estimate emissions using default emission factors from national inventories or the IPCC.

Table 7.Steps of the activity data collection

STEP	ACTION
1	Getting data for municipal/institutional buildings and facilities
2	Getting data from regional/ national sources
3	Getting data from the market operators
4	Getting data from a consumer survey
5	Making and reporting estimates

Source: JRC own elaboration.

Step 1 - Getting data for municipal/institutional buildings and facilities

Firstly, the local authority should be able to collect accurate and comprehensive final energy consumption data related to its own buildings and facilities. Well-advanced local authorities already have a full energy accounting system in place. For other local authorities who have not yet initiated such a process, the energy data collection could require the following steps (Table 8).

The local authority should be able to collect all data regarding public lighting. If it is not the case, an identification and data collection process similar to the one indicated in the previous paragraph may have to be initiated. In some cases, it may be necessary to place additional meters, for instance when an electricity supply point feeds both public lighting and building/facilities.

Table 8. Activity data collection in 6 steps for municipal/institutional buildings and facilities

STEP	ACTION
1	Identify all buildings and equipment/facilities owned/managed by the Local Authority
2	Identify all energy delivery points (electricity, natural gas, heat from district network, fuel oil tanks...)
3	Identify the person / department receiving the invoices and energy data
4	Organise a centralised collection of these documents/data
5	Select an appropriate system to store and manage the data (a simple spreadsheet or elaborate software)
6	Make sure the data is collected and introduced in the system every year. Tele measurement can ease the process of data collection.

Source: JRC own elaboration.

Note that this process of data collection may be the opportunity to deal with other important energy related issues:

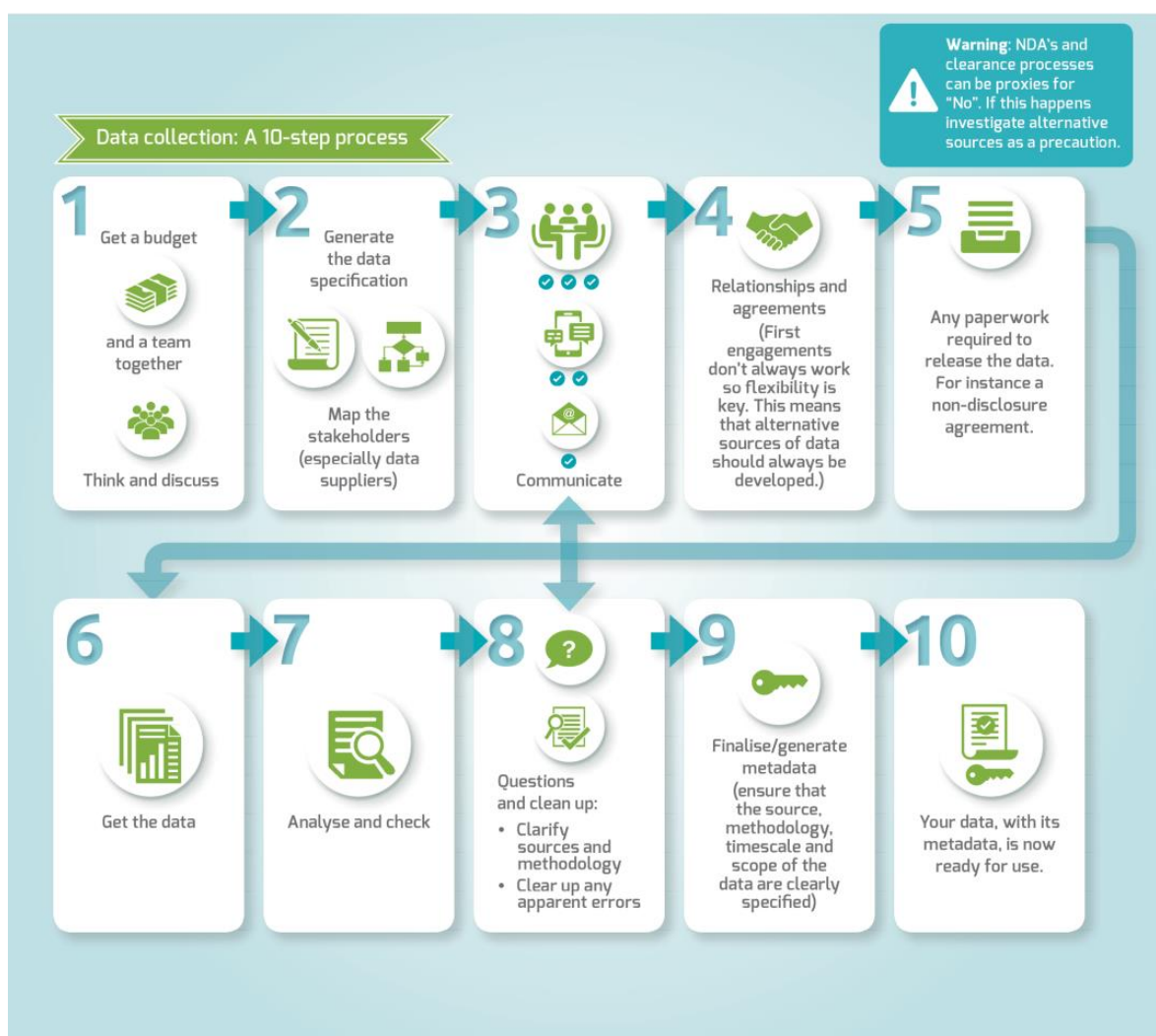
- Rationalise the number of energy delivery and invoicing points; regarding heating oil or other energy carriers delivered periodically as bulk, it is often preferable to install a measurement device (gauge, metre ...) to help determine exactly the quantity of energy consumed during a given period. An alternative is to assume that the fuel purchased each year is equal to fuel consumed. This is a good assumption if the fuel

tanks are filled at the same period each year, or if many deliveries of fuel occur each year.

- renew/improve contractual arrangements with energy suppliers; if the local authority buys electricity from renewable sources with guaranteed origin or similar, this will not affect its energy consumption, but it may be counted as a bonus to improve the CO₂ emission factor.
- Initiate a real energy management process within the local territory: identify buildings which consume most energy and select them for priority action, such as daily/weekly/monthly monitoring of energy consumption allowing identifying abnormalities and taking immediate corrective action.

A useful practical step-by-step guidance to energy and emissions data collection has been outlined by the COM SSA:

Figure 8. Step by step guidance



Source: Covenant of Mayors in Sub-Saharan Africa (CoM SSA).

Guide available at <http://comssa.org/wp-content/uploads/2018/07/data-collection-low-res.pdf>.

Step 2 - Getting data from regional/ national sources

National central databases and tools:

Before starting the activity data collection process, it is valuable to check what local data is already available at regional or national level (from statistical, energy, environmental or economic ministries or agencies or from regulatory authorities for gas and electricity). Table 9 provides examples of regional/national data centres providing energy and GHG emissions data to the local authorities (**Table 9**).

Table 9. Examples of regional/national energy data collection.

Data source	Description
Système d'information énergétique	Specific energy information systems have been established in the following countries (as part of the SIE-Africa project): Benin, Burkina Faso, Cameroon, Congo, Ivory Coast, Guinea Bissau, Mali, Niger, Central African Republic, Democratic Republic of Congo (DRC), Senegal, Togo. https://www.siequinee-dne.org/ ; www.sie-energie.gouv.sn ; www.sie-niger.ne ; www.sie-togo.tg ; https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/sie-afrique_phase_ii_sie_senegal_2006_fr.pdf
Sources of African Energy Data	National statistics systems Specialized African Energy Institutions https://afrec-energy.org/En/index.html (African Energy Commission)
International energy emission databases providers	International Energy Agency: https://www.iea.org ; Africa energy outlook: https://www.iea.org/publications/freepublications/publication/WE02014_AfricaEnergyOutlook.pdf United Nations: https://unstats.un.org/unsd/energy/ ; Technology need assessment http://unfccc.int/ttclear/tna ; State of African cities 2014: https://unhabitat.org/state-of-african-cities-2014/ World Bank: http://www.worldbank.org/ ; OPEC: https://www.opec.org/opec_web/en/index.htm ; The Emissions Database for Global Atmospheric Research: http://edgar.jrc.ec.europa.eu/# ; World Resources Institute : http://datasets.wri.org/dataset/cait-country Global Environment Facility: https://www.thegef.org/ ;

Source: JRC own elaboration.

Step 3 - Getting data from the market operators

In order to get data from market operators, local authorities have to identify which suppliers are active on their local territory and prepare a table that they would have to fill. As several energy suppliers may be active, it may be simpler to contact grid operators (for heat, gas and electricity) whenever possible (it is not very likely that more than one of them is active on the local territory, for each energy carrier).

Because such data is generally considered as commercially sensitive, in the best case it will probably be possible to only get aggregated data. Ideally, a disaggregation between the residential, tertiary and industry activity sectors, for the different energy carriers (electricity, fuelwood...) for all the postal code(s) that relate to the local municipality should be obtained.

If a greater level of disaggregation is available, then it is recommended to ask for it (e.g. to distinguish between the various sub-sectors for services and industry, private or public, individual houses or apartments).

Other interesting information relates to the names and addresses of the largest energy consumers within the local territory, and their overall energy consumption (individual energy consumption is not likely to be available as it would be commercially too sensitive). This may be useful for targeted actions and questionnaires (see step 4).

In the absence of an established practice at national level, it is highly recommended to require that the communicated results are delivered with detailed information on the assumptions made when aggregating the results (e.g. the definition of the sectors). This information should be useful for the supplier when repeating the procedure for the subsequent inventories and should be stored and used in further correspondence during the monitoring phase.

Step 4 - Getting data from a consumer survey

If all data cannot be obtained in the desired format from the market operators or from other entities, it may be necessary to make some inquiries directly to the energy consumers, in order to obtain the missing data. This is especially the case for energy carriers which do not pass through a centralised grid (fuel oil, wood, natural gas supplied in bulk, etc.). If it is not possible to identify all suppliers active in the local territory and to get data from them, it may be necessary to ask the consumers themselves.

It is worth bearing in mind that energy or statistical agencies may already be collecting such data, so make sure that data is not available elsewhere before considering sending a questionnaire.

Several options are possible:

- For sectors where there is a large number of small consumers (like the residential sector), it is recommended addressing a questionnaire to a representative sample of the population (depending on the size of the population ⁽²⁵⁾), spread over all districts of the Local Authority. The questionnaire may be on-line, but in this case make sure that this does not prevent some categories of customers from providing data, otherwise the results will be biased.
- For sectors where the number of players is limited, it may be worthwhile addressing the questionnaire to all energy consumers (this may be the case for example for the industrial sector).
- For sectors where there is a great number of players, but where there are some large ones (e.g. tertiary sector), it may be worthwhile making sure to address the questionnaire at least to all large players (e.g. all supermarkets, hospitals, universities, housing companies, large office buildings, etc.). Their identification can be done through knowledge, statistical or commercial data (such as telephone directories) inquiry to the grid operator (ask who are the main electricity/gas consumers in the local territory). Another option to identify large electricity consumers is to ask grid operators the identity of all consumers connected to the middle and high voltage distribution networks (or even to the transmission network in some rare cases).

What to ask?

It may be tempting to ask a lot of questions in the questionnaire (e.g. "is your building insulated?", "do you have solar panels?", "have you recently done energy efficiency improvements?", "do you have air conditioning?" etc.).

However, it should be kept in mind that it is very important to keep the questionnaire simple and short (ideally not more than 1 page), in order to obtain a satisfactory rate of answers. Besides the type and quantity of energy consumed and eventual local energy production (renewable, CHP, ...), 1 or 2 questions related to indicators of energy consumption (e.g. floor space (m²) of a building, number of inhabitants, number of pupils in a school) could be included for comparison or extrapolation purpose. For industry or services, ask the branch they belong to (propose some categories, if possible). For the residential sector, it is useful to ask questions that would allow extrapolation of the collected data. This depends on what kind of statistical information is available at the municipal level. It could be for example: household size (number of occupants), class of revenue, location (postal code and/or rural/urban area), dwelling type (detached house, semi-detached house or apartment), size of the dwelling (m²), etc.

⁽²⁵⁾ Using sample size calculator, e.g. <https://www.checkmarket.com/sample-size-calculator/>

Box 13. Tips to build a questionnaire

Make sure the questions are clear and precise so that they will be understood by all in the same manner. Provide some short instructions if necessary.

- To increase the amount and quality of answers, inform clearly about the purpose of the questionnaire (energy statistics and not tax purpose for example). Motivate people to answer (for example, inform that the questionnaire allows to measure progress in reaching the CO₂ reduction objectives of the local authority, or provide any other relevant incentive).
- Make the inquiries anonymous (especially in the residential sector) and explain that the data will be kept confidential.
- Do not hesitate to send reminders to those who do not reply on time, in order to increase the rate of answers; and to call directly the largest energy consumers to make sure they reply.
- Make sure that the collected data sample is representative of the population both in terms of the number of people surveyed but also in coverage of income groups. You should be aware that the response rate is generally low and those who respond are generally the most educated and climate-aware, and therefore there is the risk that the data collected is strongly biased, even if the questionnaire was addressed to a representative sample of the population. To avoid this, it may be advisable to organise data collection via face-to-face or phone interviews, especially in the residential sector.
- Decide in advance what you want to do with the data collected, to make sure that you really ask the useful and necessary questions.
- Decide whether using paper-based or digital questionnaires. Collecting data with paper questionnaire is easier but time consuming when it comes to analysing the data. Digital questionnaires simplify data processing but require having adequate equipment. Consider the possibility to partner with national institutions to get access to this equipment (e.g: the CIG in Benin). Do not hesitate to get the help of specialists (statisticians, incl. from local universities) to design your inquiry. It is advisable to communicate in advance your aims (SEACAP development) through the local media, explaining the context and expected benefits for your local community.
- Make sure to keep adequate record of the metadata (methodology, timescale and scope of the data collected).

What to do with the data?

Generally speaking, data collected via questionnaires should help the local authority to construct the energy and CO₂ data related to the local territory. Here are few examples of possible usages:

- Aggregated data should be broken down into sectors and sub-sectors, in order to target the actions and measure the results achieved by different target groups.
- Fuels ratios obtained from the sample can be used to assess the overall energy consumption for each individual fuel. For example if the overall energy and gas consumption for a given sector is available, but not the heating fuel oil consumption, the electricity/fuel oil ratio or the natural gas/fuel oil ratio of the sample can be extrapolated to the whole population, provided that the sample is representative.
- Data on the energy consumption per square metre or per inhabitant in the household sector for different types of buildings and different classes of revenues can be extrapolated to the entire sector using relevant local statistical data.

Ideally, this kind of exercise should be done with the help of statisticians to make sure the data collected and method of extrapolation provide results that are statistically

meaningful. In addition, checks should be carried out to make sure that the overall results are compatible with the data available at a more aggregate level.

Step 5 - Making and reporting estimates

The energy consumption estimated from the data collected will then need to be disaggregated (e.g. between biofuels/non biofuels fractions) or aggregated into the GCoM energy carriers categories and activity sectors. Only if energy consumption data cannot be disaggregated between all above individual activity sectors, aggregated data can be reported at the level of the macro-sector.

The level of energy consumption and related CO₂ emissions in buildings is linked to a significant number of parameters related to constructive design and the usage of the facilities. The main variables on which it is convenient to undertake actions to reduce the energy consumption are:

- Geometry, orientation, urban design and functional design of the building;
- Usage patterns and levels of indoor comfort;
- Building envelope, such as insulation, windows and solar protections;
- Equipment and systems, such as type of heat boilers, air conditioners and lighting;
- On-site energy production and renewable energy sources (RES), such as photovoltaic (PV) and thermal collectors;
- Building automation and control systems, able to continuously monitoring, analysing and adjusting the energy usage.

4.2.2.1.2 Final energy consumption in the building stock

Key aspects in the assessment of the final energy consumption in the building stock are the following:

- Share of built up areas in residential sector (formal/informal), commercial and industrial sectors;
- Share of households with access to electricity; share of households using fuelwood and or charcoal;
- Typology of the existing building stock: end-usage (residential, commerce, services, social...), age, thermal insulation and other energy-related characteristics, energy consumption and trends (if available), protection status, rate of renovation, tenancy, etc.;
- Characteristics and energy performance of new constructions and major renovations; minimal legal energy requirements for new constructions and major renovations;
- Existence of initiatives for the promotion of energy efficiency and deployment of renewables in the various categories of buildings. What results have been achieved?

Two methods are available for estimating the final energy consumption in the building stock ⁽²⁶⁾:

- Scaling national data: the share of final energy consumption in the local authority per type of energy carrier (charcoal, electricity, etc.) is similar to the share of the national energy consumption.

$$\text{Activity data at municipal level} = \frac{\text{Local Authority population}}{\text{National population}} * \text{Activity data at national level}$$

- Bottom up approach: The method is based on the survey of the households within the local authority, and it can be relatively simple to apply. This approach requires more data collection and analysis than the scaling method, but also provides far more useful information to guide local policy and planning. There are relatively simple to more sophisticated ways to apply to this method, but all are usually based on the following parameters:

⁽²⁶⁾ http://www.cityenergy.org.za/uploads/resource_461.pdf

- The shares of energy carriers used (fuelwood, charcoal, electricity, etc.) per type of end-use services (i.e. cooking, lighting and heating & cooling);
- The fuel consumption (actual in-use or alternatively national statistics) of each type of energy carrier (e. amount of charcoal sales [kg/year] or electricity sales [kWh/year]).
- The Net Calorific Value (NCV) of the fuel [e.g. in kWh/kg] (conversion factor) are available as default values (IPCC, 2006).

In order to ensure the overall consistency of the GCoM methodology, it is suggested using the equation below, which can be applied with limited effort by all GCoM signatories, as a basic approach to assess the energy consumption by type of energy carrier:

Box 14. How to estimate the activity data?

Equation 2.

Activity data = % share of energy carrier per end use service **X** fuel consumption **X** NCV

Example of calculation of energy consumption in the stationary energy sector

An example of the application is given in the following. Where data is missing, fuel sales data could be used by cities. However, this proxy should always be completed with local data or estimates, in order to better allow identifying local mitigation actions.

Population of the local authority: 1,127,900 inhabitants;

Number of households (population divided per 5): 225,380 households;

The shares of energy carriers used (fuelwood, charcoal, electricity, etc.) per type of end-use services (i.e. cooking, lighting and heating & cooling), can be derived from national statistics, or from local authority surveys.

Share of energy carriers in the residential sector (in %)	Cooking	Lighting and appliances	Heating & cooling	Total
fuelwood	21%	0%	2%	23%
charcoal	43%	0%	5%	48%
other (LPG, kerosene)	13.5%	0%	1.5%	15%
electricity	3%	10%	1%	14%
All fuels	80%	10%	10%	100%

The amount of the energy intensity can be derived from national statistics or fuel sales in the local territory from market operators.

Amount of energy carriers used in the residential sector	Cooking	Lighting and appliances	Heating & cooling	Net Calorific Value (kWh/kg)
fuelwood (kg/household)	223	-	25	4.33368
charcoal (kg/household)	246	-	27	8.1951
other (LPG, kerosene) (kg/household)	48	-	5.3	13.14
electricity (kWh/household)	140	466	65	

Assessment of the total amount of the energy consumption per type of fuel.

Estimated energy consumption per energy carrier	Assessment	Total (MWh/year)
fuelwood (kg/household)	= fuelwood (kg/household) x NCV x number of households	241,543
charcoal (kg/household)	= charcoal (kg/household) x NCV x number of households	504,091
other (LPG, kerosene) (kg/household)	= other (kg/household) x NCV x number of households	157,528
electricity (kWh/household)	= electricity (kWh/household) x number of households	46,208
Total		949,371

4.2.2.1.3 Emission factors

Local authorities can use country specific emission factors or develop own emission factors, based on the detailed properties of the fuels used within the local territory when calculating their local CO₂ or GHG emissions as long as such local data are available and reliable.

Reporting weighted EFs ⁽²⁷⁾ is needed to allow the automatic calculation of CO₂ or CO₂-eq emissions, that are as close as possible to the ones estimated in the BEI as published in their SEACAP official document, for each key sector. The local authorities shall also update these factors during the monitoring phase in case of changes in the composition/properties of the energy carriers consumed locally. This is particularly important for municipal wastes, for which both the supply chain and combustion process are often under the direct control or responsibility of the municipality. In such cases, it is important to account for the changes in the composition and treatment (plant) phases of the waste management process.

Further guidance on emission factors that better reflect the fuels used in their territory or on how estimating GHG emissions using activity-based and LCA approaches, are available from:

- IPCC (IPCC, 2006) default emissions factors, which can be used when country-specific data are unavailable (Annex 9).
- IPCC (IPCC, 2006) report, which provides general guidance for acquiring and compiling information from different sources and for applying the default emission factors. (<http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>)
- EFBD Emission Factor Database (<http://www.ipcc-nggip.iges.or.jp/EFDB/main.php>), which is a recognised library, where users can find additional emission factors and other parameters with background documentation or technical references.
- The EPLCA European Platform on Life Cycle Assessment (<http://eplca.jrc.ec.europa.eu/>).
- The JRC ILCD Handbook (Wolf et al., 2012).

The estimation of the local emissions may significantly vary according to the i) methodological approach, ii) the emission factors and iii) the greenhouse gases selected.

- The local authority can choose between the activity-based approach (recommended), in line with IPCC principles (i.e., only including the emission

⁽²⁷⁾ In some cases the local authority shall calculate weighted emission factors for reporting. This is the case when: a) The same energy carrier has different emission factors in different activity sectors or b) An energy carrier included in the final energy consumption section of the inventory includes aggregated data for two or more local energy carriers with different emission factors, the shares of which vary across activity sectors.

occurring during fuel combustion), or the LCA approach (including the emissions from both fuel combustion and the supply chain).

- ii. After selecting the emission inventory approach, the local authority can either use default emission factors or choose emission factors that are considered more appropriate.

The activity-based emission factors depend on the carbon content of the fuels and therefore do not vary significantly from case to case. In the case the LA would prefer to use its own factors, it should ensure that they are in line with the recommendations provided in IPCC (2006) guidelines on energy (<http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html>). EFs and GWP values for the fossil fuels are expected to remain constant over the monitoring period (i.e. the same reference should be used for both base year and progress monitoring years).

In order to calculate the indirect CO₂ emissions to be attributed to grid supplied energy, Covenant developed a specific methodology of estimating the local emission factor for electricity (EFE) taking into account the following components: the National emission factor for electricity consumption (NEFE); the indirect emissions from local electricity production (LPE) and the purchase and sale of Certified Electricity (CE) (see for further details in the annex 4).

- iii. The local authority has the choice to account for CO₂ emissions only or also include CH₄ and N₂O GHG emissions in the BEI/MEI. If CH₄ and N₂O are included, it is recommended to apply the IPCC Fourth Assessment Report (IPCC, 2007), Global Warming Potential (GWP) values (also used for the national inventory reporting in the so-called *Annex I countries* under the UNFCCC (2013)) in order to convert emissions of these GHGs into CO₂ equivalent (CO₂-eq). However, the LA may decide to use other IPCC GWP values. Notably, for consistency and comparability, the signatories having already built their BEI in the frame of their commitment to the 2020 target, using IPCC Second Assessment report (IPCC, 1995) GWP values are recommended to keep on using (e.g. for MEI) the same GWP values (**Table 10**).

Table 10. IPCC (1995) and IPCC (2007) GWP values

		IPCC (1995)	IPCC (2007)
Greenhouse gas	Mass of GHG in (tons)	Mass of GHG (tons CO ₂ -eq)	Mass of GHG (tons CO ₂ -eq)
Carbon dioxide	1 t CO ₂	1 t CO ₂ -eq	1 t CO ₂ -eq
Methane	1 t CH ₄	21 t CO ₂ -eq	25 t CO ₂ -eq
Nitrous oxide	1 t N ₂ O	310 t CO ₂ -eq	298 t CO ₂ -eq

4.2.2.2 Transport

This section aims to provide practical approaches to build emission inventories for the transport macro-sector focusing on CO₂ and where possible CH₄ and N₂O. Different resources and capabilities of local authorities are taken into account and options are provided that are considered to be feasible to be implemented in mid-sized and even smaller local authorities. Measuring transport emissions and collecting associated data is vital to guide climate change mitigation actions, but can also guide wider transport policy and planning. While this Guidebook focuses on greenhouse gas emissions, insights gained from the data collection and analysis described in this chapter can also inform urban planning, the provision of transport services, air quality measures and other actions.

The Global Covenant of Mayors defines the transport activity sectors, according to ownership and functionality criteria, as follows (**Table 11**):

Table 11. Mobile sources accounted in the emission inventory under the Transport sector

Sector: Transport	
Subsector	Description
Municipal fleet	All GHG emissions from fuel combustion and use of grid-supplied energy for transportation within the city boundary shall be reported and disaggregated by mode: on-road, rail, waterborne navigation, aviation and off-road: - on-road transportation: urban street network under the competence of the local authority; - on-road transportation serving a larger area and/or not under the competence of local authority (e.g. highways) may be included if mitigations actions are planned in that area - off-road transport: off road traffic of vehicles/mobile machinery in any activity sector - rail transportation: local transport (metro, tram and local trains); long-distance trains, intercity trains, regional and cargo rail transportation may be included if mitigations actions are planned in that area - waterborne navigation: local ferries in public and private transport acting on the local territory - aviation: local governments may choose to report GHG emissions from the inboundary component of domestic and/or international aviation (such as the landing and take-off cycle for aviation), or assume these are all out of boundary emissions and use the notation key "Included Elsewhere"
Public transport	
Private and commercial transport	

It is not required (but recommended when possible) to provide energy data for each individual fleet type (municipal fleet, public transport, private and commercial transport) but only at the macro-sector level, meaning road and rail travel.

The data to be collected mainly concerns the road and rail transport:

- Road and rail transport should be included if it is serving mainly the local territory and/or is regulated by the local authority, e.g. the highways and regional trains could be excluded if emissions are not significant and no actions are included in the SEACAP.
- The off-road transportation should be reported under this activity sector it serves, i.e. municipal, public, or private/commercial transport, and be included only if emissions are significant and related actions are included in the SEACAP.

Where data is not available and cannot be estimated, notation keys shall be used.

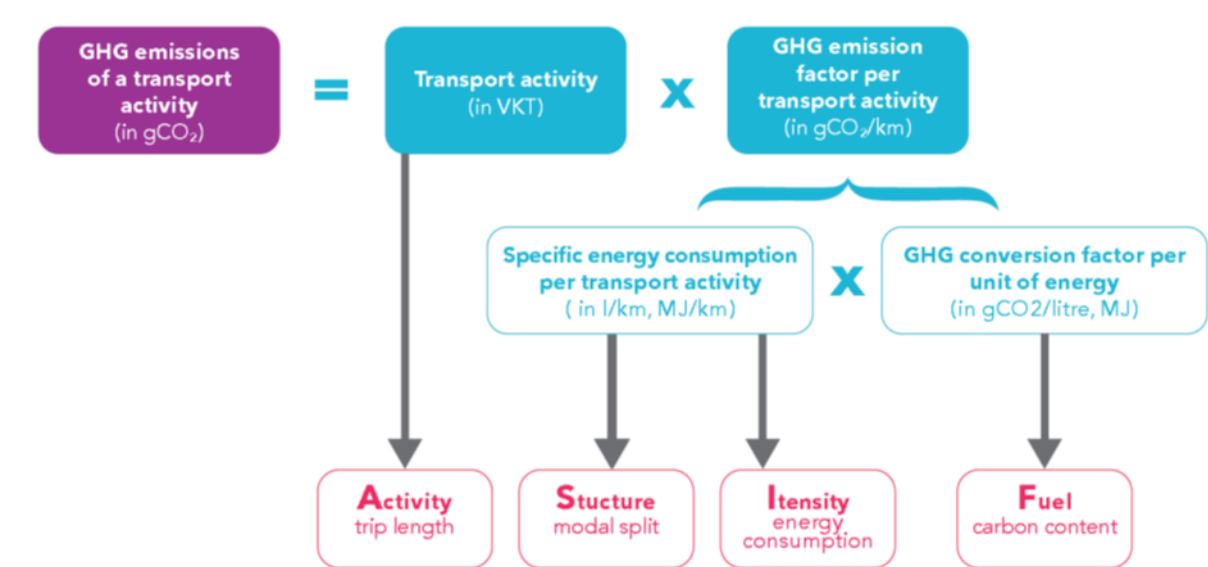
There are relatively simple to more sophisticated ways to estimate transport emissions, but all are usually based on the following parameters (**Figure 9**):

- The Vehicle-Kilometres Travelled (VKT) as a measure of traffic flow, determined by multiplying the number of vehicles on a given road or traffic network by the average length of their trips measured in kilometres; it can be measured as passenger-kilometre (a unit of measure = 1 passenger transported a distance of 1 kilometre) and tonne-kilometre (a unit of measure: 1 tonne transported a distance of 1 kilometre). There are three different methodological approaches to determine traffic activity ⁽²⁸⁾:
 - Vehicle approach, determined as: (vehicle stocks x annual average mileage);
 - User approach, determined as: (trips number by mode x the average trip distance / load factor);
 - infrastructure approach, determined as: (traffics accounts (by vehicle type) x infrastructure link length)

⁽²⁸⁾<http://mobiliseyourcity.net/>

- The modal share and distribution of trips to different types of vehicles (fleet distribution), describing the portion of trips by different modes: road (passengers and freight transport); rail, inland-waterways; air and maritime. In urban areas the most important mode relates to road passenger, which can be further disaggregated into vehicle types (e.g. passenger, light-duty or heavy-duty for road vehicles);
- Energy intensity as a measure of the fuel consumption (actual in-use or alternatively average) assessed as the product of the average fuel consumption of vehicle the type [l fuel/km] and the Net Calorific Value (NCV) of the fuel [Wh/l]. This is often affected by the age of vehicle, especially in the region where the average vehicle life is sometimes over 10 years;
- Fuel carbon intensity relates to the emission factors of the fuels (e.g. diesel, motor gasoline/petrol, electricity, hydrogen etc.).

Figure 9. The ASIF framework to calculate GHG emissions from the transport sector



Source: MobiliseYourCity, 2017

In order to ensure the overall consistency of the CoM methodology, it is suggested using the below equation (Equation 3):

$$GHG\ emissions = \sum_{MODES} \sum_{FUELS} (Activity\ trip\ length \times modal\ split \times intensity \times fuel\ carbon\ content)$$

One of the specificities of calculating the energy consumption/GHG emissions in urban transport is related to the potential high share of sources moving across the border of the urban territory, which makes it difficult to allocate the energy consumption to a certain territory.

4.2.2.2.1 Road transportation

It can be challenging to account for road transport activity sector emissions in urban areas, given the nature of the road transport, which contains numerous mobile sources moving within but also across the boundaries of the urban territory, according to various patterns.

Several approaches and methods for accounting the energy consumption from transport have been developed, which differ greatly in their level of effort required to collect and analyse data and in their level of information they provide, but can be distinguished with

two main Top down and Bottom up approaches (see for instance Dünnebeil et al., 2012; EEA, 2016):

The top down approach to assess transport activity sector greenhouse gas emissions is primarily relevant for the national level and only offers very basic information for the local level. It is commonly based on the so-called "Fuel sales method". This territorial method calculates on-road transportation emissions based on the total fuel sold within the city boundary. The fuel sold on the territory is used as a proxy for transportation activity occurring in the same territory.

This approach treats the quantity of transport fuels sold as a proxy for transportation activities. Cities may assume that all fuels sold within the boundary are used for journeys within the boundary. It is also possible to use surveys or other methods to determine the portion of fuels sold that are attributable to journeys within the boundary. Fuel sales data can be obtained from fuel dispensing facilities and/or distributors, or fuel sales tax receipts.

Bottom-up methodologies to assess emissions from transport require more data collection and analysis, but also provide far more useful information to guide local policy and planning. Unlike the fuel sales method, these bottom-up methods, based on travel patterns, can help identifying priority areas for policy intervention. For many cities, the method is indeed already integrated into the local plans (e.g. Sustainable Urban Mobility Plans, Air and Noise Pollution Mitigation Plans). The main disadvantage of these methods is that they might require significant resources with regard to data collection and analysis. According to the way energy consumption/emissions is allocated to the local territory, three main methods exist:

- Territorial method (also called geographic method): This method, which is the one recommended in the frame of this initiative, quantifies emissions from transportation activity occurring solely within local boundaries, regardless of the trip's origin or destination and whatever the driver is a resident of the municipality or not. Basic traffic counts are required to estimate the number of vehicles traveling, including the average trip length and potentially also the type of vehicle.

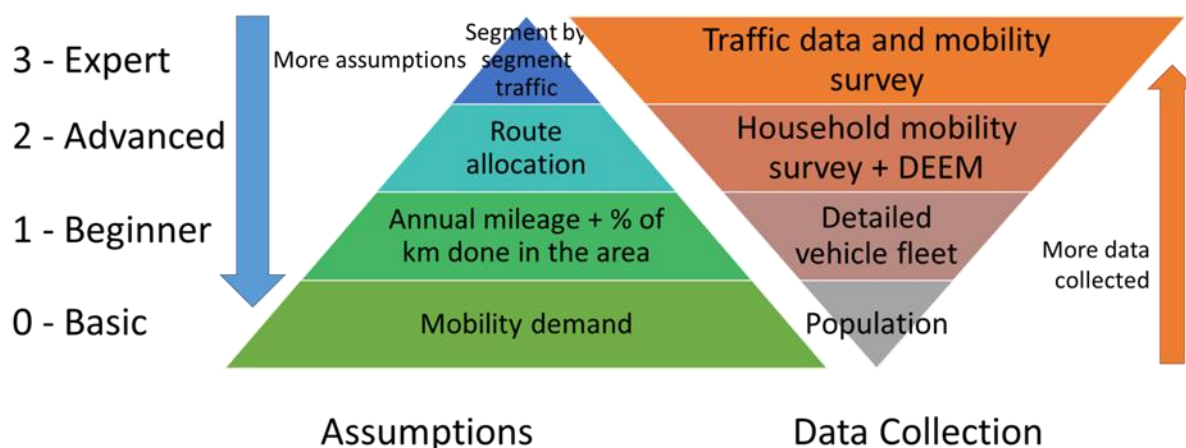
- Resident activity method: This method quantifies emissions from transportation activity undertaken by city residents only, considering all their trips, within or across the city borders. It requires information on resident Vehicle Kilometre Travelled (VKT) from vehicle registration records and surveys on travel behaviour of residents. Modest efforts are required to get relatively solid estimates with a combination of vehicle fleet registration data and surveys among residents and basic travel behaviour.

- Induced activity method: With regard to urban planning and future projections, this approach is the most sophisticated methodology as it identifies the underlying travel dynamics in the region, which can be relevant for local, regional and national policy making. It requires a substantial amount of data from city residents and other travellers, which can be gathered through different sources, including data collection at major routes, Big Data (e.g. from smart phones) and satellite data. Computer modelling allows analysing the effects/trade-off of various scenarios in transport policy and urban planning.

To develop a CO₂ emission inventory for the transport sector and to assess the direct and indirect CO₂ emission reduction potential from bottom up methods, there are a number of tools that require only minimal data and no modelling efforts, as the ones provided in the GPC Greenhouse Gas Protocol Tools (GHG Emissions from Transport): <http://www.ghgprotocol.org/calculation-tools> or as described in MobiliseYourCity project, that provides guidance for the cities involved in the initiative on urban transportation GHG-MRV approaches (http://mobiliseyourcity.net/wp-content/uploads/sites/2/2017/09/MobiliseYourCity_MRV_Approach.pdf).

The level and quality of data needed can be adapted to the city situation and resources, as explained in the figure below:

Figure 10. Four methodological approaches to get VKT



Source: MobiliseYourCity, 2017

Example of calculation of energy consumption from road transportation

An example of the application of the Eq. 3, using IPCC (2006) net calorific value for the most typical gasoline (9.2 kWh/l) and diesel fuels (10.0 kWh/l) is given in Box 15. Where the mileage (VKT) and/or fleet (type of vehicles) data is missing, fuel sales data could be used by cities in which the number of vehicle trips over the city borders is small compared with the number of trips within the city. However, this proxy should always be completed with local traffic/fleet data or estimates, in order to better allow identifying local mitigation actions.

Box 15. Example of calculation of energy consumption from road transportation

Input data:

- 1) Total mileage VKT = 4 500 million km and fleet type distribution (in % of VKT)
- 2) Average fuel consumption; Net Calorific Values and Emission factors

Input data: Fleet type distribution (in % of VKT)

	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Total
All fuels	67%	15%	2%	3%	13%	100%
- Gasoline/petrol	25%	1%	-	-	13%	39%
- Diesel	37%	14%	2%	3%	-	56%
- Electric cars	5%	-	-	-	-	5%

Input data: Average fuel consumption, NCV and Emission factors

	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Net Calorific value (NCV)	Emission factors (EF)
	(l/km)	(l/km)	(l/km)	(l/km)	(l/km)	(Wh/l)	(tCO ₂ -eq/MWh)
- Gasoline	0.0768	0.13	-	-	0.04	9,200	0.249
- Diesel	0.0658	0.098	0.298	0.292	-	10,000	0.267
- Electricity	-	-	-	-	-	-	0.46

Calculation of the energy consumption and GHG emission related						
Step 1. Estimated activity/mileage per fleet type [million km]= <i>Total VKT [million km] x Fleet type distribution (in % of VKT)</i>						
	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Total
- Gasoline	1139	40.5	-	-	580.5	1,760
- Diesel	1661	639	104	113	-	2,516
- Electric cars	225	-	-	-	-	225
Step 2. <i>Energy intensity per fleet type [Wh/km]=</i> <i>Average fuel consumption [l/km] x Net calorific value [Wh/l]</i>						
	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Total
- Gasoline	707	1196	-	-	368	
- Diesel	658	980	2980	2920	-	
- Electric cars	186	-	-	-	-	
Step 3. <i>Estimated Final energy consumption per fleet type [MWh]= Estimated mileage per fleet type [million km] x Energy intensity [Wh/km]</i>						
	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Total
- Gasoline	804,419	48,438	-	-	213,624	1,066,481
- Diesel	1,092,609	626,220	308,430	328,500	-	2,355,759
- Electric cars	41,850	-	-	-	-	41,850
Total final energy consumption	1,938,878	674,658	308,430	328,500	213,624	3,464,090
Step 4. <i>Estimated GHG emissions per fleet type [tCO₂-eq]=</i> <i>Estimated Final energy consumption [MWh] x Emission factors [in tCO₂-eq/MWh]</i>						
	Passenger cars	Light duty vehicles	Heavy duty vehicles	Busses	Two wheelers	Total
- Gasoline	200,300	12,061	-	-	53,192	265,554
- Diesel	291,727	167,201	82,351	87,710	-	628,988
- Electric cars	19,251	-	-	-	-	19,251
Total GHG emissions	511,278	179,262	82,351	87,710	53,192	913,792

4.2.2.2.2 Rail transportation

As for road transportation, the rail transportation in the local territory can be divided into two parts:

- Urban rail transportation, for example tram, metro and local trains. The inclusion of this urban rail transportation in the “public transport” activity sector in the BEI is strongly recommended.
- Other rail transportation, which covers the long-distance, intercity and regional rail transportation that occurs in the local territory. Other rail transportation does not only serve the local territory, but a larger area. Other rail transportation includes also freight transport. These emissions can be included in the BEI if the local authority aim to include measures to reduce these emissions in the SEACAP.

There are two types of activity data for rail transportation: consumption of electricity and consumption of fuel in diesel locomotives. Use of diesel locomotives in urban rail transportation is less common for local services. Number of providers of rail transport in the local territory is usually low. The LA is recommended to ask the annual electricity and fuel use data directly from the service providers. If such data are not available, the LA can estimate the emissions based on mileage travelled and average electricity or fuel consumption.

4.2.2.3 Waste

The local authority shall report all GHG emissions from disposal and treatment of waste including solid waste and wastewater⁽²⁹⁾ generated within the city boundary and disaggregated by the following sub-sectors. Further definitions and guidance on sub-sectors are provided below:

Table 12. Non-energy related activity sectors/data

Sector: Waste	
Subsector	Description
Solid waste disposal	All emissions from solid waste that are disposed of at managed sites (e.g. sanitary landfill and managed dumps), and unmanaged sites (e.g. open dumps, including above-ground piles, holes in the ground, and dumping into natural features such as ravines).
Biological treatment	All emissions from biological treatment of waste, including composting and anaerobic digestion of organic waste.
Incineration and open burning	All emissions from waste that are burned either in a controlled, industrial, process or in an uncontrolled, often illicit, process. The former is often referred to as incineration, and the latter as open burning. Note that this excludes emissions from waste incineration for the purposes of energy generation, also known as energy recovery.
Wastewater treatment & discharge	All emissions from the treatment process of wastewater, either aerobically or anaerobically, and direct discharge of wastewater into an open body of water.

Source: JRC own elaboration based on the GCoM reporting framework

The quantification of GHG emissions from disposal and treatment of waste should include the following steps:

Activity data: Local authority should identify the quantity of waste generated in the inventory year, categorised by different types of generation and treatment pathways where possible. How waste is generated affects the composition of waste, which determines the emission factors that need to be used. How waste is treated determines what GHGs are emitted as well as the emission factors. Guidance on collecting this information is available in IPCC Guidelines⁽³⁰⁾.

The emission factor: Guidance for calculating emission factors from different waste disposal and treatment pathways, including equations and default data that local authorities may use in absence of local or regional/national data, is available within the IPCC Guidelines and the Global Protocol for Community-Scale Greenhouse Gas Emission

⁽²⁹⁾ Water access: GWOPA Global Water Operator Partnership Alliance www.unhabitat.org; - Solid waste treatment: IRRRC Integrated Resource Recovery Centre – A low cost municipal solid waste management system in South East Asia- ESCAP

⁽³⁰⁾ The 2006 IPCC Guidelines focus on emission inventories at national level. The specific volume that is relevant for GCoM local authorities regarding non-energy related emissions is Volume 5, "Waste". The GPC is available at http://ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf and contains a detailed methodology, based on the IPCC one, on how to assess, at city level, the emissions from waste and wastewater (Chapter 8 "Waste").

Inventories ⁽³⁰⁾. If the local authority has chosen to use the LCA approach, emission factors for landfills are available from the ELCD (2015) database ('Landfilling' class) ⁽³¹⁾.

For the end-life management of Photovoltaic systems and the end-of-life management of batteries in the off-grid solar sector please refer to the annex 11 ⁽³²⁾.

4.2.2.4 Energy supply

Additionally to the emissions generated through energy consumption, local governments shall report GHG emissions from energy generation activities. To avoid double counting, these shall not form part of the GHG emissions inventory total, and will be reported under an "Energy Generation" or "Energy Supply" sector, as follows:

- All GHG emissions from generation of grid-supplied energy within the city boundary, and all GHG emissions from generation of grid-supplied energy by facilities owned (full or partial) by the local government outside the city boundary shall be reported and disaggregated by electricity-only, combined heat and power (CHP), and heat/cold production plants.
- GHG emissions from sources covered by a regional or national emissions trading scheme (ETS), or similar, should be identified, if existing.
- In addition, local governments should report all activity data for distributed local renewable energy generation.

The local production of energy and associated direct emissions are not part of the activity sectors included in the emission inventory but are considered in the calculation of the local emission factors to be applied to the local consumption of electricity and heat/cold. The principle is to allow signatories to reduce their emissions associated with the consumption of distributed energy, by encouraging both energy saving measures and measures related to the implementation of local energy production. JRC specific methodology for indirect CO₂ emissions calculation can be found in annex 4.

Table 13. Energy supply activity sectors/data

Sector: Energy supply	
Subsector	Description
Electricity-only generation	All activity data and GHG emissions from energy (both renewable and non-renewable) consumption for the purpose of generating grid-supplied electricity in power plants that solely generate electricity.
CHP generation	In the case of CHP plants, which generate heat and electricity simultaneously, or any other plants not listed, the amount of electricity produced (in MWh), both from renewable and non-renewable energy sources shall be reported.
District heating/cooling generation	All activity data and GHG emissions from energy (both renewable and non-renewable) consumption for the purpose of generating thermal energy in district heating/cooling plants
Distributed local renewable energy generation	All activity data and GHG emissions from local energy generation (electricity, heat, etc.) facilities not grid-connected.

Source: JRC own elaboration based on the GCoM reporting framework

⁽³¹⁾ <http://eplca.jrc.ec.europa.eu/>

⁽³²⁾ GIZ document: "END-OF-LIFE MANAGEMENT OF BATTERIES IN THE OFF-GRID SOLAR SECTOR - How to deal with hazardous battery waste from solar power projects in developing countries?" available at: <https://www.giz.de/de/downloads/giz2018-en-waste-solar-guide.pdf>

4.3 Prepare the Risk and Vulnerability Assessment (RVA)

The Climate Change Risk and Vulnerability Assessment (RVA) enables local authorities to identify their exposure to current and future climate hazards, vulnerabilities, risks and potential climate change impacts, as well as understand the main city specificities that contribute to aggravating the consequences of a specific climate hazard.

Similarly to the Baseline Emission Inventory, the RVA defines the basis for setting the priorities of adaptation action and investment and monitoring the effectiveness of implemented adaptation measures for a specific region or sector. To this end, an assessment of climate vulnerability and risk has to be undertaken - on the basis of available data - and regularly monitored and evaluated versus a baseline scenario.

In the following sections, the main concepts around climate risk as proposed by the IPCC are included as well as the requirements outlined in the GCoM common reporting framework; followed by recommendations on how to prepare a RVA together with potential sources of information.

4.3.1 Introduction

Africa is a continent blessed with a substantial amount of environmental resources, and many African countries are quite rich with respect to biodiversity, minerals and favourable environmental conditions. Yet, Africa as a whole is one of the most vulnerable continents due to its high exposure and low adaptive capacity ⁽³³⁾ (Niang et al., 2014). Indeed, the continent is highly exposed to climate change, and its structural weaknesses result in lower resilience. With 40% of its population living on arid, semi-arid, or dry sub-humid areas, Africa is one of the areas of the world most exposed to global warming. It has experienced a warming of approximately 0.7°C during the past century, and the average temperature is expected to increase by between 0.2°C and 0.5°C each decade (IPCC, 2014a).

A high proportion of Africans lives in coastal areas: one-quarter of the population resides within 100 km of a seacoast. Because of the combination of increased climate variability and rising sea levels, this population will be increasingly exposed in the coming decades. Africa is also particularly vulnerable to climate change because a large proportion of the population resides in rural areas and is heavily dependent on climate-sensitive livelihoods such as agriculture, and on water and non-timber forest products. Although more than half of the land area in southern Africa is marginal, a majority of southern Africans rely on rain-fed subsistence agriculture (Wamukonya and Rukato, 2001). African countries, as countries in other parts of the world, are highly vulnerable not only to climate shocks, but also to economic and political shocks. The conjunction of different shocks has cumulative effects and undermines countries' ability to cope with crisis.

Climate significantly influences day-to-day economic activities from household to regional levels, particularly in the agricultural and water sectors (Boko et al., 2007).

This is the case for three main reasons (Leal Filho, 2011):

- a) Climate change and the various phenomena associated with it may lead to disruptions in water cycle and subsequent increase in droughts, floods, storms and other extreme events, which may rather damage the fragile infrastructure;
- b) Climate change may affect food production and pose an additional burden to societies already experiencing serious economic and social problems;

⁽³³⁾ Adaptive capacity is defined as the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

- c) The impact of climate change-related events may especially affect the poor and most socially vulnerable people, thus negatively influencing their livelihoods and lives.

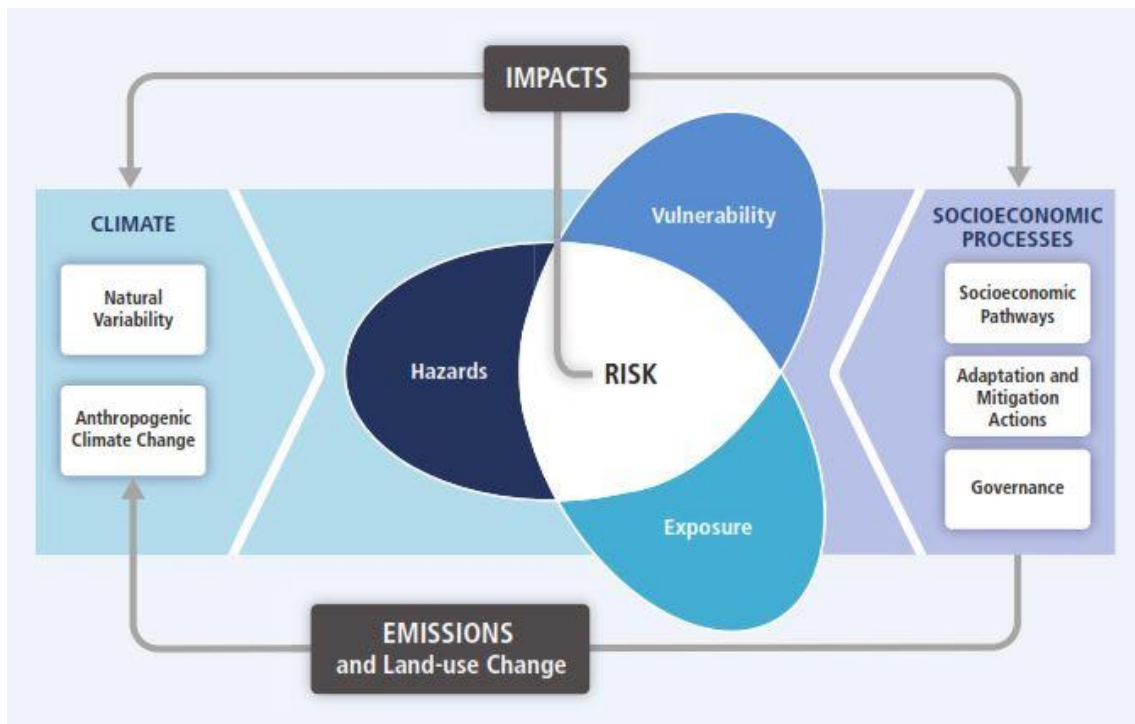
Africa is however a very diverse continent and any statement on the impact of climate change can hardly be applicable to the entire continent (Chhibber and Laajaj, 2008) (see the following Box: "Key regional risks from climate change").

4.3.2 Main concepts

The last Assessment Report of the IPCC (AR5) focuses on the concept of climate risk and proposes a new framework for its assessment (**Figure 11** in this guidebook follows this framework). Risk is defined as a function of the expected potential impacts (hazards) of climate extremes, system vulnerability, and exposure.

Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems. Changes in both the climate system (left) and socioeconomic processes - including adaptation and mitigation (right) - are drivers of hazards, exposure, and vulnerability.

Figure 11. Illustration of the core concepts of the WGII AR5



Source: (Field and et al., 2014)

Box 16. Key regional risks from climate change

Water sector:

Key Risk: The main risk factor in the water sector is the multiple stresses on water resources that are currently facing significant strain from overexploitation, degradation and the increased demand in the future. The risk confidence is higher under the context of drought stress esp. in the dry prone regions of Africa.

Adaptation issues and prospects: The adaptation issues and prospects to reduce the risk have been assessed, it consists of:

- Reducing non-climate stressors on water resources;
- Strengthening institutional capacities for demand management, groundwater assessment, integrated water-wastewater planning, and integrated land and water governance;
- Sustainable urban development.

Measuring the risk in the future: The level of risk with current adaptation is gradually increasing with decades of years starting from low in the present to very high risk in the long-term timeframe (2080 - 2100) in a world of 4°C. The increase is attenuated with additional adaptation but somehow high in longer term.

Climate drivers: Monitoring the warming trend, extreme temperature, drying trend and sea level are relatively critical to control the risks assessed in the water sector and take action accordingly.

Agriculture Sector:

Key Risk: There is currently a risk of reduction in the crop productivity associated with heat and drought stress, with strong adverse effects on regional, national, and livelihood and food security. The confidence is increasingly high given the increased pest and disease damage and flood impacts on food system infrastructure.

Adaptation issues and prospects: The adaptation issues and prospects were identified in the:

- Technological adaptation response (e.g. stress tolerant crop varieties, irrigation, enhanced observation systems);
- Enhancement of smallholder access to credit and other critical production resources, diversifying livelihoods;
- Strengthening of institutions at local, national, and regional levels to support agriculture (including early warning systems) and gender oriented policy;
- Agronomic adaptation responses (e.g., agroforestry, conservation agriculture).

Measuring the risk in the future: The risk with additional adaptation is at low level until near-term (2030-2040) however, the adaptation measures in this sector should be constantly strengthened and enhanced. Meanwhile the risk level with current adaptation is very high in longer term (2080-2100) and still very high with additional adaptation esp. under the scenario of global mean temperature increase 4°C above preindustrial level.

Climate drivers: Monitoring the warming trend, extreme temperature and the extreme precipitation are important for reducing exposure to these risks in this particular sector and take action accordingly.

Health sector:

Key Risk: The risk factors in the health sector mainly originated from the changes in the incidence and geographic range of vector and water-born diseases due to the changes in the mean and variability of temperature and precipitation, particularly along the edges of their distribution (medium confidence).

Adaptation issues and prospects: Some fundamental Adaptation issues and prospects have been identified through:

- Achieving development goals, particularly improved access to safe water and improved sanitation, and enhancement of public health functions such as surveillance;
- Vulnerability mapping and early warning systems;
- Coordination across sectors;
- Sustainable urban development.

Measuring the risk in the future: The risk is now at the medium level, but the near term scenario (2030-2040) is anticipating adaptation reinforcement that will eventually reduce the health risk level in overall Africa. If the proposed adaptation measures are being adopted, it will sustain the risk at the medium level in longer-term (2080-2100) but increase the risk level very high with current adaptation.

Climate drivers: Monitoring the warming trend, precipitation and extreme precipitation are crucial to reduce the effect of climate change in health sector and take action accordingly.

Source: (IPCC, 2014b)

Box 17. Definitions

Climate change: Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Impacts: Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard (see **Figure 11**). In this report, the term risk is used primarily to refer to the risks of climate-change impacts.

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Maladaptation: Interventions and investments in a specific location or sector that could increase the vulnerability of another location or sector, or increase the vulnerability of the target group to future climate change. Maladaptation arises not only from inadvertent badly planned actions, but also from deliberate decisions focused on short-term benefits ahead of longer-term threats, or that fail to consider the full range of interactions, feedbacks and trade-offs between systems and sectors arising from planned actions.

Source: IPCC, 2014b

Box 18 Sources of information for the adaptation pillar in SSA

Climate data and future projections

Climate Information Portal (CIP) developed by CSAG (<http://cip.csag.uct.ac.za/>)

CIP is a web interface that integrates two important information sources into one easy to use interface. The first important source is a climate database that stores and manages queries to a large suite of observational climate data as well as projections of future climate. The second important source of information is an extensive collection of guidance documentation that facilitates the best use of the climate data, its interpretation and, importantly, resultant actions. The philosophy guiding CIP is that data is not information and as such only has value when well interpreted and correctly used or applied to appropriate problems.

Future Climate Africa (<http://www.futureclimateafrica.org>)

Future Climate Africa aims to generate fundamentally new climate science focused on Africa, and to ensure that this science has an impact on human development across the continent. The website contains great number of useful sources. Among them, the report "Africa's climate: helping decision-makers make sense of climate information" contains country factsheets on the climate and the possible impacts for Rwanda, Uganda, Senegal, Zambia, Tanzania and Malawi.

The African Risk Capacity (ARC) (<http://www.africanriskcapacity.org/>)

The ARC was established as a Specialized Agency of the African Union (AU) to help member states improve their capacities to better plan, prepare and respond to extreme weather events and natural disasters, therefore protecting the food security of their vulnerable populations.

Among other documents, they published The Africa RiskView (ARV) Bulletin. It provides information about current rainfall and drought index developments, as detected by ARV, and their potential impact on vulnerable populations. It also provides updates on estimated response costs to assist potentially affected people. They also publish the Africa RiskView End-of-Season Report. The report discusses Africa RiskView's estimates of rainfall, drought and population affected, comparing them to information from the ground and from external sources. This exercise aims at reviewing the performance of the model and ensuring that the country's drought risk is accurately reproduced by Africa RiskView for drought monitoring and insurance coverage. The End-of-Season reports are also being continuously refined with a view to providing early warning to ARC member countries (Burkina Faso, Chad, Comoros, Côte d'Ivoire, The Gambia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mauritania, Niger, Nigeria, Senegal, Togo and Zimbabwe).

Disasters, disasters losses and disaster resilience

Global Assessment Report Risk Data Platform (<http://risk.preventionweb.net>)

This interactive Risk Viewer provides the global risk data from the Global Assessment Reports, presented in an easily accessible manner. Risk and exposure indicators can be overlaid with hazard data from earthquakes, cyclones, surges, floods, tsunamis and volcanoes. Other country-specific data can also be downloaded, including future projections of return periods, etc.

DesInventar (<http://www.desinventar.net>)

DesInventar is a Disaster Management Information System for generating National Disaster Inventories and constructing databases that capture information on damage, loss and general effects of disasters. It is also used to store the data sets that are reported on in the Global Assessment Reports on Disaster Risk Reduction. With increased understanding of disaster trends and their impacts, better prevention, mitigation and preparedness measures can be planned to reduce the impact of disasters on the communities. DesInventar currently covers 15 countries in sub-Saharan Africa: Comoros, Djibouti, Ethiopia, Kenya, Madagascar, Mali, Mozambique, Morocco, Mauritius, Niger, Togo, Tunisia, Senegal, Sierra Leone, Seychelles, Uganda, and Tanzania (Zanzibar only).

EM-DAT: The International Disaster Database (<http://www.emdat.be>)

EM-DAT contains essential core data on the occurrence and effects of over 18,000 mass disasters in the world from 1900 to present. The database is compiled from various sources, including UN agencies, nongovernmental organisations, insurance companies, research institutes and press agencies. Users can download data and create their own tables and figures by selecting from among the data sets.

PREVIEW Global Risk Data Platform (<http://preview.grid.unep.ch>)

The PREVIEW Global Risk Data Platform contains spatial data information on global risk from natural hazards. Users can visualise, download or extract data on past hazardous events, human and economical hazard exposure and risk from natural hazards. It covers tropical cyclones and related storm surges, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions.

Disaster Resilience Scorecard for Cities

(<https://www.unisdr.org/campaign/resilientcities/home/toolkit>)

The Scorecard provides a set of assessments that will allow local governments to assess their disaster resilience, structured around UNISDR's Ten Essentials for Making Cities Resilient. It also helps to monitor and review progress and challenges in the implementation of the Sendai Framework for Disaster Risk Reduction: 2015-2030. This tool for disaster resilience planning can be used as a stand-alone tool, it does require you to consider your city's hazards and risks. Specifically, the Scorecard prompts you to identify "most probable" and "most severe" risk scenarios for each of your identified city hazards, or for a potential multi-hazard event.

4.3.3 Climate Change Risk and Vulnerability Assessment

A Risk and Vulnerability Assessment (RVA) determines the nature and extent of a risk by analysing potential hazards and assessing the vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend (IPCC, 2014b). This can take the form of a single assessment or various assessments undertaken per sector.

RVAs are the most commonly used tools for identifying, quantifying and prioritising key risks of a system to climate change. However, before giving more details on how to prepare a RVA as well as its indicators and objectives to be included in the SEACAP, it is worth noting that not all issues that emerge from vulnerability assessments can be addressed, mainly due to budgetary limitations (World Bank, 2010). Therefore, to identify the optimal level of adaptation it is required to assess the trade-off between the costs of investment in resilience and the expected benefits in terms of reduced losses and damages, versus a scenario of inaction. This cost-benefit analysis is a crucial step in developing adaptation plans, and cities are encouraged to undertake robust estimations of costs, benefits and uncertainties to the extent possible.

Box 19. Reporting element: RVA.

All signatories shall prepare a RVA within two years after committing to the CoM SSA;

It is mandatory to include:

Boundary of assessment equal to or greater than the city boundary;

Year of approval from local government;

Data sources;

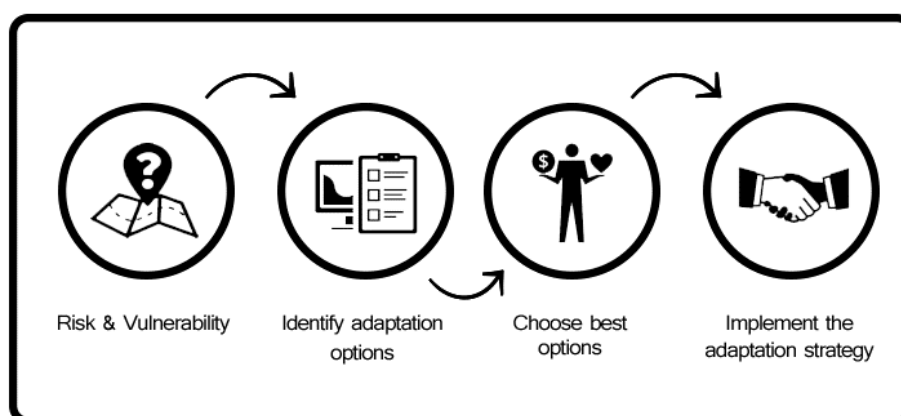
A glossary of key terms and definitions;

Leading/coordinating team in the city;

Terminologies and definitions used in the reports shall be consistent with those in the IPCC Fifth Assessment Report or update thereof as well as with national frameworks/requirements.

Source: GCoM Common Reporting Framework (see Annex 3)

Figure 12. From RVA to implementation of adaptation strategy



Source: JRC Own elaboration.

Many tools and methods exist for undertaking vulnerability and adaptation assessments, both qualitative and quantitative (Mukheibir and Ziervogel, 2007). The choice should be based on the purpose of the assessment, the spatial scale of assessment and the resources available, including data, tools, budget and technical skills. **Table 14** summarizes strengths and weaknesses of three different methodological approaches: indicator-based, model and GIS based and participatory approach.

Table 14. Strengths and weaknesses of common vulnerability assessment methodologies.

Type	Description	Strengths	Weaknesses
Indicator based	Indicator-based methodologies use a specific set or combination of proxy indicators in order to produce measurable outputs across various spatial scales. Examples of indicators include the Livelihood Vulnerability Index (LVI) (Hahn et al., 2009), Household Adaptive Capacity Index (HACI), Well-being Index (HWI), Index of Social Vulnerability to Climate Change for Africa (SVA).	Produce measurable outputs across various spatial scales that can be easily used by policy-makers Valuable for monitoring trends and exploring the implementation of adaptation responses	Limited by lack of reliable data, particularly socioeconomic sources, at the scale required for assessment Challenges associated with testing and validating the metrics used, such as good governance.
Model- and GIS-based	Model- and GIS-based methods incorporate biophysical and socioeconomic modelling, and display vulnerability spatially through mapping. These methods commonly focus on a specific driver of change or sector and apply statistical measures and mapping techniques to display vulnerability as well as measures of adaptive capacity and resilience.	Mapping of climate change vulnerability provides an insight into the vulnerability of place, and may have some value in identifying vulnerable places and people	Typically, a snapshot of vulnerability, failing to encapsulate spatial and temporal drivers of structural inequalities
Participatory approaches	Participatory approaches focus on including stakeholders in the assessment process, and this can be done in a variety of ways and to various extents. A range of tools for participatory vulnerability assessments exist, including cognitive mapping, interviews, surveys, vulnerability matrices, stakeholder engagement workshops and expert-based inputs.	Recognise the local or context-specific knowledge that exists within a system, and the fact that many aspects are best known by those individuals operating within that system	The perception and understanding shared by participants should ideally be complemented with supporting socio-economic and biophysical data Challenges associated with identification of the appropriate target group, and ensuring that all voices are heard and equally included in the process

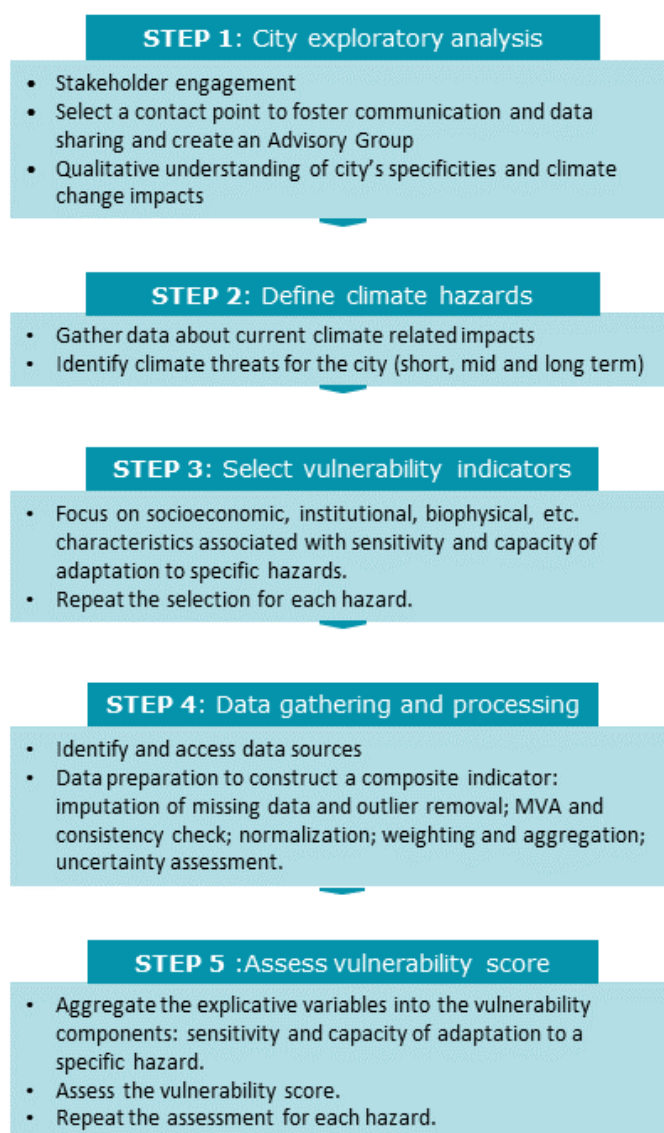
Source: (Davis and Vincent, 2017)

The Model- and GIS-based approach typically requires advanced technical skills and robust georeferenced datasets, which makes it more accessible to big cities that have the necessary resources and capacities.

The indicator-based approach requires less resources and technical skills which makes this type of vulnerability assessment a viable option for small and medium cities. The approach is described in more details in the following paragraph.

4.3.3.1 Indicator-based vulnerability assessment

Figure 13. Sequence of steps and main activities for indicator based vulnerability assessment.



Source: own elaboration.

STEP 1: City exploratory analysis. This step includes a kick-off meeting with city stakeholders in order to contextualize the assessment, understand needs and expectations, identify instances of climate change impacts, select a contact point in the LA (for example from the environment or planning department), and clearly explain the RVA approach and the required data. Weber *et al.* (2015) suggest creating an Advisory Group of relevant experts from academia, NGOs, city government and private sector, to help construct sound and policy-relevant indicators and selecting the best scale of analysis (e.g., neighbourhood or settlements). Input from city decision makers and local institutions steers the project towards actionable results. The main sources of information – such as city departments/agencies, civil protection, utility companies, and universities, among others – should be mapped. The contact point at the LA should be entrusted with facilitating the communication between the parties and fostering data sharing.

STEP 2: Define climate hazards. **Figure 14** proposes a regional assessment of expected climate-change impacts in sub-Saharan Africa. This coarse assessment or any other

hazard maps can help drive the discussion with key-stakeholders (STEP 1) about expected climate hazards by localizing the city within a specific risk zone. The macro-scale information should be calibrated through observed instances of climate-related impacts within the city. This information should be derived from data on the most relevant climate threats faced by the region. Also according to the GCoM common reporting framework (see Annex 3), local governments shall identify the most significant climate hazards faced by the community. For each hazard identified, the local authority shall collect the following information:

- current risk level (probability x consequence) of the hazard;
- description of expected future impacts;
- expected intensity, frequency, and timescale ⁽³⁴⁾ of the hazard;
- all relevant sectors, assets, and services that are expected to be most impacted by the hazard in future and the magnitude of the impact for each of them ⁽³⁵⁾.

It is further recommended to identify the vulnerability for each hazard: Information on vulnerable population groups (e.g. poor, elderly, youth, people with chronic disease, unemployed, etc.) that are expected to be most affected by future hazards. This information can help the local government in having a better understanding of the vulnerability dimension of risks and in prioritizing their adaptation actions.

Besides the assessment of future hazards, the local government shall also assess the following information about major hazards that occurred in the past years:

- Scale of the hazard, including loss of human lives, economic losses (direct and indirect, if possible), environmental and other impacts;
- Current risk level of the hazards (probability X consequence);
- Intensity and frequency of the hazard;
- All relevant sectors, assets, or services most impacted by the hazard and the magnitude of impact for each of them;
- Vulnerable population groups most affected by the hazard (if available).

STEP 3: Select vulnerability indicators. In this step, it is necessary to correctly identify the indicators that drive urban vulnerability to the selected climate hazards, through literature review and consultation with the Advisory Group (some examples are provided in Section **Table 15.**)

STEP 4: Data gathering and processing. In this step, it is important to extract city socioeconomic indicators and information about the built environment and biophysical attributes from existing databases at local, regional and national level.

STEP 4: Assess vulnerability score. In this step, it is critical to calculate the sensitivity³⁶ as well as the adaptation capacity for specific climate threats through different equations and aggregation approaches.

The GCoM common reporting framework asks cities to identify factors that will most affect its own and the city's adaptive capacity and enhance climate resilience. For each factor, the local government shall report the following information:

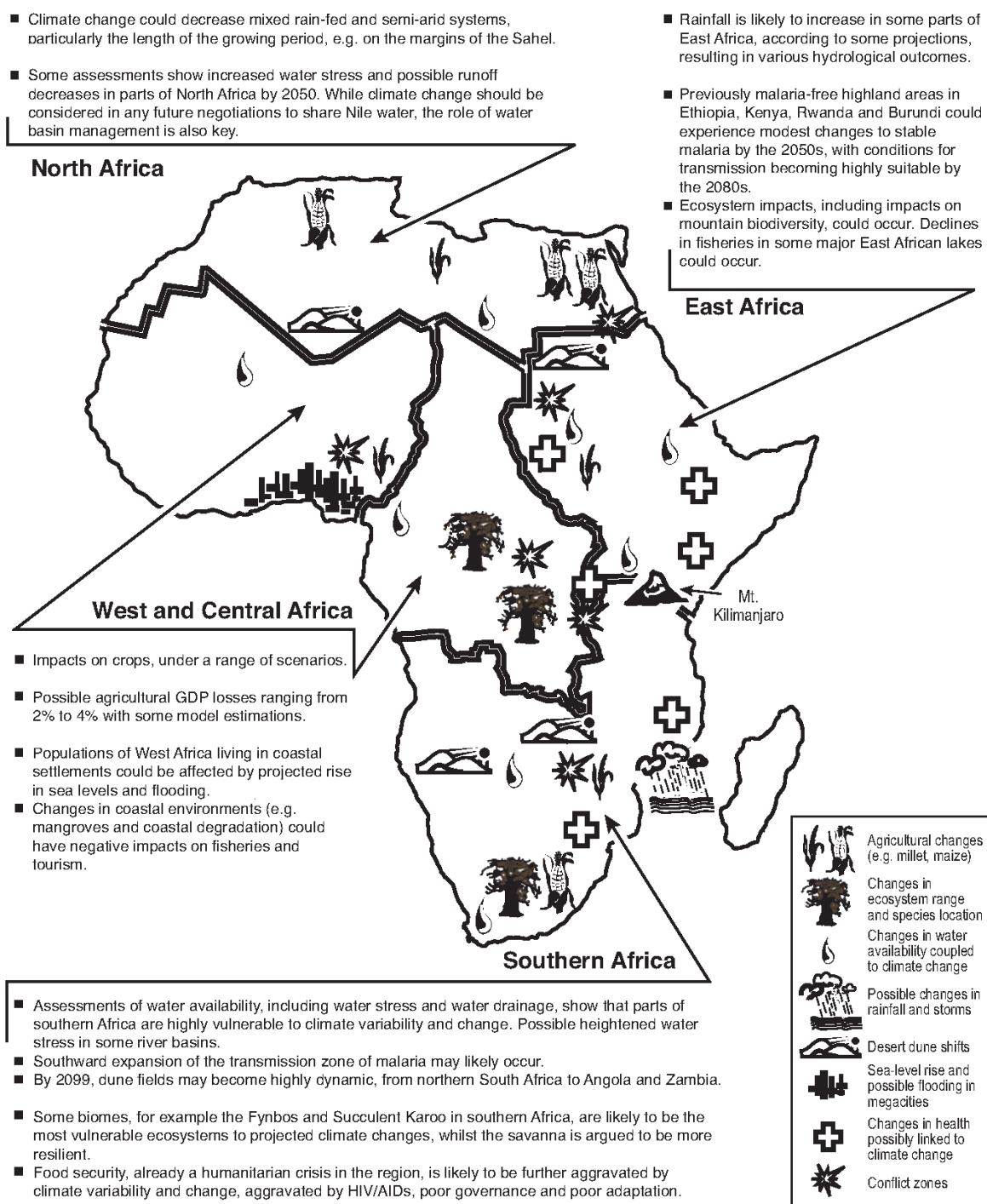
⁽³⁴⁾ A qualitative description of time-scales (short term – less than 10 years; near term 2030 - 2040 and long term 2080- 2100) of the expected impacts should be provided in order to correctly prioritize investments.

⁽³⁵⁾ The exposed/vulnerable sectors – such as buildings, transport, energy, water, waste, food & agriculture, environment, forestry, biodiversity, health, among others – may be possibly impacted with different levels of severity (low, moderate, high) and over different time periods (e.g.: short-term, medium-term, long-term).

⁽³⁶⁾ IPCC defines as sensitivity the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).

- Description of the factor as it relates to (supporting or challenging) the adaptive capacity
- Degree to which the factor challenges (as opposed to supports) the adaptive capacity and obstructs enhanced climate resilience

Figure 14. Examples of current and possible future impacts and vulnerability associated with climate variability and climate change for Africa.



Source: (Boko et al., 2007).

4.3.4 Adaptation indicators

There are no single and unanimously adopted criteria to quantify vulnerability. For example, Eriksen and Kelly (2007) provide an assessment of the different types of vulnerability indicators developed for climate policy assessments, and highlight the fact that some approaches emphasize the physical more than the social aspects and vice versa. Table 15 and also Annex 7 serve the purpose of providing CoM SSA signatories with some examples of vulnerability indicators.

Table 15. Examples of Adaptation Indicators.

Vulnerability Type	Vulnerability- related indicator
Climatic	Number of days/nights with extreme temperature (compared to ref. annual/seasonal temperatures at day/night times)
Climatic	Frequency of heat/cold waves
Climatic	Number of days/nights with extreme precipitation (compared to ref. annual/seasonal precipitation at day/night times for each season)
Climatic	Number of consecutive days/nights without rainfall
Socio-economic	Current population vs. projections 2020/2030/2050
Socio-economic	Population density (compared to national/regional average in year X in country/region X)
Socio-economic	% share of sensitive population groups (e.g. elderly (65+)/young (25-) people, lonely pensioner households, low-income/unemployed households) - compared to national average in year X in country X
Socio-economic	% of population living in areas at risk (e.g. flood/drought/heat wave/forest or land fire)
Socio-economic	% of areas non-accessible for emergency / firefighting services
Physical & environmental	% change in average annual/monthly temperature
Physical & environmental	% change in average annual/monthly precipitation
Physical & environmental	Length of transport network (e.g. road/rail) located in areas at risk (e.g. flood/drought/heat wave/ forest or land fire)
Physical & environmental	Length of coastline / river(s) affected by extreme weather conditions / soil erosion (without adaptation)
Physical & environmental	% of low-lying or at altitude areas
Physical & environmental	% of areas at coasts or rivers
Physical & environmental	% of protected (ecologically and/or culturally sensitive) areas / % of forest cover
Physical & environmental	% of (e.g. residential/commercial/agricultural/industrial/touristic) areas at risk (e.g. flood/drought/heat wave/ forest or land fire)
Physical & environmental	Current energy consumption per capita vs. projections 2020/2030/2050
Physical & environmental	Current water consumption per capita vs. projections 2020/2030/2050

Source: JRC own elaboration.

4.4 State of access to energy

Energy is a key input for meeting basic needs and for achieving socio-economic development goals: access to energy, fuel for cooking, heating and lighting in households, power for industry, and petroleum products for transportation. The growth of the information and communications technology sector relies on the access to electricity specifically and access to energy in general. Energy access is linked to other basic services such as water and sanitation. The use of energy, the types of energy used and the lack of access to sufficient energy have far reaching implications for a city's economic development, its environmental health and for the poor. Access to energy is one of the factors that bring together human development, economic growth and sustainability. Energy planning and energy policy are tackled across different levels of government.

According to the African Progress Panel, on current trends, Africa won't achieve universal access to electricity until 2080. Universal access to clean cooking facilities would occur around 100 years later, sometime after the middle of the 22nd century (Africa Progress Panel, 2015). But, how far is it? The distance could be measured by looking at: how much power generation capacity there is (and if it is sufficient to provide for current included suppressed demand as well as the future demand); how much power is used (consumption) and whether the people can actually obtain electricity and modern fuels (access).

Sub-Saharan Africa is indeed short of electricity. The region's grid has a power generation capacity of just 122 gigawatts (GW) and half of it is located in one country, South Africa (International Energy Agency, 2017). Italy, with a population of 60 million – 15 times less than sub-Saharan Africa, has a similar installed generation capacity.

Total losses in industrialized countries are typically between 7 per cent and 10 per cent. The Africa Infrastructure Country Diagnostic (Foster and Briceño-Garmendia (ed.), 2010) found that transmission and distribution losses were as high as 50 per cent in some African countries. Other estimates have put the average at 27.5 per cent and distribution losses alone to average 23 per cent (Eberhard et al., 2011). Angola, Botswana and Burundi, for example, had losses of 15 per cent in 2000, while Swaziland's losses were 68 per cent. Benin, Swaziland and Togo total electricity losses over 50% of total generation. Technical losses occur when power is lost in transmission and distribution lines, transformers and meters, often poorly maintained or low-quality. Also the power plants in operation are less efficient than those found in industrial countries, contributing to the increase in the level of technical. The World Bank's suggested benchmark for technical losses in Africa is 10 per cent of total power produced (Africa Progress Panel, 2017).

Most non-technical losses are caused by electricity theft, usually by tampering with or by-passing meters. Electricity theft also occurs through the systematic nonpayment of bills. In Africa most electricity theft is not carried out by people too poor to afford electricity, but by people and organizations that consume large amounts of electricity and could pay for it. Annually, US\$1.73 billion is not collected across the region (Africa Progress Panel, 2017), compared with US\$1.48 billion in system losses.

All these losses reduce the revenues of financially stretched utilities, impacting on their ability to invest in infrastructure improvements and to extend services to connect unserved population. It overall increases the cost of electricity of African consumers, and puts an extra environmental burden, since energy is lost after the environmental externalities are already produced.

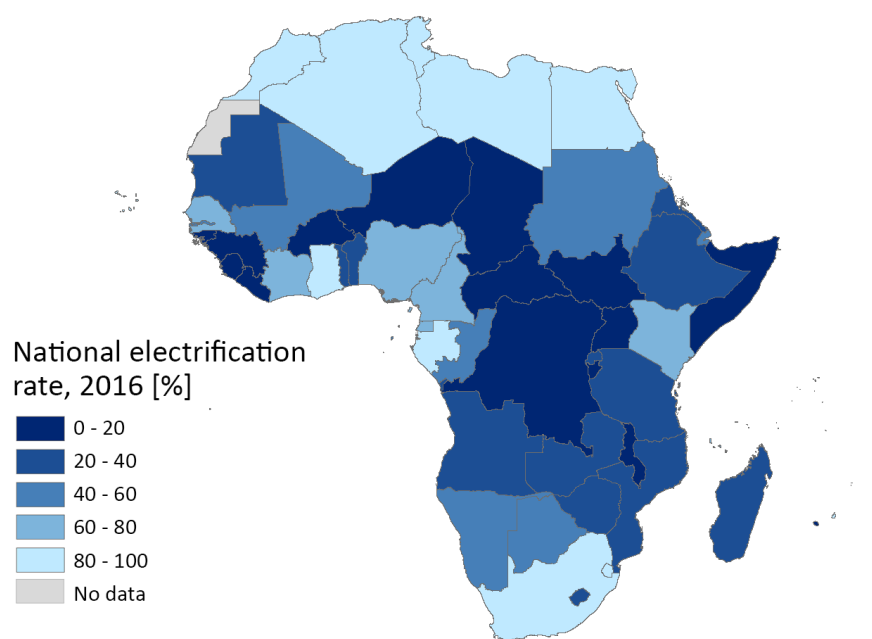
Data on power generation and electricity use highlight the gap between Africa and the rest of the world. But they do not capture the underlying inequalities in access to energy.

4.4.1 Introduction

Access to electricity

Sub-Saharan Africa has the world's lowest coverage rates for modern energy. Two in every three people, around 600 million in total, have no access to electricity (International Energy Agency, 2017). In South Sudan, Central African Republic, Chad, Sierra Leone and Burundi, fewer than one in ten people have access to electricity. There are just 14 countries in Sub-Saharan Africa with electricity access rates above 60 per cent (**Figure 15**). Another 12 countries have electricity access rates of 20 per cent or less. Regionally (**Table 16**), access rate range from 80% in West Africa (in Southern Africa region, South Africa was not included) to 35% in East Africa. There are around 20 countries in the region with 10 million or more people lacking access to electricity (**Table 17**).

Figure 15: Electricity access in Africa: national rate of access, 2016.



Source: (OECD / IEA, 2017a)

Table 16. Electricity Access in Africa, data disaggregated by regions.

	Rate of access [%]						Pop without access [Mill] 2016
	2000	2005	2010	2016	Urban 2016	Rural 2016	
World	73%	76%	81%	85%	96%	73%	1060
Africa	34%	39%	43%	51%	77%	31%	600
North Africa	90%	96%	99%	100%	100%	99%	<1
Sub-Saharan Africa	23%	27%	32%	42%	71%	22%	600
Central Africa	10%	15%	21%	25%	50%	5%	98
East Africa	10%	17%	21%	35%	66%	25%	184
West Africa	33%	37%	42%	52%	80%	28%	175
Other Southern Africa	14%	16%	22%	31%	65%	13%	135

Source: (OECD / IEA, 2017a)

Table 17. Access to electricity in Africa: total population and national, urban and rural access rates for 2016.

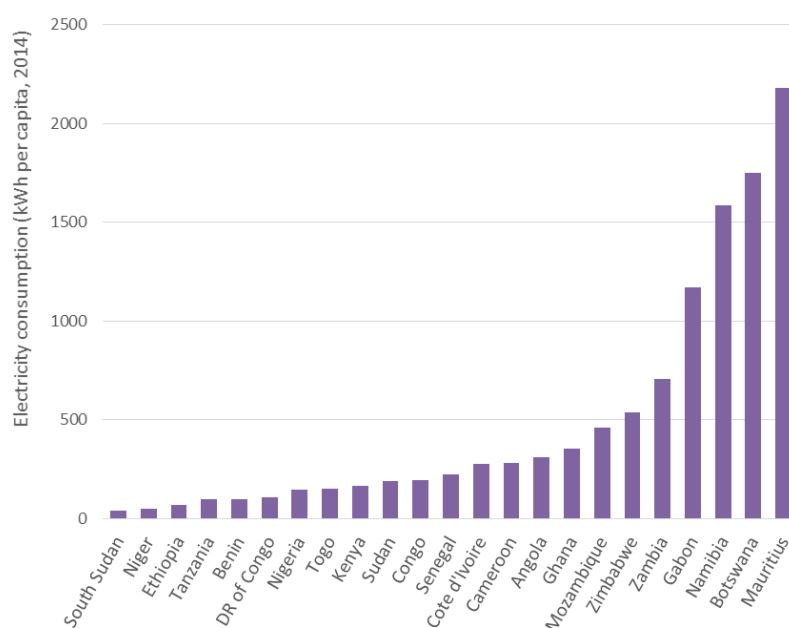
		Access rate 2016			Pop without electricity [Mill]
	ISO3	National	Urban	Rural	
WORLD		86%	96%	73%	1060,4
Africa		51%	77%	31%	600,3
North Africa		100%	100%	99%	<1
Algeria	DZA	100%	100%	97%	<1
Egypt	EGY	100%	100%	100%	-
Libya	LBY	100%	100%	99%	<1
Morocco	MAR	99%	100%	97%	<1
Tunisia	TUN	100%	100%	100%	-
Sub-Saharan Africa		42%	71%	22%	599,9
Central Africa		25%	50%	5%	97,6
Cameroon	CMR	63%	94%	21%	8,8
Central African Republic	CAF	3%	5%	1%	4,9
Chad	TCD	9%	32%	1%	13,2
Congo	COG	43%	56%	16%	2,7
Democratic Republic of the Congo	COD	15%	35%	0%	67,6
Equatorial Guinea	GNQ	68%	93%	48%	<1
Gabon	GAB	90%	97%	38%	<1
East Africa		35%	66%	25%	184,4
Burundi	BDI	10%	35%	7%	10,4
Djibouti	DJI	42%	54%	1%	<1
Eritrea	ERI	33%	86%	17%	3,6
Ethiopia	ETH	40%	85%	29%	60,7
Kenya	KEN	65%	78%	60%	16,8
Rwanda	RWA	30%	72%	12%	8,3
Somalia	SOM	16%	35%	4%	9,3
South Sudan	SSD	1%	4%	0%	12,6
Sudan	SDN	46%	71%	31%	22,1
Uganda	UGA	19%	23%	19%	32,5
West Africa		52%	80%	28%	175,1
Nigeria	NGA	61%	86%	34%	73,6
Benin	BEN	32%	56%	11%	7,6
Cote d'Ivoire	CIV	63%	88%	32%	8,7
Ghana	GHA	84%	95%	71%	4,5
Senegal	SEN	64%	90%	44%	5,6
Togo	TGO	35%	74%	5%	4,9
Burkina Faso	BFA	20%	58%	2%	14,9
Cape Verde	CPV	97%	100%	89%	<1
Gambia	GMB	48%	66%	13%	1,1
Guinea	GIN	20%	46%	1%	10,4
Guinea-Bissau	GNB	13%	23%	1%	1,6
Liberia	LBR	12%	16%	3%	4,1
Mali	MLI	41%	83%	6%	10,8
Mauritania	MRT	31%	47%	2%	2,9
Niger	NER	11%	54%	0%	18,4
Sao Tome and Principe	STP	59%	70%	40%	<1
Sierra Leone	SLE	9%	12%	6%	6,0
South Africa	ZAF	86%	87%	83%	7,6
Other Southern Africa		31%	65%	13%	135,1
Angola	AGO	35%	69%	6%	16,9
Botswana	BWA	55%	69%	32%	1,0
Comoros	COM	71%	89%	62%	<1
Lesotho	LSO	34%	63%	24%	1,4
Madagascar	MDG	23%	52%	7%	19,2
Malawi	MWI	11%	49%	3%	15,7
Mauritius	MUS	100%	100%	100%	-
Mozambique	MOZ	29%	57%	15%	20,5
Namibia	NAM	56%	78%	34%	1,1
Seychelles	SYC	99%	99%	99%	<1
Swaziland	SWZ	84%	90%	71%	<1
Tanzania	TZA	33%	65%	17%	37,1
Zambia	ZMB	34%	67%	7%	11,1
Zimbabwe	ZWE	34%	81%	11%	10,6

Source: (OECD / IEA, 2017a)

Electricity consumption

Many in sub-Saharan Africa do not have access to electricity: those who do consume on average 162 kilowatt-hours (kWh) per capita a year, the lowest level of electricity for any region in the world. One-third of the region's population lives in countries where annual electricity use averages less than 100 kWh each (**Figure 16**). Total Africa's electricity consumption in 2004 was (and it is still) overwhelmingly dominated by South Africa and the five North African countries which accounted for 80 per cent of the 477 TWh of Africa's total electricity consumption. Nigeria accounted for 3 per cent of this total. This means that the 46 sub-Saharan Africa (excluding South Africa and Nigeria) accounted for only 17 per cent of the total (UN-ENERGY/Africa, 2007).

Figure 16: Electricity consumption per capita in selected sub-Saharan Africa countries (kWh per capita, 2014)



Source: (The World Bank, 2017)

Access to clean cooking

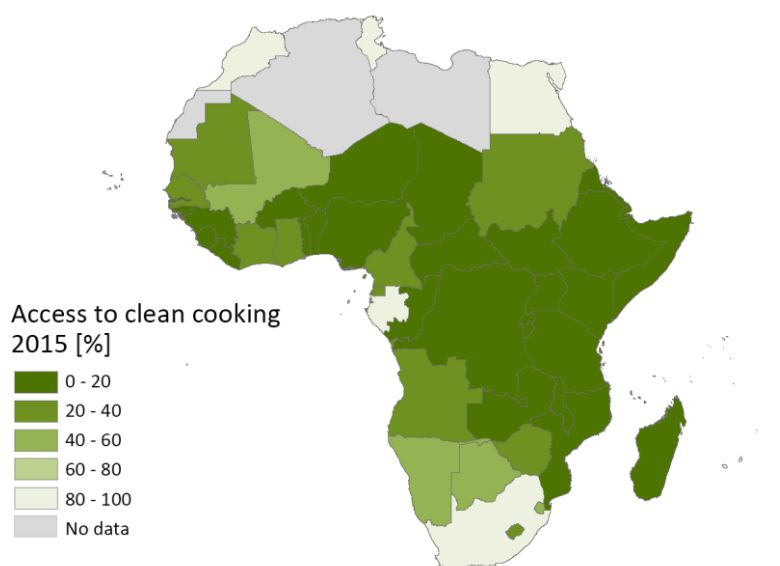
Four in five people in Sub-Saharan Africa (785 million) rely for cooking on solid biomass, mainly fuel wood and charcoal (OECD / IEA, 2017b). Clean, non-polluting cooking facilities are vital to reduce number of death from household air pollution in Africa, and yet access to these is even more restricted than access to electricity.

The access to clean cooking rate varies across countries. In 29 countries, less than 20 per cent of the population has access. There are just 4 countries in sub-Saharan Africa with clean cooking access rates above 80% (**Figure 17**). The differences between regional access (**Table 18**) show slight variations when expressed in percentage (from 9% in Central Africa to 14% in Southern Africa, excluding South Africa) when it is West Africa the region responsible of almost 40% of the total sub-Saharan Africa. There are 27 countries with 10 million or more people without access to clean cooking (adding up a total of almost 800 million, 92% relying on biomass, **Table 19**).

Over 90 per cent of rural households in Mali, Mozambique and Tanzania rely on firewood and straw for cooking. Even if urban households have more diverse sources of fuel, charcoal is the preferred cooking fuel. But not always: for instance in Kano, a city of over four million people in northern Nigeria, wood fuel accounts for up to two-thirds of energy consumption, yet fuelwood related issues are not given the necessary priority in energy-environment-development debates (Tanko, 2016). Yet, experience across Africa suggests

that demand for charcoal will increase rapidly following urbanization trends. Households will first use it as a complementary fuel to firewood but gradually shift entirely as it is more convenient, given than alternatives such as LPG and electricity continue being expensive (Ministry of Infrastructure - Republic of Rwanda, 2015). As the size of the city continue to expand, and surrounding rural areas are integrated into the urban systems, over-exploitation of natural resources in hinterland urban areas will expand.

Figure 17: Access to clean cooking in Africa: national rate of access, 2015.



Source: (OECD / IEA, 2017b)

Table 18. Access to clean cooking in Africa, data disaggregated by region, 2000 – 2015.

	People with access to clean cooking				Population without access [Mill]	Population relying on biomass [Mill]
	2000	2005	2010	2015	2015	2015
World	54%	56%	58%	62%	2792	2500
Africa	24%	25%	28%	29%	848	785
North Africa	91%	97%	99%	99%	2	1
Sub-Saharan Africa	9%	11%	14%	16%	846	783
Central Africa	7%	8%	8%	9%	116	113
East Africa	5%	5%	14%	10%	249	240
West Africa	5%	5%	6%	13%	308	263
Other Southern Afri	14%	14%	13%	14%	164	161

Source: (OECD / IEA, 2017b)

The transition from a “non-cost” traditional fuel (fuelwood or cow-dung) to a modern renewable fuel, (biogas, o energy-efficient wood stove) requires an initial capital investment on the part of the individual user which is beyond the capability of the urban poor (UN-ENERGY/Africa, 2007).

Sub-Saharan Africa currently accounts for 4% of global energy investment, although it contains 14% of the world’s population (International Energy Agency, 2017).The social, economic and human costs of Africa’s energy crisis are not sufficiently recognized. Most of Africa’s school children attend classes without access to electricity. Energy-sector disruptions and power shortages cost the region 2-4 per cent of GDP annually. Governments spend US\$21 billion a year covering utility losses and subsidizing oil-based products. Companies in Tanzania and Ghana are losing 15 per cent of the value of sales as a result of power outages (Africa Progress Panel, 2015).

Table 19. Access to clean cooking in Africa, 2015

	ISO3	Population, 2015 [Mill]		
		Without access [%]	Without access	Relying on biomass
WORLD		38%	2792,3	2499,6
Africa		72%	847,7	784,5
North Africa		1%	2,1	1,4
Algeria	DZA	-	-	-
Egypt	EGY	1%	<1	<1
Libya	LBY	-	-	-
Morocco	MAR	3%	1,2	1,2
Tunisia	TUN	2%	<1	<1
Sub-Saharan Africa		84%	845,5	783,0
Central Africa		91%	115,5	113,4
Cameroon	CMR	77%	18,0	17,0
Central African Republic	CAF	>95%	4,8	4,8
Chad	TCD	95%	13,3	13,2
Congo	COG	84%	3,9	3,4
Democratic Republic of the Congo	COD	>95%	74,7	74,4
Equatorial Guinea	GNQ	77%	<1	<1
Gabon	GAB	15%	<1	<1
East Africa		90%	248,5	240,2
Burundi	BDI	>95%	10,9	10,8
Djibouti	DJI	94%	<1	<1
Eritrea	ERI	90%	4,8	3,9
Ethiopia	ETH	95%	93,9	93,1
Kenya	KEN	86%	39,7	34,1
Rwanda	RWA	>95%	11,5	11,5
Somalia	SOM	>95%	10,8	10,7
South Sudan	SSD	>95%	12,0	12,0
Sudan	SDN	65%	26,1	26,1
Uganda	UGA	>95%	38,1	37,9
West Africa		87%	308,2	263,3
Nigeria	NGA	94%	171,2	127,6
Benin	BEN	90%	9,8	9,6
Cote d'Ivoire	CIV	77%	17,4	17,3
Ghana	GHA	71%	19,6	19,5
Senegal	SEN	71%	10,8	10,2
Togo	TGO	91%	6,6	6,6
Burkina Faso	BFA	87%	15,7	15,6
Cape Verde	CPV	25%	<1	<1
Gambia	GMB	90%	1,8	1,8
Guinea	GIN	>95%	12,1	12,1
Guinea-Bissau	GNB	>95%	1,8	1,8
Liberia	LBR	>95%	4,5	4,5
Mali	MLI	50%	8,7	8,7
Mauritania	MRT	66%	2,7	2,4
Niger	NER	>95%	19,1	19,1
Sao Tome and Principe	STP	40%	<1	<1
Sierra Leone	SLE	>95%	6,3	6,3
South Africa	ZAF	18%	9,6	5,0
Other Southern Africa		86%	163,6	161,0
Angola	AGO	61%	15,1	14,9
Botswana	BWA	43%	<1	<1
Comoros	COM	93%	<1	<1
Lesotho	LSO	63%	1,3	1,2
Madagascar	MDG	>95%	23,9	23,9
Malawi	MWI	>95%	16,7	16,7
Mauritius	MUS	2%	<1	<1
Mozambique	MOZ	95%	26,5	26,2
Namibia	NAM	55%	1,4	1,3
Seychelles	SYC	2%	<1	<1
Swaziland	SWZ	50%	<1	<1
Tanzania	TZA	>95%	51,1	50,0
Zambia	ZMB	87%	14,1	14,1
Zimbabwe	ZWE	71%	11,1	10,6

Source: (OECD / IEA, 2017b)

Energy in urban areas

More than 50% of the world population (7 billion) lives in cities. By 2050, 70% of the world population will be in cities; close to 90% of the population growth is expected in cities. The pressure in sustainability is huge: challenges in terms of housing, infrastructure, basic services, food security, health, education, decent jobs, safety and natural resources, among others. Energy related challenges have grown tremendously already during the last century in cities all around the globe, in all countries, regardless the level of development. While cities acquire an increasingly dominant role in the global economy as centers of production and consumption, this rapid urban growth throughout the developing world is overtaking their capacity to provide adequate services for their citizens (ICLEI - Local Governments for Sustainability et al., 2009)

Cities, with high population densities, tend to concentrate environmental problems, air pollution, whose impacts can be felt both inside (may affect the health of the urban residents) and outside (affecting crops of near rural areas) (UN-ENERGY/Africa, 2007). Cities are typically more vulnerable to specific climate risks, such as increased temperatures and heat waves due to heat island effects, as well as to flooding resulting in increased surface run-off. On the other hand, it makes it easier to plan the provision of basic services (water and sanitation, electricity, waste collection and treatment, health, public transport, infrastructure) to citizens. As a result, urban areas tend to offer better social and economic opportunities than rural areas.

Differences in opportunities are found also within the city. Urban societies in developing countries are dual in nature: in some segments of the society, incomes are quite high, and their energy-consumption patterns are similar to those of industrialized countries, with increasing demand for high-intensity energy-consuming services, such as refrigeration, air-conditioning and personal transport. For the remaining segments of society, which constitute the overwhelming majority of the population, consumption patterns are similar to those in rural areas. Indeed, almost a billion urban residents live in informal settlements in developing country cities (UN-ENERGY/Africa, 2007).

Energy is used in urban centers for transportation, industrial production, in households and in office activities. In households, energy is mainly used for cooking, heating, cooling and lighting, being household income and climate the most influencing factors in the source of energy used and in the pattern. In some cases, it is also used for productive uses. In most low-income countries, a high proportion (up to 90 per cent) of the energy used in residential building is for cooking (UN-ENERGY/Africa, 2007). In poor urban communities, firewood alone often meets nearly all the energy needs of households. Traditional food processing and cooking are too time-consuming for most women who have to seek paid work to earn money: thus, an increasingly important activity in urban agglomerations is the street sale of foods – often utilizing highly energy inefficient cooking appliances (UN-ENERGY/Africa, 2007).

Several authors see the challenges facing African's growing cities as an opportunity to a transition towards sustainability (Swilling, 2015):

Africa is urbanizing at a rate of 4 per cent per year. Africa is less than 50% urbanized (UN Habitat, 2016).

In 2014, only 37 % of the entire population of sub-Saharan Africa lived in cities, making it the world's least urbanized region. The African continent is urbanising fast. By the mid-2030s, the majority of Africans will live in urban areas. The urban population of sub-Saharan Africa is expected to grow by 800 million people from 2014 to 2050. West and East Africa will witness the largest increases (Escudero et al., 2017). By 2050, sub-Saharan Africa's cities will have grown by almost 800 million people. This represents nearly half of the projected rise in numbers of urban dwellers globally. The enormous urban population growth puts cities at the centre of development planning as energy demand increases, whilst climate change threatens to deepen social urban vulnerabilities. Around two thirds of the infrastructure required to support Africa's urban population in the next three decades is yet to be built, offering more

efficient and low carbon pathway. How these urban areas will be constructed will have a fundamental impact on the environmental, and economic growth situation (Escudero et al., 2017).

The “African Economic Outlook” (AfDB / OECD / UNDP, 2016) explores the links between urbanization and structural transformation. New urban development policies can better harness the potential of sustainable cities to foster three types of development: economic development, social development and environmental development.

Number of mega cities ⁽³⁷⁾ will grow significantly. In 2014, there were 3 mega cities in Africa: Lagos (Nigeria, 21 million); Cairo (Egypt, 19 million) and Kinshasa (Democratic Republic of Congo, almost 12 million). Three more will join the list by 2030: Johannesburg, Luanda and Dar es Salaam. Much of the current debate regarding sustainable cities focuses on the formidable problems for the world’s largest urban agglomerations. However, smaller urban settlements are also growing rapidly and the majority of all urban dwellers reside in such smaller urban centres (ICLEI - Local Governments for Sustainability et al., 2009)

70% of Africa’s urban population lives in informal settlements and 60 per cent of total urban employment is in the informal economy (Escudero et al., 2017).

Progress in meeting the challenge caused by the urban growth would be shown by a fall in the proportion of slum-dwellers, who currently account for 70 % of the urban population of sub-Saharan Africa lives in informal settlements and slums (Escudero et al., 2017). In 2014 that share was almost 15 percentage points smaller. A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions: access to improved water, access to improved sanitation, sufficient living area (more than three persons per room), and durability of housing. Sub-Saharan Africa has a slum population of 201.5 million (2014, most recent year available in World Bank database). Africa is home to big slums such as West Point in Monrovia (Liberia’s capital) with more than 75,000 people, and Kibera in Nairobi (Kenya) the largest slum in Africa with over 2 million inhabitants (Bafana, 2016). This is a sign of a poorly planned and managed urban sector and a malfunctioning housing sector.

Inadequate sanitation infrastructure in Africa’s urban areas is costing economy around US\$5.5 billion every year amounting to between 1 and 2.5 per cent of GDP (The World Bank, 2013).

It’s common practice that in the Least Development Countries (33 in sub-Saharan Africa, 15 in other regions) it is primarily the private sector or donors that are involved in providing household stand-alone systems and devices in rural areas. Purely commercial models for grid electrification remain rare, reflecting high costs and limited demand, and rural electrification schemes emphasizing cost recovery and financial viability have proved neither affordable nor sustainable (United Nations Conference on Trade and Development, 2017). Circular rural-urban-rural migration is increasing the expectations of rural communities with respect to electricity access

The overall access in sub-Saharan Africa in 2016 was 42 per cent, rural access below 25 per cent, and urban-rural gaps between 4 (in Central African Republic) and above 75 per cent (in Mali). Such wide rural-urban differences in access to electricity are a major factor in urban bias in sub-Saharan Africa, not only lowering living standards in rural areas, but also reinforcing other disadvantages of rural populations. Rural electrification is thus a contributor in ensuring that rural-urban population is mainly driven by choice and not by necessity and in keeping rate of urbanization sustainable (United Nations Conference on Trade and Development, 2017).

⁽³⁷⁾ Metropolitan area with total population of more than ten million people.

4.4.2 Definitions and data

The IEA defines energy access as *"a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average"*. A basic bundle of energy services means, at a minimum, several lightbulbs, task lighting (such as a flashlight), phone charging and a radio. Access to clean cooking facilities means *"access to (and primary use of) modern fuels and technologies, including natural gas, liquefied petroleum gas (LPG), electricity and biogas, or improved biomass cookstoves (ICS), as opposed to the basic biomass cookstoves and three-stone fires used in developing countries"*. This energy access definition serves as a benchmark to measure progress towards SDGs (International Energy Agency, 2017).

More recently, however, there have been efforts in the context of the Sustainable Energy for All (SE4All) initiative to broaden understanding of access to energy in various dimensions (Bhatia and Angelou, 2015). The World Bank's Energy Sector Management Assistance Program is undertaking surveys in 15 countries to measure energy access according to the **"Multi-Tier Framework"**, a methodology which measures multiple attributes of the supplied electricity and cooking fuel. It seeks to understand electricity access not in binary terms. The approach excludes illegal connections.

- From a focus on households to encompass businesses and public and community facilities;
- From electricity supply to encompass modern fuels for cooking and (where needed) heating;
- From access to energy to technologies for its use (particularly improved and energy-efficient stoves);
- From a binary definition (of having or not having access) to a continuum, reflected in several tiers of access;
- From physical connection or availability to include attributes of supply, including quantity, reliability, continuity and safety;
- From physical supply to affordability;
- From access at a point in time to a progressive upgrading in access over time.

In the same report (Bhatia and Angelou, 2015), the definition of access to energy services highlights the ability of the end user to utilize energy services (such as lighting, phone charging, cooking, air circulation, refrigeration, air conditioning, heating, communication, entertainment, computation, motive power, etc.) that require an energy appliance and suitable energy supply.

In practice, the attributes of the energy supply will influence its usability for various energy services. Up to eight key attributes could be used with the purpose of defining and measuring energy access: capacity, affordability, availability, reliability, quality, health and safety, legality, and convenience (United Nations Conference on Trade and Development, 2017). Yet, SDG7 specifically mentions four: *affordable, reliable, sustainable and modern*.

Secure energy

Inadequate or unreliable access to electricity remains one of the biggest binding constraints on economic development (AfDB / OECD / UNDP, 2016):

- Power outages are considered one of the biggest obstacles faced by firms. In sub-Saharan Africa, 49% of small and medium-sized enterprises consider electricity as a major constraint. The manufacturing sector experiences power outage 56 days per year on average. Investing in generators costs three times the price of purchasing electricity from the public grid.
- Unreliable electricity is one of the main reasons preventing firms from growing bigger. In the informal sector, power outages cause up to 16% loss of sales revenues compared to 6% in the formal sector. Outages also discourage start-ups as they lack capital to invest in generators.

- Lack of access to electricity also leads banks to decline loans because it increases firms' economic risks.

Not just firms but also urban residents carry with the consequences of an unreliable power supply. For example, Nigerians spent \$13 billion a year on private diesel operated generators to compensate for the electricity shortages. About 86% of the companies in Nigeria run or share a generator and about 48% of total electricity demand is covered by this private generators ⁽³⁸⁾. The expected result is that costs for electricity are higher due to the need for back-up power (mainly diesel powered generators).

Sustainable energy

Local renewable energy sources such as biomass, solar radiation, hydropower and wind are all abundant in Africa. Energy recovery from waste can play a role in minimising the impact of Municipal Solid Waste (MSW) on the environment with the additional benefit of providing a local source of energy (Scarlat et al., 2015).

Renewable energy is especially relevant for African cities, help fill the energy gap (AfDB / OECD / UNDP, 2016), since they have the greatest need for local, decentralized energy capacity (UN Habitat, 2014). These technologies can best be deployed, tested and improved within African urban environments, where the skills and labour bases to implement decentralized systems are greatest. Given the projected demand for decentralized energy in African cities, the market for these technologies will ensure the growth to make these operations viable.

The International Energy Agency defend that renewables play a growing role, also in grid-connected electrification not just off-grid, also decentralized (International Energy Agency, 2017). But even among urban dwellers, off-grid solar products are finding a market. Many urban families are unable or unwilling to pay high connection charges. Grid-connection charges in Africa range from US\$2 to US\$400 (Africa Progress Panel, 2017). In Kenya, Rwanda, Tanzania, Burkina Faso and the Central African Republic, connection fees are more than the average monthly income. Solar lanterns or smaller solar home systems are often more affordable and immediately available. For the minority of Africans who do have a connection, solar home systems and solar lanterns can offer stop-gap measures to cope with unreliable grid power.

Affordable energy

Within African countries, the electricity grid serves the wealthiest and urban areas. Among the poorest 40% of the population, coverage rates are well below 10%. Connection to the grid exceeds 80% for the wealthiest one-fifth of households (Africa Progress Panel, 2017).

Energy access and poverty are highly correlated in urban areas. Castán Broto et al., 2017 describes an illustrative example in Ghana, where about 1.7 million people gained access to electricity every year from 2012 to 2014. Huge rolling blackouts, however, compromised these advances, particularly for poorer households lacking backup systems. This reality is especially shocking in the case of low-income rural-migrant populations, generally used to relatively easy access to non-commercial fuels in their villages. When they migrate to cities are often forced to buy commercial fuels for the very first time and at great expense (UN-ENERGY/Africa, 2007).

In part due to poor infrastructure and prohibitively high up-front costs, the poor often face much higher energy costs than the non-poor. This is compounded by the limited access to appropriate financing schemes that can allow the poor to overcome the high-up front costs of cleaner energy devices and appliances (UN-ENERGY/Africa, 2007).

According to the Africa Progress Panel, 138 million households comprising people living on less than US\$2.50 a day were spending US\$10 billion annually on energy-related

⁽³⁸⁾ <https://www.esi-africa.com/news/nigeria-eu-commits-184m-boost-electricity-network/>

products, such as charcoal, candles, kerosene and firewood. Translated into equivalent cost terms, these households spent around US\$10/kWh on lighting, which is about 20 times the amount spent by high-income households with a connection to the grid for their lighting. The average cost for electricity per kWh in the United States is US\$0.12 and in the United Kingdom is US\$0.15 (Africa Progress Panel, 2015).

Data on energy access

Official databases on access to electricity with global coverage show important discrepancies. The difference between IEA (estimates based on utility connections, reports higher figures) and World Bank (estimates based on household surveys) for figures on electricity access for 2014 is approximately 200 million (World Bank, 2015). IEA 2017 provides access data for 2016.

While most of major methodologies tracking electricity access have focused on grid electrification (including those by IEA in 2016 and prior), many are shifting to include all forms of electricity access, including off-grid. For example, the IEA Energy Access Outlook Special Report released in October 2017 provides data that also incorporates renewable off- or mini-grid connections with sufficient capacity to provide a minimum bundle of energy services (Dalberg Advisors and Lighting Global, 2018).

For clean cooking, a new historical analysis of reliance on cooking fuel use was undertaken for this report. The main source was the World Health Organisation (WHO) Household Energy Database 2016, which compiles national survey data on household cooking practices at urban and rural levels ⁽³⁹⁾.

- **At country level:** African Economic Outlook ⁽⁴⁰⁾, theme 2016 "Sustainable cities and Structural transformation": country profile to download. It does not include the most up-to-date information (2015 might be the most recent), but has a homogeneous coverage. It gives information on urban population, drivers of urbanization, national initiatives and main programs tackling urbanization, sustainability, environment, sanitation, etc. In the annexes, Angola country profile is included as an example.

- **At city level:** The UN-Habitat's Global Urban Observatory website contains free access urban indicators. Urban statistics are collected through household surveys and censuses conducted by national statistics authorities. It can help supporting governments, local authorities and civil society organizations to develop urban indicators, data and statistics. There are data on more than 750 cities, 51 in sub-Saharan Africa.

Indicators

Monitoring energy access is a challenging task. If no survey is conducted regularly in the national/regional/ local level including questions on the issue, it could become very demanding since it generally requires conducting surveys and interviews. Energy Access Indicators are the quantitative and/or qualitative measures derived from a series of observed facts that can reveal a country, community or person's relative status in modern energy access (OECD, 2008). Energy access indicators can be single (one-dimensional), a set of individual non-aggregated indicators (dashboards), or composite (multidimensional). Some examples are listed below:

- Number/percentage of population with electricity access.
- Electricity consumption per capita.
- The Multidimensional Energy Poverty Index (MEPI) developed by a team at UNIDO.
- The Energy Development Index (EDI) used by the International Energy Agency.
- The Energy Access Index proposed by the UK Charity, Practical Action.

⁽³⁹⁾ Unfortunately, IEA does not provide all the data included in the WHO Household Energy Database, but just a summary adding up, for example, rural and urban data.

⁽⁴⁰⁾ <http://www.africaneconomicoutlook.org/en/theme/sustainable-cities-and-structural-transformation>

4.4.3 Energy access implications

The effort to expand energy access in Sub-Saharan Africa shall be made with consideration to climate change issues, since its impacts could hamper progresses towards access and impose further social and environmental costs. Within this framework, opportunities for new, sustainable and reliable energy options arise. SSA is a minor contributor in the global GHG emissions but it shows a vast underutilised potential for renewable energy resources (Sokosan et al., 2012). Moreover, improving the access to energy has several implications for communities, for special social groups, for the economy of the city and of the region as well. A fair and improved access to modern energy service is considered a mean to improve the quality of life and to reduce poverty in sub-Saharan Africa (The world Bank, 2017b). The term “modern” is often introduced in the access discourse to make a distinction between traditional forms of energy like firewood or agricultural residues and commercial forms of energy like electricity or LPG (Brew-Hammond, 2010). Access to electricity refers to the availability of electricity in areas not reached by the grid. In this case, there are options for providing electricity by a decentralised or stand-alone power source (petrol or diesel generator), or a renewable energy device (solar PV, wind turbine or biomass gasifier). Electrification and transition to clean cooking, while being a priority, find several barriers among which the inability of the customers to pay regularly, the informality of the settlements, the impossibility of signing formal agreements and difficult cooperation between utilities, dwellers, and local authorities. This calls for a strategic engagement of different stakeholders that may participate actively in the decisions regarding the provision of the energy services.

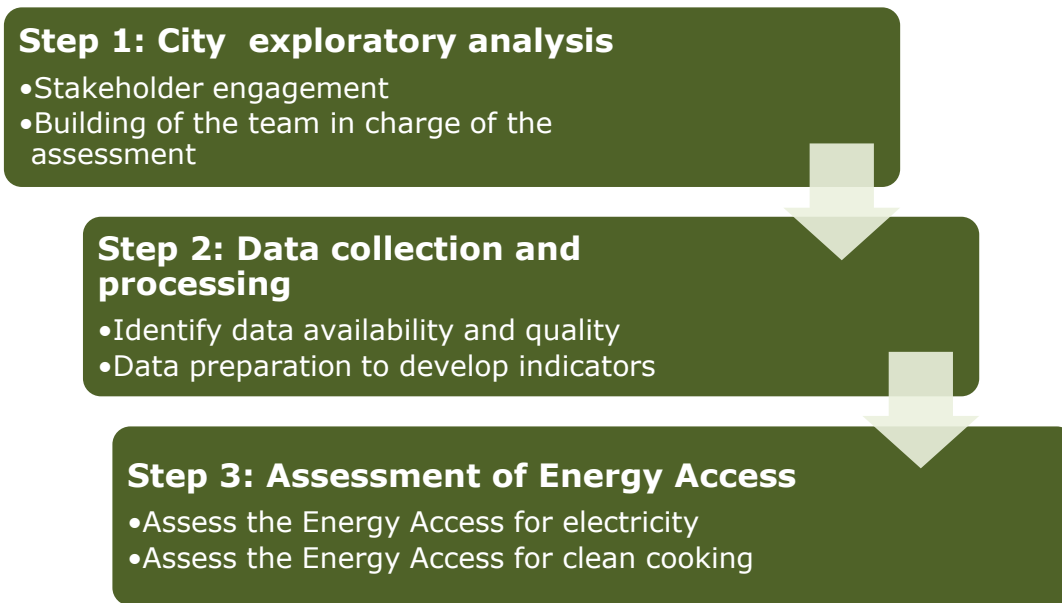
Against this background, the energy access approach includes the attributes of secure, sustainable and affordable energy, which have been already presented through the present document. As a consequence, any assessment of Access to Energy shall take into consideration these attributes. In the following paragraphs, how these attributes are assessed in the AEA framework is further developed.

4.4.4 Access to Energy Assessment (AEA)

The Access to Energy Assessment (AEA) is developed as a dashboard of multiple indicators that help to figure out a clear picture of the current condition of the local authority. The first step of the procedure consists in building the team responsible for the assessment. For effective results, suitable skills and knowledge of both the topic and the territory should be important requirements for the team members. Moreover, the involvement of stakeholders may be essential for the following step. The second step regards the collection of data necessary for developing the indicators. In the third step, the indicators are used to assess the energy access in the key fields proposed within the CoM framework (**Figure 18**). Detailed assessment of the current condition can support decision making process regarding policies and investments.

It must be noted that at the date of the preparation of the present document, the recommendations of the GCoM TWG on energy access and energy poverty are not yet available.

Figure 18. Procedure for the Energy Access Assessment



4.4.4.1 Sectors and energy uses covered

In the framework of the CoM SSA initiative the fields to be considered to assess the energy access in Sub-Saharan Africa are: clean cooking and electricity in households and public buildings. This allows taking into consideration both the single house detailed approach and the community one. While the lack of modern cooking systems affects mainly health and family issues, lack of electricity access has a strong impact on education and on productive income-generating activities. Access to electricity refers not only to household activities but also to community services from infrastructure such as hospitals and schools. As a consequence, it is important to recognise energy needs across homes, workplaces and community. The Sustainable Development Goals (SDG) related to living standards include (among the others) the access to both the mentioned aspects: clean cooking fuels and electricity (SDG 7). All developing regions of the world suffer from low access to clean cooking. In particular, in Sub-Saharan Africa by 2010 less than 30% of population had access to clean cooking fuels (Rao et al. 2017). Externalities arising from the lack of access to clean cooking include increased health risks due to smoke exposure, deforestation and social and gender imbalance.

Despite the significant progresses in electrification, 590 million people – roughly 57% of the population – remain unconnected in SSA (OECD/IEA, 2017). The use of electricity has numerous benefits including: increased lighting, ecological aspects (air quality and forest protection) and health well-being. As a result, the electricity for many households implies a change in welfare (Abdullaha and Jeanty, 2009).

The question of energy access requires the involvement of higher centralised institutional bodies. However, the local authority has a great role to play. Firstly in outlining and overviewing the local current status of electrification and cooking fuels. Secondly in establishing close cooperation with central governments and industrial bodies.

When developing the assessment, the disparity between urban and rural areas within the city and the state of informal settlements are key aspects to be taken into consideration. Only 22% of the population in rural areas has access to clean cooking. The Sustainable Energy for All (SE4All) Global Tracking Framework (2017) estimates that the 45% of the global population living without access to electricity is settled in rural areas of Sub-Saharan Africa, while only the 9% is in the urban areas of the region.

National figures may not be representative of the local conditions, since these are not sensitive to the significant differences and disparities among cities and between rural and urban areas within a local authority's area of jurisdiction. As a consequence,

although national statistics and figures represent a key support for assessing the current condition of energy access, there is the need for a local approach. This enables local authorities to build a sound knowledge of the status of their territories and inhabitants and underpins premises for action. In this context, the assessment of the initial level of energy access is crucial. The key variables included in the assessment to describe the energy access and the main indicator used, are further developed in the following paragraphs.

4.4.4.2 Data collection

The collection of data to develop the assessment is a key step of the process. However, data is not always available. It also may vary in terms of detail, scale, aggregation, and typology. For this reason, several options of data collection can be considered and a combination of the different opportunities may allow filling the gaps. Modelling outcomes are a resource, as well. As previously mentioned, data regarding local territories is ideal, but in case this is not accessible, integration with more aggregated data at regional or country level may be feasible. In this perspective, National data from public institutions may represent a key starting point. Statistical Services may conduct periodic national population and housing census that may include household energy usage data ⁽⁴¹⁾. There may also be initiatives led by central governments or international institutions focusing on particular regions or areas. In these cases, comparisons or modelling methodologies based on these data, if transparent and well-explained, may lead to acceptable results and estimations. As an example, the International Energy Agency has historical values since 1971, by country and regions, including actual consumption levels and share of households relying on traditional fuels as primary source for cooking. Food and Agriculture Organization (FAO) is working on the area of fuel and energy for cooking, heating, lighting and powering. Resources on this topic are publicly available on the website (<http://www.fao.org>).

Other options for data collection can be online platforms like the Climate Information Platform of CSAG - Climate System Analysis Group (<http://www.csag.uct.ac.za/>). Collaborations with universities may be a strong point in the fact that specific courses, master thesis and PhD researches can focus on specific topics in areas within the local authority territory and produce useful results. This underlines the importance of collaboration and stakeholders' involvement.

Moreover, local authorities should have a clear picture of the financial institutions (FI) to be partnered with. FI should be contacted at the beginning of the SEACAP process (see chapter 8 on financing), since their support may deal with numerous options in addition to funds. As an example, scholarships may be funded allowing students and researchers to work on projects that are able to provide key data. Energy surveys are an essential data-collection tool. The preparation of the survey is a crucial step. Questions should be focused in order to gather useful data for building the indicators and samples must be chosen accurately. Moreover, the same survey could be used to establish energy access and household fuel use for inventory purposes. In this context, it is also important to keep track of the categories and the samples surveyed. This tool could be useful in the case of off-grid areas and households. As an example, Winrock International conducted a survey on a small sample of the population in Liberia ⁽⁴²⁾ (Alfaro and Miller, 2014). The survey results have been used for the determination of expected monthly electricity bills and customers' ability and willingness to pay.

⁽⁴¹⁾ See the case of Ghana for instance. Mensaha G. S., Kemausuor, F., Brew-Hammon, A. (2014). Energy access indicators and trends in Ghana. *Renewable and Sustainable Energy Review* 30, pp. 317-323

⁽⁴²⁾ Winrock International (2011). Load demand assessment and socio economic survey for proposed mein mini hydropower project. Monrovia, Liberia.

4.4.4.3 Key variables and indicators

Access to energy has a multi-dimensional nature which makes its assessment challenging. As previously stated, binary definitions of energy access – ‘having access’ or ‘not having access’ – are unable to catch important differences in terms of energy technologies and communities’ needs. On the contrary, the use of multiple indicators allows evaluating energy access with the aim of supporting decision making, and clearly monitoring progress made. In literature numerous types of energy access indicators exist. In this guidebook, a collection of one-dimensional indicators, which measure a single aspect of energy access, is proposed. These indicators are easy to calculate and to interpret. They reflect the multi-faceted key elements (sustainability, security and affordability) of energy access. Through the selection of multiple indicators, several aspects of energy access and their implications are measured and a holistic perspective is ensured. This approach enables also to identify co-benefits and avoid trade-offs. However, keeping track of specific issues (such as informal fuel selling and illegal electricity connections) is extremely difficult. For this reason, local authorities are not required to assess these aspects but are encouraged to do so, through their initiative and subjective proposal.

4.4.4.4 Electricity Key indicators

In this section ten key indicators for electricity access are proposed and the fundamentals for their developments are explained. There is an overall indicator and 9 indicators (**Table 20**) which are individually related to one of the three key attributes of energy access, as detailed in the following. To lead the AEA, the local authority has to select and evaluate at least one indicator per each category, along with the overall one.

Overall indicators:

- 1) Percentage of population or households having access to electricity (grid/off-grid) [%]
 - a) Number of persons per households [n°] or number households [n°] or average surface of households [m²]

Linked to the Security (SC) attribute:

- 2) Number of hours per day of available electricity [h/day]
- 3) Average number of electricity interruptions per day [n°/day]
- 4) Number of days without electricity per year [n°/year]

Linked to the Sustainability (SU) attribute:

- 5) Percentage of electricity from Renewable Energy Sources (RES) [%]
- 6) Number of minigrids and stand-alone systems [n°]
- 7) Laws and regulations in place for mini-grids/stands-alone systems [+/-]

Linked to the Affordability (AF) attribute:

- 8) Percentage of population able to pay for electricity [%]
- 9) Percentage of expenditure of Public Buildings for electricity [%]
- 10) Financial and regulatory incentives for renewable energy in place [+/-]

Table 20. Access to Energy indicators - Electricity

Attribute	Related Indicator
Overall	Percentage of population or households in having access to electricity (grid/off-grid) [%]
SC2	Number of hours per day of available electricity [h/day]
SC3	Average number of electricity interruptions per day [n°/day]
SC4	Number of days without electricity per year [n°/year]
SU5	Percentage of electricity from RES [%]
SU6	Number of minigrids and stand-alone systems [n°]
SU7	Laws and regulations in place for mini-grids/stands-alone systems [+/-]
AF8	Percentage of population able to pay for electricity [%] or willingness to pay
AF9	Percentage of expenditure of Public Buildings for electricity [%]
AF10	Financial and regulatory incentives for renewable energy in place [+/-]

The Overall indicator gives a general picture of the current situation of the access to energy in the local authority. This includes aggregated data that help building a starting point to be further developed with the use of other specific indicators (SU, AF, SC). Local authorities could only determine a comprehensive framework with the combination of multiple information and perspectives, which the proposed indicators aim to support. Moreover, as reported in a) giving information on the average characteristics of households is very important to build correct figures of the local situation. However, this is recommended but not mandatory.

SC (2/3/4) – In many Sub-Saharan African countries, electricity supply is unreliable. Frequently, supply is not sufficient to meet demand because of its instability, with a growth in the number of customers requiring electricity services. As a consequence, low electric power quality, exemplified by the occurrence of localised outages (interruption of the transmission and distribution of electricity due to a technical problem, a tempering or an overload) and load shedding (load reduction as a controlled option to respond to unplanned events to protect the electricity power system from a total blackout), incurs significant costs (Ahlborg, et al., 2015) and badly characterises the quality of energy when it is available. The indicators in this category aim at assessing the reliability and the quality degree to which households and public buildings have access and use electricity. SC2 is calculated by considering the average number of hours of daily supply. SC3 assesses the average interruption of the energy supply during the day, while SC4 the shortfall in energy supplies during the year.

SU (5/6/7) - The share of renewable energy in the energy mix is crucial, also for creating more sustainable and inclusive communities. The solar energy potential for African cities is evident and it is gaining a wider consensus among citizens and stakeholders.

SU5- This indicator measures the share of renewable energy in electricity generation. The increase of renewable energy in the energy mix is an agreed target among international, national and regional levels. Renewable energy options are aggregated within the

calculation of this indicator. The share of renewables in electricity is calculated as the electricity generated by renewables divided by total electricity use.

SU6- Technological innovations and new business models are making mini grids a scalable option for expanding energy services in low access areas like Sub-Saharan Africa. Mini-grid solutions need to be tracked and monitored in order to get a better understanding of the current condition.

SU7- The regulatory uncertainty and inadequacy of policies may hinder the advancement of the off-grid sector. The development of a regulatory framework represents a key aspect to assess the current status and the potential development of a fruitful environment for the off-grid sector. The positive value of the indicator indicates that policies or regulations are in place or under development. On the contrary, a negative value shows a policy vacuum.

AF (8/9/10)- Affordable electricity in Sub-Saharan region is a multifaceted question. Affordable energy is a mean to reduce poverty and increase the well-being of communities and put the basis for a continuous progress.

AF8- The share of households able to pay and/or the amount households are willing to pay for electricity services represent figures that may guide stakeholders when making tariff decisions and policy makers when examining the welfare impacts and viability of these services (Abdullahi and Jeanty, 2009). Willingness to pay may be evaluated through surveys with different stakeholders as previously mentioned. Data regarding the percentage of households able to pay may be gathered by Energy suppliers.

AF9- This indicator aims at assessing the incidence of electricity cost in public expenditure. The services provided by public facilities (health centres, schools, municipal offices ...) are determinant for the proper functioning of public affairs and for assuring wealth of communities. As a consequence, this indicator helps determining if the public facilities are able to afford these costs and may support policies towards the cost reduction and energy efficiency, in order to keep at acceptable level the public services provided to citizens.

AF10- Financial and regulatory incentives refer to measures to improve the financial returns or reduce the risk of private renewable generation projects. These mechanisms are one of the most cost effective supports for private investments in this field. This indicator will be positive if there is at least a scheme to support renewable energy penetration or the provision of grants or subsidies. These may be framed at national level and then disseminated and further developed at local level, tailored to specific conditions in urban and rural areas.

4.4.4.5 Clean cooking Key indicators

Due to the cross-sectoral nature of the access to cleaner cooking fuels and more efficient cook stoves, indicators may relate to indirectly linked variables. However, this allows assessing the potential impacts of improvement on the local community on the whole. In this paragraph the nine key indicators for clean cooking are listed and the fundamentals for their developments are explained. The approach considers one overall indicator and 8 indicators (**Table 21**) which are individually related to one of the three key attributes of energy access, as detailed in the following. To lead the AEA, the local authority has to select and evaluate at least one indicator per each category, along with the general one.

Overall indicators:

1. Percentage of population/households with clean cooking access [%]

Linked to Security attribute (SC)

2. Percentage of population/households relying on the traditional use of biomass for cooking [%]
3. Percentage of population/households relying on LPG or other sources [%]
4. Availability of resources: time and distance to gather fuelwood [h and km]

Linked to the Sustainability attribute (SU)

5. Number of improved cook stoves [n°]
6. Sustainable production (charcoal, biomass...) [Y/N]
7. Awareness and/or Education programmes in place [Y/N]

Linked to the Affordability attribute (AF)

8. Financial and regulatory incentives or subsidy mechanisms in place [Y/N]
9. Percentage of population able to pay (or willingness to pay) for the transition to clean cooking [%]

Table 21. Access to Energy indicators – Clean cooking

Attribute	Related Indicator
Overall	Percentage of population/households with clean cooking access [%]
SC2	Percentage of population/households relying on the traditional use of biomass for cooking [%]
SC3	Percentage of population/households relying on LPG or other sources [%]
SC4	Availability of resources: time and distance to gather fuelwood [h and km]
SU5	Number of improved cook stoves used [n°]
SU6	Sustainable charcoal production [Y/N]
SU7	Awareness and/or Education programmes in place [Y/N]
AF8	Financial and regulatory incentives or subsidy mechanisms in place [Y/N]
AF9	Percentage of population able to pay (or willingness to pay) for the transition to clean cooking [%].

The Overall indicator gives a general picture of the current situation of the access to energy in the local authority. This indicator includes aggregated data that help building a starting point to be further developed with the use of the other specific indicators (SU, AF, SC). Local authorities could only determine a comprehensive framework with the combination of multiple information and perspectives, which the proposed indicators aim to support.

SC (2/3/4) According to OECD/IEA, 2017 access to clean cooking facilities means access to and primary use of modern fuels and technologies, including natural gas, liquefied petroleum gas (LPG), electricity and biogas, or improved biomass cook stoves, as opposed to the basic biomass cook stoves and three-stone fires.

SC2- The use of solid fuels, traditional biomass and coal, represent a measure of the deprivation of using more modern fuels. In the case data are not available, surveys may be conducted.

SC3- LPG is produced from natural gas liquids and from refinery supply and it is relatively safe compared to kerosene. LPG is transported and sold pressurised in cylinders, and therefore needs some distribution infrastructure, together with reliable roads. As a consequence, LPG is a common path to access clean cooking options, especially in urban areas (OECD/IEA, 2017). Along with LPG, other less polluting are accepted. Data could be locally available. However, the indicator can be calculated by cross-referencing data by suppliers by local census.

SC4- Women spend numerous hours in collecting fuelwood (usually at greater distance from the household) and in cooking. It is crucial to develop more detailed figures on this aspect to build upon strategies to reduce time spent in those activities and, in parallel, improve the conditions of women.

SU (5/6/7) The access to clean cooking is achievable principally through sustainable supply and improved cook stoves.

SU5- A traditional (or basic) cook stove is typically identified as a very cheap or no-cost device, characterised by very low efficiency and high burns solid biomass. An improved biomass cook stove (ICS) typically describes a stove which has a higher efficiency or lower level of pollution than a traditional stove, through improvements ⁽⁴³⁾. The introduction of improved cook stoves, that decrease firewood and/or charcoal use, contributes to the provision of clean cooking access in rural areas.

SU6- Sustainable charcoal production may reduce the impacts on the environment. There are already regulations and projects in place that support the use of certified charcoal. The indicator aims at assessing if there is a sustainable production of charcoal within the boundary of local authorities and, if positive, to provide further information in this regards.

SU7- The increase of education and awareness about the importance of clean cooking and the fuel and time savings, health and environment co-benefits is determinant for the transition. As a result, this indicator assesses if programmes are already in place.

AF (8/9) Affordability can be assessed through an overall perspective that includes also issues related to sustainable and secure energy.

AF8- Financial and regulatory incentives and subsidy mechanisms refer to measures to boost the transition towards LPG or ICS. This indicator will be positive if there is at least a scheme to support the change in the supply or the provision of grants or subsidies. These may be framed at national level and then disseminated and further developed at local level.

AF9- The share of households able to pay and/or the amount households are willing to pay for changing the fuel and/or method to cook represent figures that may guide stakeholders when making tariff decisions and policy makers when examining the feasibility of financial policies. This indicator is strongly related to SU7 and AF8. Willingness to pay may be evaluated through surveys as previously mentioned. Data regarding the percentage of households able to pay may be gathered by energy suppliers.

⁽⁴³⁾ USAID/WINROCK. Clean and efficient cooking technologies and fuels

5 Sustainable Energy Access and Climate Action Plan (SEACAP) process: development of the plan / moving forward

Plan elaboration – that is, breaking the target down into actions the local authority will undertake in the sectors addressed – serves several functions as well as translating the city's vision into practical actions assigning deadlines and a budget for each of them. It outlines what the city will look like in the future in terms of energy, mobility, resilience infrastructure and land use, population, consumption patterns and climate projections while also communicating the plan to stakeholders. In addition to generating a roadmap of specific, scheduled, budgeted actions, roles and responsibilities, SEACAP serves as a reference during implementation and monitoring.

The following characteristics may be useful to develop sound SEACAP actions:

- **Measurable:** Design actions based on the indicators used for the BEI and the RVA.
- **Thorough:** Elucidate actions in depth to get a clear and realistic sense of requirements and results (resources, budget, timeframe, policy integration, etc.). All actions adopted in the SEACAP should be carefully designed and properly described, including timing, budget, responsibilities and sources of financing.
- **Realistic:** Assess action implementation requirements against available capacity and resources.
- **Appropriate:** Actions depend on the specific context of each local authority and the quality of the assessment of the existing local, regional and national policy framework.

For each action explored, consider also where chief responsibility lies (whether or not they are addressed by the local administration and/or require coordination with higher or national authorities), what instruments will be used (regulation, financial support, communication and information, demonstration, etc.) and the impact on energy production and consumption patterns (energy efficiency of equipment, buildings, cars; behavioural change such as turning off lights, using public transportation; cleaner energy such as renewable energies, biofuels) and or vulnerable sectors. More specifically, for each action included in the action plan, the local government should provide the following:

- Brief description of the action/action area/sector
- Assessment of energy saving, renewable energy production, and GHG emissions reduction by action, action area or sector (only applicable to mitigation actions).
- Financial strategy for implementing the action/action area/sector
- Implementation status, cost and timeframe
- Implementing agency(ies)
- Stakeholders involved in planning and implementation
- Prioritization of actions
- Policy instrument(s) to implement the actions

Most local authority activity concerns buildings and transport, the use of renewable energy sources to produce energy locally, urban and land-use policies, and public procurement. In most countries, however, these policies are decided at regional and national levels and local authorities are not always part of the decision-making. In assessing existing policies, concentrate on the local authorities' capacity to go beyond national policies in the territory under their responsibility and to ensure resources and financing for the proposed actions.

Box 20. SEACAP actions: best practices

- Catalogue existing activity/policy; Analyse best practices;
- Set priorities based on the results of pre-assessment;
- Carry out risk analysis;
- Specify timing, responsibilities, budget and financing;
- Seek approval and funding;
- Review/Update and communicate SEACAP regularly.

It is worth noting that continuous monitoring and evaluation is needed to follow SEACAP implementation and progresses towards the defined targets and eventually to make corrections. Regular monitoring followed by adequate adaptations of the plan allows initiating a continuous improvement cycle. This is the "loop" principle of the project management cycle: *Plan, Do, Check, Act*. It is extremely important that progress is reported to the political leadership.

5.1 Setting objectives and targets

5.1.1 Long-term vision

Local authorities should establish a long-term vision with clear SMART ⁽⁴⁴⁾ objectives. The vision shall be tackled as the guiding principle of the SEACAP work, pointing out the direction that the municipality wants to follow. A comparison between the vision and the local authority's current situation is the basis for identifying which action is needed to reach the desired objectives. The SEACAP work is a systematic approach to gradually get closer to the vision.

The vision should be elaborated with the local communities through citizen participation and discussion groups in order to allow for the unification of all the stakeholders.

Despite the fact that the vision needs to be compatible with the CoM SSA commitments, it could also be more ambitious than that. Some cities already plan to become carbon neutral in the long run. Setting a longer-term target is considered a key success factor of SEACAPs as it clearly shows the local authority's political commitment and gives a strong message to citizens and stakeholders on how the local authority wants to develop in the future, paving the way for more substantial investment in sustainable infrastructure (Rivas et al., 2015). The vision should be realistic but still ambitious and aligned with the national and international policy landscape. It should describe the desired future of the city and be expressed in visual terms to make it more understandable for citizens and stakeholders.

5.1.2 Targets

Once the vision is well established, it is necessary to translate it into more specific objectives and targets, for the different sectors in which the local authority intends to take action. Such targets and objectives should follow the principles of the SMART acronym: Specific, Measurable, Achievable, Realistic, and Time-bound. The concept of SMART objectives became popular in the 1980s as an efficient management concept. To set SMART targets, use the following questions:

Specific (well-defined, focused, detailed and concrete): What are we trying to do? Why is this important? Who is going to do what? When do we need it done? How are we going to do it?

⁽⁴⁸⁾ The principles of the SMART acronym: Specific, Measurable, Achievable, Realistic, and Time-bound.

Measurable (kWh, time, money, %, etc.): How will we know when this objective has been achieved? How can we make the relevant measurements?

Achievable (feasible, actionable): Is this possible? Can we get it done within the timeframe? Do we understand the constraints and risk factors? Has this been done (successfully) before?

Realistic (in the context of the resources that can be made available): Do we currently have the resources required to achieve this objective? If not, can we secure extra resources? Do we need to reprioritise the allocation of time, budget and human resources to make this happen?

Time-Bound (defined deadline or schedule): When will this objective be accomplished? Is the deadline unambiguous? Is the deadline achievable and realistic?

Table 22 lists some examples of SMART targets set for two concrete instruments, energy performance standard and subsidy scheme.

Table 22. Examples of SMART objectives.

Type of instrument	Examples of SMART targets
Energy performance standard	S: Focus on specific product or product group M: Performance characteristics aimed for/set baseline A: Performance standard links to best available product on the market and is regularly updated R: Best available product is accepted by the target group T: Set clear target period
Subsidy scheme	S: Focus on a specific target group and on specific technologies M: Quantified energy savings target/set baseline A: Minimize free riders R: Link the savings target to the available budget T: Link the energy savings target to a target period

Source: <http://www.aid-ee.org/documents/SummaryreportFinal.PDF>.

With regards to mitigation, all local governments and cities are required to set and report city-wide emissions reduction targets. The GCoM defines eight categories of requirements for target setting, as explained below ⁽⁴⁵⁾:

- **Boundary (geographic coverage, sectors, and GHGs):** The emissions boundary shall be consistent with all emissions sources included in the GHG emissions inventory, with the possibility to exclude sources that are not controlled by the local government. In case that the target boundary does not align with the inventory boundary, any additions or exclusions shall be specified and justified.
- **Target type:** Local governments shall use one of the following four target types: base year emissions target, base year intensity target, baseline scenario target, or fixed level target (Box 21). For a baseline scenario target, the modelling methodologies, and parameters shall be transparently described.
- **Target year:** The target year shall be the same as the target year adopted in the Nationally Determined Contribution (NDC). Cities that set a target year beyond 2030 shall include an interim target before 2030.
- **Base year** (for base year target and base year intensity targets only): The base year shall be the same as the base year used in the NDC. Where the base year is different from the NDC (e.g. due to a lack of data availability), this shall be justified.

⁽⁴⁵⁾ See also the Global Protocol for Community Scale Greenhouse Gas Inventory (GPC) available at: <https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>

- **Ambition:** At a minimum, the target shall be as ambitious as the unconditional components of the NDC. Local governments should set targets that are more ambitious than the NDC.
- **Units:** Targets shall be reported as a percentage (%) reduction from the base year or scenario year. The absolute emissions in the target year(s) in metric tonnes CO₂-eq shall also be reported.
- The use of transferable emissions units is only permissible when a city's target ambition exceeds the NDC. Where this is the case, the local government shall report the target, with and without the transferable emissions units, as well as identify the source of the transferable emissions units.
- Any conditional components included in the target shall be identified. Where possible the conditional components should also to be quantified. Conditional components include where cities set a stretch target, or where actions are identified for other key stakeholders beyond that which they have committed to themselves (for example, where a local government assumes a more ambitious reduction in the carbon-intensity of the national electricity grid than that committed to in the NDC or official government policy), if possible.

Box 21. Target type

Base year emissions target: Reduce, or control the increase of, emissions by a specified quantity relative to a base year. For example, a 25% reduction from 1990 levels by 2030.

Base year intensity target: Reduce emissions intensity (emissions per unit of another variable, typically GDP or capital Gross Domestic Product – GDP or per capita) by a specified quantity relative to a base year. For example, a 40% reduction from 1990 base year intensity by 2030.

Baseline scenario target: Reduce emissions by a specified quantity relative to a projected emissions baseline scenario. A Business as Usual (BaU) baseline scenario is a reference case that represents future events or conditions most likely to occur in the absence of activities taken to meet the mitigation target. For example, a 30% reduction from baseline scenario emissions in 2030.

Fixed-level target: Reduce, or control the increase of, emissions to an absolute emissions level in a target year. One type of fixed-level target is carbon neutrality

5.1.3 Setting the targets for energy access

Under the GCoM framework, the Local Authorities may commit to improving the access to energy within the area of their responsibility. Through the indicators, an overview of the strategy adopted is provided. The will to invest time and money on a certain field, rather than another, shapes the way the targets are to be achieved. Moreover, indicators are determinant, along with the assessment of the current status, to monitor the progresses after the selection of the strategies and implementation of the actions. On the basis of the indicators and requirement previously described, LAs can choose and declare their objective, that means the extent to which they intend to increase the access to energy towards the 2030 SDG, and therefore, which indicators will change and how. The achievement of a minimum condition is essential for the overall indicators. Suggestions are provided for the specific ones (SC-SU-AF). This approach enables to keep a high level of flexibility which supports the consideration of local peculiarities. On the other side, the process to improve the energy access selected by local authorities will be clearly showed by the progresses in each indicator. In the following box, the requirements and suggestions for the ambitious differentiated actions of SDG 7 are reported.

Box 22. SUSTAINABLE DEVELOPMENT GOAL n°7 (SDG7)

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all. The targets are:

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

7.2 Increase substantially the share of renewable energy in the global energy mix by 2030

7.3 double the global rate of improvement in energy efficiency by 2030

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, and promote investment in energy infrastructure and clean energy technologies

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, particularly least developed countries (LDCs) and small island developing states (SIDS).

5.1.3.1 Electricity targets

In line with the SDG 7 targets, LAs need to contribute to the universal access to energy. For this reason, along with the target for 2030, a mid-term target at 2025 for the overall indicator (*Percentage of population or households having access to electricity*) can be set. A target of at least a 20% increase is suggested for the indicator.

LAs shall declare the target years for the other indicators according to their conditions and potentials.

In literature (Worldbank, 2014), the supply of electricity for less than 8 hours per day cannot be considered adequate. Therefore, the indicator SC2 should show an increase of the duration of electricity beyond the 8 hours per day. However, in cases this would not be feasible, an increase of the number of hours will be already a successful step towards the final overall target. For SC3 the fewer the number of electricity interruptions, the more reliable is the energy supply. Having no interruptions is a key indicator of reliability. Also for SC4, a high quality energy supply should not encounter days without service. Although, the reduction of the number of days without electricity is linked to the supplier, also LAs can contribute to the quality of energy supply by supporting policies regarding the energy mix and taking care of the infrastructures within its boundaries.

Regarding the Sustainability (SU) indicators, LAs could choose the degree of commitment and improvement of energy sustainability within their authority. An increase of at least 20% could be considered in SU5 and SU6 (in the number), while the qualitative approach for SU7 includes the development of new specific regulations and their prospective amendment.

An improvement in the energy access is also described by an increase of the *Percentage of population able to pay for electricity* (AF8). Since the ambition is to assure universal access to energy, the combination of this indicator and the AF10 is of utmost importance to reach the 100% target of universal access. While the former provides a quantitative evaluation, the latter is qualitative and includes the development of new specific financing schemes or incentives that may make the electricity more affordable. Also for these two indicators (AF8 and AF9) a medium-term target, beyond the 2030, is recommended. AF9 is also a measure of energy efficiency, hence, it is important to keep the quality of the service while reducing the expenditures.

5.1.3.2 Clean cooking targets

Within the clean cooking field, a mid-term target at 2025, along with the target for 2030, for the overall indicator (*Percentage of population/households with clean cooking access*) could be set. A target of at least a 20% increase for households could be considered.

Suggestions for SC indicators aim at reducing the reliance on traditional biomass (SC2) and in parallel, at increasing the use of other (sustainable, secure and renewable) sources (SC3). Moreover, SC2 is significantly linked to SC4: once SC2 tends to zero, also SC4 will tend to be nil. These ambitious goals should be achieved with a progressive improvement. Therefore, for these indicators setting a medium-term target is recommended.

The Sustainability (SU) indicators include two qualitative approaches (SU6 and SU7) and a quantitative one (SU5). The former will assess an improvement in the cleaning cooking condition if the development of awareness and education campaigns is put in place and if a sustainable charcoal production or identification of other energy sources for cooking is underway. However, the effects of these potential measures will be tangible on the long term. Therefore, it is important to have a short term target to start the measures. As an example, the target could be to replace the overall cook stoves for SU5 by 2030.

An improvement in the clean cooking access is also described by an increase of the percentage of population able to pay for it (AF9). Since the ambition is to assure universal access to energy, the combination of this indicator and the AF8 is of utmost importance to reach the 100% target of universal energy access. While the former is qualitative and includes the development of new specific financing schemes or incentives that allow implementing healthier ways of cooking, the latter provides a quantitative evaluation of the real potential of paying, which must increase in time. Also for these two indicators (AF8 and AF9) a mid-term target, beyond the 2030, is recommended.

5.1.4 Actions with co-benefits

The benefits of policies that are implemented for various reasons at the same time are numerous. Most including climate change mitigation policies, designed to address greenhouse gas mitigation, also have other, often at least equally important, rationales (e.g. related to objectives of development, sustainability and equity).

Immediate needs (such as high levels of unemployment, poverty, high crime rates, and infrastructural backlogs) compete with climate change for political attention and resources, so any action must have development co-benefits.

African cities take advantage of the opportunity to leapfrog the carbon-intensive and ecologically destructive development path of the past and that this framework engages in an appropriate way with the challenge of high levels of informality and still-evolving governance structures. This requires that the climate question is asked in a different way in Africa – that is, how does a low carbon development pathway create increased adaptive capacity, and how can that adaptive capacity be used to meet growing development needs in a more sustainable and resilient way? To enable this, innovative finance mechanisms that directly support city-level action are essential following COP21 in Paris, 2015 (from ARC3.2 Climate Change and Cities) (Rosenzweig et al., 2015).

Box 23. Case of synergies and trade-offs: Durban hosting COP17

Ethekwini Municipality put out a public call for potential carbon offset options for COP17, but, of the five submissions received, none was regarded as suitable. The evaluation process used the UN Development Programme's Millennium Development Goals Carbon Safeguard Principles to assess the environmental and social sustainability of the proposed offset projects and the sustainability track record of the organizations involved. The negative outcome highlighted that carbon offsetting potential and sustainability are not necessarily synonymous and that the full range of benefits and disadvantages of any offset option must be carefully reviewed.

They opted for expanding carbon sequestration work through a community- based reforestation project located adjacent to a local nature reserve. The project is also significant in that it resulted in the development of the Community-Ecosystem-Based Adaptation (CEBA) concept. This looks to eventually expand the original reforestation approach to embrace a more complete understanding of the link between communities and the ecosystems that underwrite their welfare and livelihoods by creating cleaner and greener neighbourhoods that are less dependent on costly utilities and services (e.g., through water recycling and the use of renewable energy). The CEBA approach is now being implemented throughout the province of KwaZulu-Natal.

(O'Donoghue and Roberts, a Case Study in Rozenweig et al., 2015)

The following sections provide a short overview of the policies and measures usually implemented by local authorities to reduce their energy consumption and CO₂ emissions in the mandatory and non-mandatory sectors on one hand and to enhance climate vulnerability and risk reduction on the other hand.

5.2 Elaboration of the plan: Mitigation actions

5.2.1 Local policies to support Sustainable Energy Access and Climate Action Plans

Strengthening the multilevel governance allows addressing more effectively the issues of climate change in cities. The transition towards a more sustainable urban environment at the local level includes a common understanding of the importance of curbing the city's CO₂ emissions. This understanding provides a basis upon which political leadership instigates a process of exploring possibilities and discussing different options with a wide range of stakeholders towards selecting, detailing, implementing and monitoring local action. For successful climate and energy policies there are two main different forms of collaboration horizontal and vertical. Both of them are crucial to bridge the gaps of knowledge, skills and authority. In this process, local authorities play a key role in facing climate change issues and have the capacity to support and mobilize action for local energy generation investments through several modes of urban climate governance. In the following, four modes of urban energy and climate governance are investigated and a policy matrix that summarizes the scope of each mode along with the main tools, the barrier that requires being addressed and exemplary actions to support local energy sustainability is provided. The modes of urban energy and climate governance ⁽⁴⁶⁾ can be mainly summarised as:

- Municipal self-governing
- Municipal enabling (governing through enabling)
- Governing through provision
- Regulation and planning (governing by authority)

Overall, the barriers that can be addressed with each main tool under these modes of governance are different. For this reason, it is often necessary to combine multiple modes of governance to reinforce and align incentives for particular objectives. This must be supported by an analysis of the legal, physical, social and economic barriers hindering local energy generation prior to considering corrective actions and measures.

5.2.1.1 *Municipal self-governing*

Local Authorities have the capacity to govern their own activities and undertake strategic investments in municipality-owned assets (Kern and Alber, 2009), which include investments in energy efficiency and local energy generation based on renewable energy sources. The main tools that are used by local authorities in this capacity are energy audits, demonstration projects in public facilities and public procurement, which can be used to better manage the local authority estate. Through these tools, local authority can provide technical validation and stimulate energy efficiency and demand for renewable energy and/or its purchase from district networks (**Table 23**). Moreover, this mode of governance also relies on reorganisation and institutional innovation. Awareness raising among public servants and transversal communication among different departments are key measure to implement SEACAPs and progress towards sustainability.

⁽⁴⁶⁾ Modes of urban climate governance are based on definitions in Kern and Alber, OECD and IEA

Table 23. Municipal self-governing mode of urban climate governance

Mode of urban climate governance ⁽⁴⁶⁾	Tools	Barrier addressed	Action examples
Municipal self-governing: Strategic investments in municipality-owned assets to increase local energy generation	Energy management of local authority estate	Lack of transparent and consistent monitoring and control of energy use; Disincentive for energy efficiency efforts in budget; Difficulty for public entities to contract and manage energy service providers.	Establish standards for monitoring and management of energy to improve efficiency in a systematic and sustainable way; Adopt high energy efficiency performance standard for public buildings.
	Demonstration projects in public facilities	Need for technical validation and demonstration of performances.	Town halls with solar energy façades and PV powered schools Counter of emission avoided publicly shown; Showcases of obtained results to raise citizen awareness.
	Green public procurement	Need to stimulate demand for energy efficiency renewable energy and/or the purchase of district heating/cooling; Need for National implementation of core criteria as a reference for green public procurement procedures; Deficiency in national and regional platform of public procurement.	Green public procurement for purchasing energy efficient appliances and clean vehicles; Low-carbon, distributed energy supply in public buildings and schools; Municipal purchases of certified green electricity; Clean and sustainable procurement of the LA fleet.
	Institutional reorganisation	Allocation of competencies split in different departments.	Allocation of competencies split in different departments.

5.2.1.2 Municipal enabling (governing through enabling)

As a facilitator, the local authority has an active role in enabling cooperation between community actors, including those that lead to the launch of public-private partnerships to promote local energy generation⁽⁴⁷⁾. Moreover, the involvement of a range of different partners increases the democracy of the processes. The LA also has a crucial role in engaging in awareness and capacity building campaigns that promote energy efficiency in buildings, sustainable transport and behaviour, utilization of renewable energy sources and the deployment of local energy generation technologies. These tools can be actively used within the capacity of local authorities to overcome any lack of

⁽⁴⁷⁾ "The state of European Cities 2016". EU, UN-Habitat 2016.

business models to leverage financial resources as well as inadequate knowledge and skills (**Table 24**).

Table 24. Municipal enabling mode of urban climate governance

Mode of urban climate governance ⁽⁴⁶⁾	Tools	Barrier addressed	Action examples
Governing through enabling: Facilitating co-operation among stakeholders and awareness building	Labels and certificates in the building sector	Lack of reliable and credible advice on the building performance and awareness of energy savings potential.	Implement all national and/or regional provisions; Promote the adoption of additional voluntary schemes.
	Partnership with transport service providers	Fragmentation of modes	Integrated ticketing and charging.
	Public-private partnerships	Lack of business models to leverage financial resources; Budget constraints in LA.	Public-private partnership for anaerobic digestion of biowaste for CHP-based district heating; Co-financing between local and regional authorities and private investors for public energy upgrading.
	Awareness raising/training	Inadequate knowledge and skills that may hinder undertaking renewable energy projects. Need for capacity building of LA staff.	Promotional and Communication campaigns to promote behavioural changes; Effective communication on public transport; Promote competitions, awards and contests for climate protection and GHG reduction efforts; Provide guidelines for energy efficiency improvement; Networking with other LA, regional / national authorities, universities to ease the access to funding opportunities; Showcases of obtained results; Appropriate training activities for LA staff.
	Community cooperatives for local energy projects	Need to overcome perceptions of risk as a barrier to citizen involvement.	Supporting tools and information sessions for citizen empowerment

5.2.1.3 Governing through provision

The Local Authority is a provider of urban services and as such, has control or influence over infrastructure development. Within this capacity, the LA can effectively guide development in a way that increases energy efficiency in all urban sectors, support transition to sustainable transport and promote local energy production (**Table 25**).

Table 25. Governing through provision mode of urban climate governance

Mode of urban climate governance ⁽⁴⁶⁾	Tools	Barrier addressed	Action examples
Governing through provision: Providing services and financial resources	Public sector financial management and procurement policies	Split incentives and difficulties to access them; Fragmentation in processes and actors of the building trade; Budget constraints.	Revise budgetary rules to allow retention of energy cost savings for other justified public spending; Revise public procurement rules (GPP) to allow for contracting of energy service providers and adopt EE purchase requirements.
	Direct infrastructure investments for transport	Congestion and high energy consumptions and related emissions due to private transport modes; Low density territories.	Reliable and affordable public transport infrastructure (light rail system and bus rapid transit); Fine tune public transport to the characteristics of the territory (density, type of fluxes).
	Financial incentives in transport	High cost and low financial sustainability of electric mobility ;	LA incentives for purchasing clean vehicles and electric bikes.
	Direct energy infrastructure investments	Insufficient energy infrastructure to provide access to renewable energy;	Investments in electric networks; Minimum quotas for renewable energy supply or co-generation provided by LA owned utilities; Renewable energy sources in public housing.
	Incentives and grants to local energy generation	Insufficient financial incentive; Constrains of local budget; Competition with other investment priorities; Presence of market failures for related technological options.	Use public funds (also national) to leverage private and commercial investments; Third party financing; ESCOs; City Council subsidies for renewable energy.

5.2.1.4 Regulation and planning (governing by authority)

In addition to capacities as implementer, enabler, and provider, local authorities govern by authority through setting regulations and putting forth urban planning principles ⁽⁴⁸⁾.

Among other tools, local authorities can revise building codes to promote the improvement of energy efficiency in buildings, impose road charging to reduce congestion as well as incentive the use of renewable energy in the building stock for distributed generation. In the context of local energy generation, this mode of governing involves setting requirements on the mandatory use of renewable energy and ruling on strategic energy planning decisions. Based on such tools as ordinances and strategic energy planning, local authorities can assist in addressing certain shortcomings for supporting niche markets and emerging technologies as well as insufficient guidance to inform decision-making for local energy generation (**Table 26**).

Table 26. Policy matrix for local energy generation organized by mode of urban climate governance

Mode of urban climate governance ⁽⁴⁶⁾	Tools	Barrier addressed	Action examples
Regulation and planning: Requirements and guidance in support of energy efficiency and local energy generation	Mandatory standards and building codes	Fragmentation and gaps in the regulatory action of public planning; Urban planners lacking of skills to include energy and climate issues in their work.	Prepare a comprehensive plan to improve energy efficiency in buildings; Develop building codes that addresses energy efficient buildings with minimum energy requirements; Introduce subsidies and bonus;
	Regulation, controls and sanctions		Establish a supporting program to assist in the retrofitting of buildings; Capacity building on climate and energy for urban planners.
	Zoning, urban regeneration and mixed used developments	Sprawl and brownfields.	Creating mixed-use developments; Review the public transport considering mobility patterns of different types of users; Smart intermodal mobility planning; Encourage renovation of existing buildings.
	Regulation and pricing in the transport sector	Difficulty in promoting the use of public and collective transport; Congestion.	Road pricing and congestion charges; Parking management;

⁽⁴⁸⁾ OECD (2010), *Cities and Climate Change*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264091375-en>.

	Ordinances on the mandatory use of renewable energy	Lack of support for niche markets or emerging technologies.	Incentivise the installation of solar water heating/solar PV systems in new buildings; Construction of nearly or net-zero-energy buildings.
	Revision of administrative procedures for energy projects	Uncertainty of administrative procedures.	Advantageous conditions to projects in the "Public Interest".
	Strategic energy planning to support local energy generation	Insufficient guidance and access to data to better inform decision-making.	Local maps with heat demand density and industrial waste heat; Land use planning for large-scale solar plants and wind turbines.

5.2.1.5 Public Procurement

Public procurement refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies. Public procurement and the way procurement processes are shaped and priorities are set in the procurement decisions, offer a significant opportunity for local authorities to improve their overall energy efficiency.

Green public procurement is the process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. This means that public contracting authorities take environmental considerations into account when procuring goods, services or works. Sustainable public procurement goes even further and means that the contracting authorities take into account the three pillars of sustainable development – the effects on environment, society and economy - when procuring goods, services or works.

Energy efficient public procurement allows improving energy efficiency by setting it as relevant criteria in the tendering and decision-making processes related to goods, services or works. It applies to the design, construction and management of buildings, the procurement of energy consuming equipment, such as HVAC systems, vehicles and electrical equipment, and also to the direct purchase of energy, e.g. electricity, gas. It includes practices such as life-cycle costing, the setting of minimum energy-efficiency standards, the use of energy efficient criteria in the tendering process, and measures to promote energy efficiency across organisations.

Energy-efficient procurement offers public authorities, and their communities, social, economic and environmental benefits:

- By using less energy, public authorities will reduce unnecessary costs, and save money;
- Some energy-efficient goods, such as light bulbs, have a longer lifespan and are of higher quality than their cheaper alternatives. Purchasing them will reduce valuable time and effort involved in frequently replacing equipment;
- Reducing CO₂ emissions as a result of energy-efficient procurement will help public authorities to decrease their carbon footprint;

- Through leading by example, public authorities help to convince the general public and private businesses of the importance of energy efficiency and support the development of green economy.

The interest in developing Green Public Procurement regards not only its impact in terms of CO₂ emission reduction, but also in terms of its financial impact. Here are some examples of energy-efficient measures proposed in high-priority product groups (**Table 27**). In the transport sector, a public procurement may require environmental specifications for the LA fleet.

Table 27. Examples of energy-efficient measures proposed in high-priority product groups

Product group	Examples of Public procurement requirement
Public transport	Purchase low-emission buses and public fleet vehicles. The buses have to be equipped with driving-style meters to monitor fuel usage.
Electricity	Increase the share of electricity from renewable sources going beyond national support schemes.
IT products	Purchase of environmentally friendly IT goods that meet the highest standards for energy performance, such as Energy Star. Provide training to users on how to save energy using their IT devices.
Building construction/ renovation	Use of localised renewable energy sources (RES) Impose high efficiency standards that reduce the building's energy consumption. Energy efficient lighting. Using energy efficient cooling equipment or making use of natural ventilation instead of expensive cooling systems.

Green, sustainable or energy-efficient public procurements are highly recommended. However, in the context of the Covenant of Mayors SSA, only measures related to energy-efficient public procurement will be reflected in the CO₂ emission inventories. Nevertheless, a comprehensive GPP policy will be considered as a good way to enhance sustainable governance dealing also with the resources used in cities (support the reuse or refurbishment of goods and materials).

Green Electricity Purchasing: In order to ensure that the electricity supplied comes from a renewable energy source, consumers have the possibility to request guarantees of origin certificates of the electricity. The supplier has also the possibility to provide independent proof of the fact that a corresponding quantity of electricity has been generated from renewable sources, or produced by means of high-efficiency cogeneration⁽⁴⁹⁾. Price differences between conventional and green electricity depend on the status of liberalisation, the features of the national support schemes and the existence of green electricity suppliers. Green electricity has proven to be a product group which is available for public procurement on a competitive basis.

5.2.2 Information measures and public awareness

Public awareness and social engaging play a pivotal role for successful climate action. Measures to induce behaviour change and to provide education significantly contribute to

⁽⁴⁹⁾ Further information on www.procuraplus.org

the decrease of energy consumption through social and non-technological approaches that must be included in policies that support energy efficiency and energy savings.

In the CoM SSA framework, local authorities are integrating policies aiming at increasing public awareness (such as information and benefit campaigns) towards a behavioural change in energy use in their territories.

This chapter aims at guiding local authorities in the preparation and successful implementation of this kind of measures that allow improving the impact of their information and training campaigns.

5.2.2.1 Type of measure

Measures targeting different groups and covering several sectors are frequently selected from local authorities in their Sustainable Energy and Climate Actions Plans.

The most common tools which the measures rely on include:

- web based platforms, whose popularity is growing;
- mass info campaigns: In general the scope and messages to be communicated are extremely varied. There is a need to tailor-made targeted messages for specific audiences. However, they must target specific areas of society, and the message need to be repeated to be effective
- based on active communication on-line tools: to calculate CO₂ reduction or energy savings estimations.
- database containing examples of energy efficiency applications: illustrated examples of energy renovated houses, energy efficient expert list. These kinds of measures targeting users with previous knowledge on the topic may be very effective.
- energy days, dedicated moments and spots to specific topics enable to raise the attention of public on themes that may be daily neglected (helpdesk and info points).
- "Training measures" may have a great impact on community since they target more enthusiastic or empathic audience (students, energy related workers). However, these measures are not very common, because they are more difficult to set and organize, requiring specific skills. Three most common training measures are:
 - General training to adults, targeting sectors or general ones
 - Education and awareness raising at schools
 - Ecodriving, general (adults, students) or professional (drivers, energy related workers) ones.

5.2.2.2 Planning implementing and monitoring an information measure

5.2.2.2.1 Planning

Literature and experience show the relevance of an optimal planning of information measures to be implemented. A carefully designed strategic plan to develop measures improves effectiveness⁽⁵⁰⁾. The recommended planning steps are:

- setting the measure/program goals in line with policy goals;
- analysis the determinants of desired behavioural change;
- analysis market segmentation and choice of target groups;
- choice of instruments;

⁽⁵⁰⁾ Case studies on innovative communication campaign packages on EE Global CCS institute study. Available at: <https://hub.globalccsinstitute.com/publications/energy-efficiency-recipe-success/case-studies-innovative-communication-campaign-packages-energy-efficiency>

- planning the organization and management;
- risk analysis and backup plan;
- programmer testing and pilot campaigning;
- planning the resources;
- planning the monitoring and evaluation.

One of the most important factors to be considered in the planning phase is the selection of the communication channel. This is based on:

- cost-efficiency;
- media brands;
- media coverage and access;
- cultural factors;
- long-term view and repetition.

In particular, the repetition is a frequently underestimated factor, which is on the contrary, a key to initiate the process for a change in the behaviour. Repetition or further development of the campaign is recommended in order to keep the message in the minds of the target group.

However, pure information doesn't necessarily result in behavioural changes: information materials must be accompanied by actions allowing people reproducing a new behaviour.

Finally, the suitability of the selected communication tools is another important element. Often it is much more effective to write a personal letter than to use anonymous direct mailing. Face-to-face contacts are more appropriate than telephone calls. Pictures and films are livelier than brochures and texts and leave a more lasting impression.

5.2.2.2.2 Implementing

The effectiveness of information campaign relies mostly on the effectiveness of delivered messages. They must be simple, adequate to the targeted group, easy to understand and inspiring. Three main aspects need to be considered ⁽⁵¹⁾:

Emotions and rational arguments: Emotions are a very appropriate way to raise awareness. Once the target group is aware of the problem (e.g. motorised transport) and also of their own role, it makes sense to provide also rational arguments that support a change of behaviour.

Tone: pessimistic and catastrophic messages are not translated in a positive behavioural change. Experience shows that the message needs to be funny and must engage the audience. It needs to be tailored, positive and based on principles of cooperation and self-responsibility. The main pillars of this type of communication are: information, consultation, cooperation and self-responsibility. Moreover, the message must clearly reach the audience, so it might have to be disseminated in local languages.

Feasibility: Maybe the most important aspect to be addressed to ensure the effectiveness of measures. Citizens need to be informed and motivated, but they absolutely need to be able to adopt the measures. The role of the authorities is to provide opportunities for feasible actions. It should also be considered that only reliable information can enable the implementation of effective solutions.

⁽⁵¹⁾ Stewart Barr et al.(2005).The household energy gap: examining the divide between habitual- and purchase-related conservation behaviours. Energy Policy 33 pp. 1425–1444

5.2.2.2.3 Monitoring and evaluation

The monitoring and evaluation phase of any kind of measure is crucial. It must be integrated in the planning phase, especially when trying to adapt or modify human behaviour. The evaluation of the effectiveness of the measure needs to:

- choose an evaluation method. A current challenge is to find better ways to evaluate measures effectiveness, to develop new indicators for societal progress allowing to measure if higher awareness is translated into more energy efficient individual behaviours;
- collect the data;
- conduct the evaluation and report results and disseminate the results to improve the effectiveness of future programs.

Even if there is still not an harmonised world-wide method for comparing energy behavioural measures, literature gives several examples that can easily be adopted by local authorities: "comparison before the program and after"; the use of statistical analysis like the *Difference in differences* (DDI) "comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group" or the *Randomized control trial* (RCT) "the people being studied are randomly allocated one or other of the different treatments under study" Schulz K.F. et al. (2010). **Table 28** shows strengths emerged from information measures implemented in the CoM framework.

Table 28. Strengths/ tips on information campaign Covenant signatories

Strengths:

- ✓ unifying information in web pages(information hubs)
- ✓ the development of active communication tools is growing
- ✓ generation of datasets targeting audience with energy knowledge
- ✓ easier and more engaging access to energy information through energy days and info-points

5.2.2.3 Overall recommendations

There is still a lack of knowledge among end-consumers of the existing economic and health potential associated with energy savings and solutions available. Furthermore, the low level of knowledge is not due to the inadequacy of available information. On the contrary, it depends on the way the information is provided. It might be deduced that previous approaches such as the price-based approach (save money) and the environmental approach (save the planet) were not completely successful. Based on the fact that human behaviour and decision making are the core of the Climate Change problem, and that solutions should come from that, the social approach could succeed where other approaches failed. The social approach may drive information and awareness measures for changing the energy behaviour towards sustainable practices. Improvements are still necessary: people need to be inspired, to be engaged, to have fun when receiving the message. This must be carefully selected and keep as simple as possible. **Table 29** summarizes these considerations.

Table 29. Overall recommendations

City planners should consider

- ✓ emphasize energy use/Climate Change as a real, actual local and personal risk
- ✓ facilitate more affective and experiential engagement (personal stories)
- ✓ leverage relevant social group norms
- ✓ frame policy solutions on what can be gained from immediate action
- ✓ appeal to intrinsically valued long-term goals and outcomes

5.2.3 Buildings

Buildings and transports are among the most energy intensive sectors at local level. However, they are also fields where local authorities can take action to reduce energy consumption and carbon emissions in the framework of CoM SSA. The reduction of final energy consumption in the building sector contributes to Climate Change mitigation and to reduce the dependence on fossil energy sources.

Numerous actions planned will in the whole allow to achieve the targets set in the SEACAP. First and foremost, the local authority itself assumes an exemplary role in the implementation of these actions. Committing to highly efficient buildings in their own facilities is a way local authorities can reduce emissions and lead by example, showing the community how to deal with the issue and results achieved. Public buildings do represent a field where large reductions in energy consumption can be achieved. By developing energy efficiency projects in their buildings, local authorities set an example to the local community, inspiring citizens to adopt sustainable and low-carbon practice.

Moreover, local authorities empowered with the jurisdiction to build upon national efficiency policies in the building sector can implement codes and regulation with more stringent requirements than national ones. Through these regulations, integrated actions to improve energy efficiency in the buildings are provided and the use of renewable sources for space heating and cooling is fostered.

To achieve the carbon reduction goals, local authorities must work with national and regional/provincial governments, as well as with other stakeholders (e.g. building owners, energy utilities, energy service traders and banks) and design specific measures in the action plan that are also able to remove and addresses the main common barriers in the building sector.

These may include: regulatory and institutional barriers, financial challenges, market inefficiencies, and, lastly, the lack of knowledge and know-how.

This chapter aims at overviewing the key municipal policies and strategies to improve the energy performance of the building stock. It also gives broader insights on specific potential measures that may be implemented either for existing buildings or for new construction and provides a collection of best practices that highlights the role of local authority in steering the changes in the building sector.

To address the major barriers and to scaling up energy efficiency in existing, it is important for a local authority to outline a clear and comprehensive overview of the main issues, opportunities, and options available. A key first step is to carry out a sectorial assessment that can cover either the entire building sector or a certain specific segment.

An overview of the most common policies and related tools available to increase energy efficiency in buildings is shown in **Table 30** which also includes indications of the barriers that the measures intend to address, and the potential role of the local authority in their implementation.

The Global Alliance for Buildings and Construction, as part of the Global Climate Action Agenda initiative, promotes a zero-emission, efficient and resilient buildings and construction sector. More recommendations can be found on its website (<https://www.globalabc.org/>) and in their annual status report (link to the 2017 GABC Global Status report: <https://www.globalabc.org/uploads/media/default/0001/01/35860b0b1bb31a8bcf2f6b0acd18841d8d00e1f6.pdf>).

Table 30. Policy matrix for on energy efficiency in buildings organized by mode of urban climate governance

Mode of urban climate governance ⁽⁴⁶⁾	Policies and tools	Addressed Barrier	Illustrative Measures	Local potentials (What local authority can do)
Municipal self-governing: Strategies for municipality-owned assets to reduce final energy consumption and to inspire community engagement	Energy management of local authority estate Demonstration projects in public facilities Green Public procurement Institutional reorganisation	Lack of transparent and consistent monitoring and control of energy use; Disincentive for energy efficiency efforts in budget supported public entities; Difficulty for public entities to contract energy service providers; Need for technical validation and demonstration; Allocation of competencies split in different departments.	Undertaking of cost-effective energy efficient investment in public buildings and LA's facilities (town-hall, schools...) such as: - energy audits; - energy management systems; - retrofit facilities for energy efficiency improvement; Energy services companies (ESCO); Integration of tasks into interdepartmental units.	Establish standards for monitoring and management of energy to improve efficiency in a systematic and sustainable way; Adopt high energy efficiency performance standard for new buildings; Procurement of energy efficient appliances; Showcases of obtained results to raise citizen awareness.
Regulation and planning: Requirements and guidance in support of energy efficiency in buildings	Mandatory standards and codes Regulation, controls and sanctions	Fragmentation and gaps in the regulatory action of public planning; Disincentive for energy utilities to invest in demand-side activities to lost sales.	Minimal environmental criteria; Minimum performance standard for buildings and appliances; Decouple energy utility revenue from sales.	Prepare a comprehensive plan to improve energy efficiency in the buildings; Develop building codes that addresses energy efficient buildings with minimum energy requirements (stricter than national ones); Introduce subsidies and bonus (e.g. reduction in development fees, expedited permit process or allowances for extra building floor/volume) for building with high energy performance; Establish a supporting program to assist in the retrofitting of old buildings.
Governing through enabling: Facilitating co-operation among stakeholders and awareness raising	Labels and certificates	Lack of reliable and credible advice on the building performance and awareness of energy savings potential	Energy Performance Certificates (EPCs); Energy label for appliances and materials; Voluntary certification schemes.	Implement all national and/or regional provisions; Promote the adoption of additional voluntary schemes.
	Public-private Partnerships	Segmentation of knowledge , skills and actions	Organize working groups that bring together companies and investors with the necessary expertise to develop strategies for energy saving in buildings.	The involvement of a range of different partners increases the democracy of the processes.

Mode of urban climate governance ⁽⁴⁶⁾	Policies and tools	Addressed Barrier	Illustrative Measures	Local potentials (What local authority can do)
	Capacity building, education and awareness raising	Inadequate knowledge and skills for standards and building codes compliance. Lack of internal competencies in small LA.	Institution of local energy/environmental agencies; Energy efficiency training to design, engineering, building operations and maintenance staff; Public campaign to promote efficient use of energy; Dissemination of best practices and achieved results.	Ensures that municipal staff receive appropriate training; Promote competitions, awards and contests for climate protection and GHG reduction efforts; Provide guidelines for energy efficiency improvement in buildings.
Governing through provision: Providing services and financial resources for buildings energy efficiency projects	Public sector financial management and procurement policies	Split incentives; Fragmentation of the building trade.	Use Revise budgetary rules to allow retention of energy cost savings for other justified public spending; Revise public procurement rules to allow for contracting of energy service providers and adopt EE purchase requirements;	Make adjustments based on the local peculiarities to address energy efficiency in buildings.
	Financial facilitation	Insufficient financial incentive for citizens; Constraints of local budget; Competition with other investment priorities.	Subsidies for energy efficiency investments; Develop a dedicated energy efficiency fund and/or credit-line; Establish a partial risk guarantee.	Use public funds (also national) to leverage private and commercial investments; Third party financing; Energy services companies (ESCO)

5.2.3.1 Specific considerations related to different kinds of buildings

The demand for energy in buildings is linked to a significant number of parameters related to constructive design and the usage of the facilities. The main variables on which it is convenient to undertake actions to reduce the energy consumption are:

- Geometry, orientation, urban design and functional design of the building, including bioclimatic design and natural ventilation;
- Usage patterns and levels of indoor comfort;
- Building envelope, such as insulation, windows and solar protections;
- Equipment and systems, such as type of heat boilers, air conditioners and lighting;
- On-site energy production and renewable energy sources (RES), such as photovoltaic (PV) and thermal collectors;
- Building automation and control systems, able to continuously monitoring, analysing and adjusting the energy usage.

For each of these domains, both the current design capacity and the available technology options allow applying the energy efficiency principle, the importance of which is indisputable at global level. In addition to cutting emissions and energy bills, energy efficiency brings relevant additional benefits (i.e. better and healthier comfort conditions, new jobs and greater energy security). Moreover, according to the types of buildings and their conditions, the identified variables differently influence the energy performance, therefore, implying specific energy efficiency measures. However, although the benefits of efficient buildings are obvious, time and resources to be allocated are frequently significant barriers for the local administrations. At this level, it is crucial to find potential common allies, able to share policy best practices and exemplary applications.

In the following paragraphs, an insight on status, strategies and tools for specific kinds of buildings, namely new buildings, existing buildings and public buildings, is provided.

New buildings: Newly constructed buildings represent the best opportunity to reach very low energy consumptions (or even positive levels, where energy production exceeds consumption), introducing energy efficiency technologies that can result very cost-effective over the course of their life cycle (also 30-50 years). These results can most effectively be achieved by introducing regulatory policies (minimum energy performance standards) at national, regional or local level (i.e. building energy efficiency codes). Another valuable option in this framework is incentivising owners, investors and developers to exceed the current minimum energy performance standards. To this aim, the current energy certification scheme (or other voluntary rating systems) can be used to apply incentives whether financial (e.g. tax discounts) or not (e.g. volumetric increments).

Whether a well-designed and constructed new building achieves expected energy savings will largely depend also on user behaviour and operational management. As a consequence, the use of information and communication technologies (ICT) should be recommended in large new buildings, particularly the non-residential ones. 'Smart buildings' refer to more efficient buildings whose design, construction and operation is integrating ICT techniques like "Building Management Systems" (BMS) that run heating, cooling, ventilation or lighting systems according to the occupants' needs, or software that switches off all PCs and monitors after everyone has gone home. BMSs can be used to collect data allowing the identification of additional opportunities for efficiency improvements.

Existing buildings undergoing major refurbishments: The retrofitting of existing structures and the replacement of old energy-consuming systems is often considered one of the most valuable strategies to achieve high energy savings. The most common strategy for the energy refurbishment consists in minimizing thermal losses through the envelope, but the control of the solar heat gains and the reduction of cooling loads are also beneficial.

Encouraging retrofits of buildings in the residential sector is generally more challenging than in other sectors because of the highly disaggregated nature of home ownership and the small size of individual investments and returns. In the past, most efforts have focused on equipment replacement (such as incandescent lamps and refrigerators), encouraging or requiring the energy utilities to carry out demand-side management programs. Frequently, local authorities provide forms of incentives and subsidies to boost the implementation of energy measures and retrofit of buildings among citizens.

Social housing is included in the building sector and it is crucial for the overall improvement of energy efficiency at local level. The retrofitting of existing buildings within the social housing stock allows reaching an important reduction of consumption due to an old building stock in many countries. Furthermore, the social housing refurbishment may address also fuel poverty and energy access issues. As a consequence, the refurbishment of Social Housing building stock is an integrated policy that while dealing with Climate Change achieves other policy objectives.

Larger margins for the local authorities to intervene are possible in the sector of the private-owned commercial buildings. Here the use of a combination of regulatory and incentive instruments can help to overcome financing barriers and scale up investments. For instance, national financial incentives could be used to encourage comprehensive retrofit projects, preventing the sporadic implementation of partial retrofit projects by market participants.

Public Buildings: The buildings owned, controlled or managed by the local authority itself are those on which the local authority has the greatest control. Therefore, it is expected that the local authority should lead by example by testing new policy measures and initiating cost-effective activities that increase the efficiency of its own buildings.

Focusing on the existing ones, a retrofit programme of public building should be set up, defining the scope and depth of a retrofit scheme, the delivery mechanism of the retrofit program, and the financing and repayment arrangements for the project. The choice of which retrofit option to apply is based on the local climatic conditions and on detailed energy audits. Depending on the complexity of the programme and the financing arrangements, the local administrators may follow several commonly used contracting models. The guaranteed-savings contracts are an interesting option. They only require Energy Services Companies (ESCOs) to implement the retrofit projects, and can guarantee a stable stream of annual energy cost savings to repay the financiers.

5.2.3.2 Measures for energy efficient buildings

All the processes that are involved in the energy efficiency of buildings, from the design and the construction, to the renovation and operation, recognize the provision of healthy and comfortable environments to its occupants as the main purpose of any buildings. The 'sustainable comfort' can be defined as achieving good comfort conditions with no or limited use of resource energy and through the use of environmentally non-harmful materials.

In this framework, ten steps are suggested to improve the energy efficiency of buildings, which implies also adopting measures on both thermal and electric energy (e.g. through reducing the wall transmittance in the former and using efficient appliances in the latter). This approach leaves ample freedom to designers while supporting them in adopting solutions that also take into consideration local specificities of climate, culture, locally available materials:

1. Define explicitly the building objectives, with particular focus on the thermal comfort.
2. Assess the microclimatic factors and intervene on the site layout and features which can affect the comfort indoor.
3. Control the heat gains at the external surface of the building envelope.
4. Control and modulate heat transfer through the building envelope.

5. Control the internal gains from appliances and lighting.
6. Allow for local and individual adaptation.
7. Use passive means and strategies ⁽⁵²⁾ to deliver and remove thermal energy to/from the building.
8. Use HVAC systems assisted by natural (and renewable) energy sources.
9. Use high efficiency active conventional heating and cooling plants, if still necessary.
10. Train building managers and occupants on how to use, monitor the performance of and adequately operate and maintain the building.

The first two points refer to the comfort requirements and the multiple interactions between indoor and outdoor environments. Steps 3 and 4 include all technologies and strategies associated to the building envelope from which the net thermal energy needs for heating and cooling ⁽⁵³⁾ depend. Steps 5 and 6 have to do with the way a building is used and occupied. Points 7, 8 and 9 provide sustainable approach to reach low levels of delivered (or final) energy consumption ⁽⁵⁴⁾ implementing appropriate system solutions. The last step includes all strategies needed to verify and adapt the building performance during the real-life operation.

The tables below provide an overview of the prevailing technologies and strategies which could be considered for intermediate/warm climates (**Table 31**) in accordance to the methodological step (introduced above) and the building type.

⁽⁵²⁾ This does not exclude the use of a fan or a pump when their application might enhance the performance.

⁽⁵³⁾ Energy needed for heating and cooling means heat to be delivered to or extracted from a conditioned space to maintain intended temperature conditions during a given period of time.

⁽⁵⁴⁾ Energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.).

Table 31. Building technologies and strategies for warm and intermediate climates, according to methodological step and construction type.

Warm and intermediate Climate (Heating degree days < 3 350)	
New building	Renovation
- Summer Adaptive comfort - Optimised distribution of internal spaces	
- Main building axis oriented east-west - Cool materials and finishing for urban surfaces - Inclusion of greening strategies in the design (vegetation and surface water)	- Cool materials and finishing for urban surfaces - Inclusion of greening strategies in the design
- Architectural shading - Reflective (cool) roof - Ventilated roof, double-skin façades - Double-glazed low-e or windows with low g-value - Exterior window shading/blinds and dynamic shading - Finishing material - Low heat conductivity building materials	- Reflective (cool) roof - Double-glazed windows with low g-value - Exterior window shading/blinds and dynamic shading - Window film reducing g-value - Finishing material - Low heat conductivity building materials
- Medium-highly insulated roof and external walls - Optimised thermal mass inertia	- Medium insulated roof and external walls - phase-change materials
- Daylighting solutions - Very efficient lighting sources and systems - Very efficient appliances and equipment - Smart shutdown logics	- Very efficient lighting sources and systems - Very efficient appliances and equipment - Smart shutdown logics
- Openable windows - Ceiling fan - Low thermal insulation furniture - Flexible dressing code	- Openable windows - Ceiling fan - Low thermal insulation furniture - Flexible dressing code
- Architectural features - Dynamic glass/shades - Comfort daytime and night ventilation - Ground heat exchanger - Direct or indirect evaporative cooling - Radiative cooling - Open groundwater or surface water systems	- Dynamic glass/shades - Comfort daytime and night ventilation
- Ground source heat pump - Solar cooling systems	- Ground source heat pump - Solar cooling systems
- Very efficient HVAC systems - Condensing boiler - Insulated distribution plant - Straight distribution ducts layout and efficient fans/pumps	- Very efficient HVAC systems - Condensing boiler - Insulated distribution plant - Straight distribution ducts layout and efficient fans/pumps
- Clear and exhaustive building manuals - Monitoring plan - Maintenance plan	- Clear and exhaustive building manuals - Monitoring plan - Maintenance plan

5.2.3.3 Improvement of the envelope and other aspects

One of the most common strategies for energy retrofit of buildings usually consists in reducing both thermal losses through the envelope and cooling loads and in controlling the solar heat gains.

The losses of energy through the envelope may be reduced through the implementation of several measures that affects glazing and frames and the walls and roofs characteristics.

- Gains and losses of energy through windows are four to five times higher than the rest of the surfaces. Both daylight provision and gaining or protecting from solar radiation penetration must be taken into account in the choice of appropriate glazing. New technologies with decreased values of transmittance for glazing are available.

- Either internal or external thermal insulation of walls reduces their transmittance values according to specific needs and location of the buildings. Commonly-used types of insulation in building construction include: Fibreglass, Polyurethane foam, Polystyrene foam, Cellulose insulation and Rock wool. These materials also contribute to reduce the effect of thermal bridge and to improve sound insulation and thermal inertia.
- The abatement of cooling loads is achieved by reducing solar radiation penetration through the use of shading devices. These comprise: movable devices which can be controlled either manually or automatically; internal and external blinds which help control lighting level and uniformity, and allow stopping solar radiation before penetrating into the room when arranged externally.
- An increased energy performance of buildings is achievable by operating on the heating system. The overall efficiency of the space heating system includes the efficiency of the generator and the losses of distribution, emission and inaccurate control systems.

5.2.3.4 Lighting

5.2.3.4.1 Domestic and professional buildings lighting

Lighting consumes between about 29-35% of the energy used within tertiary buildings while lighting only consumes about 11% of the energy used in a residential environment. Through conscientious design of the lighting systems, the lighting load can be reduced by more than half within both environments ⁽⁵⁵⁾. A set of options in the lighting sector allows reaching up to 50% of savings. The most common measure is the replacement of lamps with more efficient ones (lower consumption with the same performance). Moreover, correcting the misuse of the lighting appliances shows to be a significant contribution in the saving options. In this perspective, the systems that can control and modulate the light sources (presence detectors, brightness sensors, dimmers, lighting systems) have a large impact on total lighting energy use. Savings may be also achieved by using high-quality and high-precision optical appliances that guarantee a high performance of the whole system and by implementing a careful lighting design process. The lighting influence on energy consumption varies according to the types of buildings. In particular, tertiary buildings and offices show the highest energy consumption due to lighting and, hence, may be the target where implement saving strategies to yield more efficient results. On the contrary, lighting in residential buildings have a lower impact on the overall energy consumption which implies a limited selection of measures to be implemented and a chance to increase the energy access to this aim. However, despite being accessible, there is a number of barriers that limits the implementation of efficient lighting. Among these, the unawareness of saving potentials and the higher initial cost of efficient lighting systems ⁽⁵⁶⁾.

5.2.3.4.2 Characteristic parameters and definitions

Luminous flux: is the measure of perceived power of light in the unit time [lm].

Luminous efficiency: is the parameter that allows an evaluation of the energy efficiency of the lamp. It gives an idea of the amount of absorbed electricity that is transformed into light. It represents the relationship between the luminous flux of the lamp and the electric power supply [lm/W].

Colour Rendering Index (CRI): ranging from 0 to 100, it indicates how faithfully a light source reveals colours of objects in comparison with an ideal or natural light source. The higher the colour rendering index, the less colour shift or distortion occurs.

⁽⁵⁵⁾ Osburn, L. Green Building Handbook for South Africa, Chapter: Lighting CSIR Built Environment

⁽⁵⁶⁾ The Greenlight project's webpage contains wider information about lighting <http://www.eu-greenlight.org/index.htm>

Incandescent lamps: typically emit 12 lm/W, representing energy-to light conversion efficiency of 5%.

Halogen lamps: are incandescent lamps with small sizes that allow their use in compact optical systems for projectors and illumination. They will be banned from September 2018.

CFL (Compact Fluorescent Lamps) have attracted great interest in households as they can easily be adapted to the existing installation. Due to their Mercury contents, this kind of lamp requires well-planned recycling management. They show a luminous efficiency of about 40-60 Lumen/Watt.

LED (Light Emitting Diodes) originally used in electronics are now widespread also to as lighting systems. These lamps are energy efficient (class A) and characterized by a high life span. They show a luminous efficiency between about 50-100 Lumen/Watt.

Lighting controls are devices that regulate the operation of the lighting system in response to an external signal (manual contact, occupancy, clock, light level). Energy-efficient control systems include:

- Localised manual switch
- Occupancy linking control
- Time scheduling control
- Day lighting responsive control

5.2.3.4.3 Strategies for efficient lighting in buildings

Indoor illumination of tertiary-sector buildings uses the largest proportion of lighting electrical energy. A significant option is to encourage designs that provide artificial lighting with minimal energy consumption and recognise lighting design practices that offer greater flexibility for light switching, making it easier to light only occupied areas.

Strategies for improving the energy efficiency in lighting vary if either a new building or an existing one is considered. In the first case, more incisive results can be achieved, since architectural issues contribute to the lighting needs of spaces. Building modification to optimise use of natural light is restricted to initial construction and renovation. Natural light during daylight hours limit the use of artificial light, hence reducing electrical consumption and thermal load, and improve comfort. Alongside, 1) the planimetrical distribution of the building, 2) the geometric configuration 3) and the type of windows determine the natural light penetration in rooms.

In addition, these are the factors that influence the energy demand due to lighting in both new and existing buildings:

- the choice of the type of lamp;
- the displacement of lamps;
- the relation between lamp and luminaires.

In a typical lighting system only 30% of the lumens emitted by the lamp contribute to the lit environment. There is a huge amount of losses due to the luminaire, the light absorption on surrounding surfaces and the light redirection to avoidable areas. In existing buildings, the most common strategy is the replacement of old inefficient lamps, with new performing ones. Moreover, when estimating a building's lighting needs, various spaces shall be considered separately, both quantitatively and qualitatively.

Depending on the type of work developed, the frequency of use and the physical conditions of such spaces, the lighting installations will require different designs. It is important to control the lighting level, ensuring that spaces have required light and that no light is wasted. Particular tasks, such as reading, writing or drawing, require higher than average lighting levels. In this case, additional lighting should be supplied only in

those areas where such tasks are performed. This approach is useful in open spaces, offices and studies.

Conventional offices within South Africa have large window façades, which is capable of adequately lighting the area near the window, the space in which the work station is often placed. Allowing the energy conscious office worker to individually control the individual luminaires could result in significant energy saving. Such manual control can be used in conjunction with automatic dimming controls ⁽⁵⁵⁾. Sensors and other control devices are frequently used tools for the design and the management of low consumption lighting systems with simple payback of 2-3 years. As a side-effect of the energy saving in lighting, designers should take into account the reduction of cooling needs due to the decrease of heat emitted by bulbs.

5.2.3.5 Other measures in buildings

Other simple measures may contribute in the reduction of energy consumption in buildings and in configuring sustainable buildings simultaneously. Along with lower environmental impact, sustainable buildings are relatively low cost to run and in the long term, more valuable properties ⁽⁵⁷⁾. Some of the policies described below may need to be supported by specific political strategies adopted by the local authorities.

Behaviour and building management: adequate behaviour of building occupants may also generate significant savings. Information and motivation campaigns could be organised in order to get support of the occupants. In such cases, it is important that a good example is also given by the hierarchy and by the authorities in charge of the building management. There are numerous social approaches that may help in achieving a behaviour change: Sharing the savings between occupants and the local authority could be a good way of motivating action; cooperating to reach a common environmental goal (families in the same building can work together); competitive approaches provide motivation among occupants especially if publically recognised. Publicly displaying the energy certificate of the building is an example of sharing that may induce the mentioned approaches among citizens. Moreover, special efforts must be concentrated to lower the rebound effect. Expected energy savings might be reduced by behavioural reactions, which induces an increase in the usage of energy-consuming technologies, made less expensive by efficiency itself.

The management of technical installations in buildings may lead to energy savings: make sure heating is turned off during week-ends and holidays, make sure lighting is off after work, fine tuning of the heating/cooling operation, adequate set points for heating and cooling. For simple buildings, a technician or an energy manager could be appointed for such tasks. For complex buildings, the help of a specialised company may be necessary. Therefore, it may be necessary to renew or set up a new contract with a competent maintenance company with adequate requirements in terms of energy performance. Be aware that the way the contract is drafted could highly influence the motivation of such a company to effectively find out ways of reducing energy consumption.

Retro-commissioning: improve the efficiency of equipment and systems in existing buildings. It frequently addresses issues developed throughout the building's life. It consists in the adaptation and regulation of the technical installations to the current uses and owner's requirement (bring equipment to its proper operational state, improve indoor air quality, increase equipment lifespan, improve maintenance operations...). The Retro-commissioning ⁽⁵⁸⁾ requires small investments related to the control and regulation of the technical installations which, however, may generate significant savings. Maintenance: good maintenance of the HVAC systems may also reduce the energy consumption with low budgets.

⁽⁵⁷⁾ LEVEL(s) PROJECT <http://ec.europa.eu/environment/eussd/buildings.htm>

⁽⁵⁸⁾ Book: Energy Efficiency Guide for Existing Commercial Buildings: The Business Case for Building Owners and Managers published by ASHRAE.

Location: buildings located in summer climates will require active protection against solar radiation in order to minimise cooling loads. Natural ventilation strategies help to increase the comfort in buildings and, hence, wind characteristics and building shapes should be studied in detail.

Hours of Operation: The most energy-intensive building types are those in continuous use, such as hospitals. In these buildings, the balance of heating and heat removal (cooling) may be dramatically different from that of an office building with typical working hours. For example, the around-the-clock generation of heat by lights, people, and equipment will greatly reduce the amount of heating energy used and may even warrant a change in the heating system. Intensive building use also increases the need for well-controlled, high-efficiency lighting systems. Hours of use can also enhance the cost effectiveness of low-energy design strategies. In contrast, buildings scheduled for operations during abbreviated hours, should be designed with limited use clearly in mind.

5.2.3.6 Additional Demand Side Management Measures

Utilities are able to meet their customers' energy needs in a number of different ways. DSM can be defined as measures taken by the utility to reduce energy demand through improvements in the way in which energy is used. DSM promotes energy efficiency and encourages the choice of energy sources by consumers (Kelly, and Marvin,1995). DSM measures may be implemented by both the utilities and by public institutions. Measures include insulation programmes, high efficiency motors and lighting, timers on water heaters, direct load control, differential tariff pricing and interruptible service, information campaigns (replacement of obsolete electrical equipment, energy labelling...)⁽⁵⁹⁾.

The purchase of green electricity by the public administration, households and companies, is a great incentive for companies to invest in the diversification of clean energy generation power plants. There is some experience of local authorities buying green electricity from power plants owned by a local company.

5.2.3.7 Energy Audits and measurements

An energy audit is defined as a systematic inspection of energy use and energy consumption of a site, building, system or organisation with the objectives of establishing energy flows, identifying the potential for energy efficiency improvements and reporting them to the energy user.

The purpose of energy audits is to perform an analysis of energy flows in buildings or processes that allows understanding how efficient the use of energy is. In addition, it should propose corrective measures in those areas with poor energy performance. Energy audits are generally carried out in public and tertiary buildings in order to understand the current state of the energy consumptions and implement methods and actions to improve the overall energy performance of building (including behaviour issues and appliances). The characteristics of the building or equipment to be audited, as well as the energy consumption and performance data, are collected by means of surveys, measurements or energy consumption bills provided by utilities and operators or simulations performed, using validated software. As measurement and data acquisition are an important issue in energy-efficiency projects, the way to do it has to be planned in advance.

Some benefits arising from the realization of energy audits may include the identification of the greatest opportunities for energy savings, thus offering the opportunity to reduce the energy costs of buildings and organizations, improving profitability and investment capacity. Energy audits also can identify potentials for improvement in business and production processes and, thereby, contribute to improved productivity, help

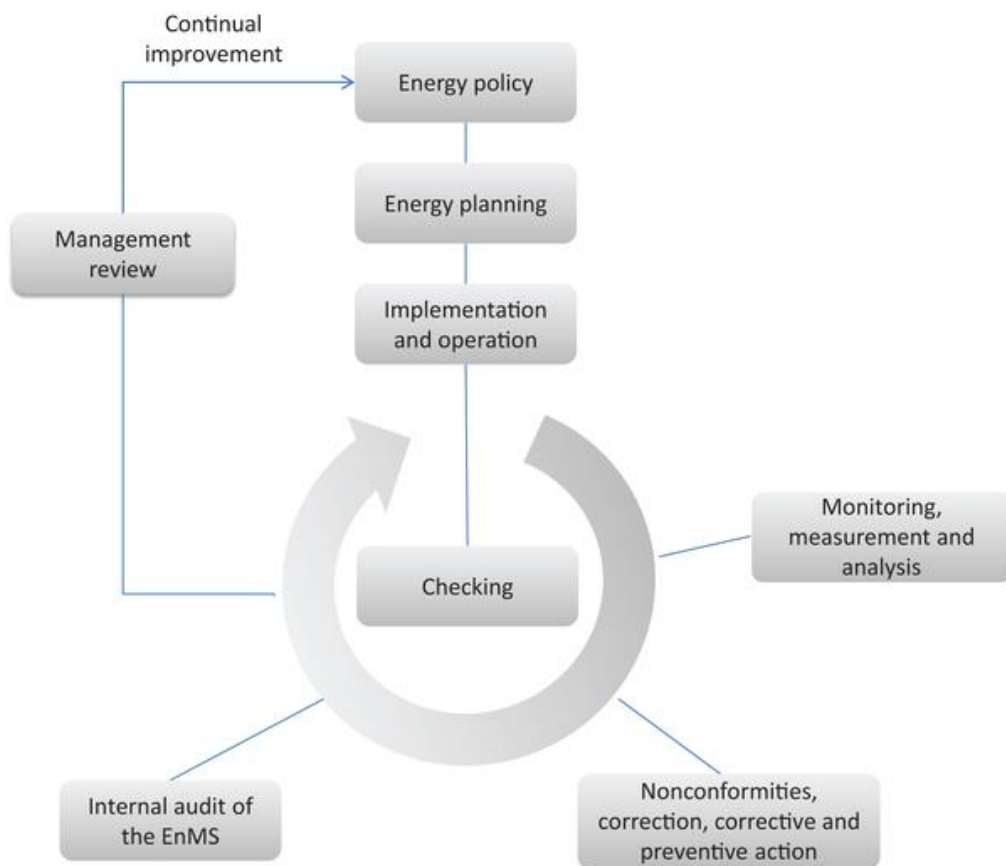
⁽⁵⁹⁾ Demand Side Management Information available on the International Energy Agency Demand Side Management webpage www.ieadsm.org. The Topen websites provide a selection of best appliances from the energy point of view www.topen.info (project supported by Intelligent Energy Europe)

organizations reduce the environmental impact of their activities and project a positive image to costumers and the wider community.

5.2.3.8 Building Energy Management Systems (BEMS)

The implementation of an energy management system requires to an organization of any king to follow a series of pre-defined steps, which typically include establishing an energy policy, assigning responsibilities within the organization, identifying main energy users, setting measurable goals and targets, implementing actions to meet these goals, checking for success of actions, and a continuous review of the system. Similarly to other management systems like the ISO 9001 (**Figure 19**), the principle of Plan, Do, Check, Act also applies with the continuous improvement as a main driver for the evolution of such system.

Figure 19. Energy Management System model for ISO 50001



Some tools that may be implemented within an energy management system are Building Energy Management Systems, which may be helpful for energy managers to better visualize the buildings' energy flows and act upon the information being served.

Building energy management systems (BEMS) are computer-based control systems generally applied to the control of systems such as heating, ventilation, and air-conditioning (HVAC). BEMS use software to control energy-consuming equipment or the full buildings' energy consumption, and can monitor and report on the buildings' performance, allow for dedicated controls and energy sub-metering by the individualization of energy flows by energy carrier and the type of use or equipment.

BEMS have been existing for quite some time now, especially in energy-intensive buildings, where a fine monitoring of the energy flows is of a greater importance.

BEMS are generally composed by:

- Controllers, sensors (temperature, humidity, luminance, presence...) and actuators (valves, switches...) for different types of parameters distributed in various zones of the buildings;
- HVAC central system with local controllers for each area or room in the building (zoning) and central computer assisted control;
- Central control hardware and software (with general control, monitoring functions) Monitoring through energy consumption measurement devices

With the advent of the smartphone and the massification of personal computers all over the world, being connected to the internet has passed from a work related need to an almost basic need. This has allowed for the development of the “smart” ecosystem, especially within the residential market. With the roll-out of smart meters, an increasing development of smart grid projects, a growing Demand Response market and the access to fast internet, has potentiated the development of the Home Energy Management Systems.

The most important feature of Building/Home management systems is probably the ease of access of information that is being delivered to the final energy consumer or the energy managers within organizations, giving them an actual tool to act upon this information and potentiate energy savings in the long run. The “JRC Science for Policy Report: Energy Feedback Systems: Evaluation of Meta-studies on energy savings through feedback” ⁽⁶⁰⁾ has focused on the potential energy savings arising from energy feedback being given to residential energy consumers. In general, the study has found that effective feedback, other than the traditional energy bill can realistically reduce households’ energy consumption up to 10%, especially when it is tailored to the householder, presented clearly and engagingly, accompanied by advice for reducing energy consumptions, delivered regularly and with high frequency.

5.2.3.9 Office appliances

Energy savings in office appliances are possible through the selection of energy-efficient products. Only an assessment of the systems and the needs can determine which measures are both applicable and profitable. This could be done by a qualified energy expert with IT experience. The assessment conclusions should include hints for procurement of the equipment, via purchase or leasing. The definition of energy-efficiency measures in IT in the early planning stage can result in a significant reduction of loads for air conditioning and UPS, and thus, can optimise the efficiency for both investments and operation costs. Additionally the duplex printing and paper saving in general are important measures for saving energy for paper production, as well as reducing operation costs. The following tables (**Table 32, Table 33, Table 34**) show the potentially significant energy savings measures which might be applicable to your IT landscape. In each table the measures are presented, beginning with those that have a large potential impact and are the easiest to implement.

Table 32. Step 1: Selection of energy efficient product – Examples

Description of measure	Saving potential
Centralised multi-function devices replacing separate single-function devices save energy, but only if the multi-function is used	Up to 50 %
Centralised printer (and multi-function devices) replacing personal printers save energy, when well dimensioned for the application	Up to 50 %

⁽⁶⁰⁾ <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/energy-feedback-systems-evaluation-meta-studies-energy-savings-through-feedback>

Table 33. Step 2: Selection of energy-efficient devices in a defined product group – examples

Description of measure	Saving potential
The specific appliance dimension for the realistic application is the most relevant factor for energy efficiency	Not quantified
Use of Energy-Star criteria as a minimum criterion for call for tender will prevent the purchase of inefficient devices	0 – 30 % compared to state of the art
Make sure that the power management is part of the specification in the call for tender and that it is configured by installation of the new appliances	Up to 30 %

Table 34. Step 3: Check power management and user-specific saving potentials – Examples

Description of measure	Saving potential
The power management should be initiated in all devices	Up to 30 %
Screensavers do not save energy and thus, should be replaced by a quick start of standby/sleep mode	Up to 30 %
Use of a switchable multi-way connector can avoid power consumption in off-mode for a set of office equipment for night and absence	Up to 20 %
To switch off monitors and printers during breaks and meetings reduce energy consumption in stand-by mode	Up to 15 %

Two European experiences can be named: the label ENERGY STAR ⁽⁶¹⁾, available for energy-efficient office equipment, covers a wide range of products from simple scanners to complete desktop home computer systems. The requirements and specifications of a product to be labelled can be found at www.eu-energystar.org. A product-comparison tool is available that allows the user to select the most energy-efficient equipment. The EU Ecolabel Product Catalogue ⁽⁶²⁾ covers a wide range of product groups, namely Personal, Notebook and Tablet Computers and makes sure that the products constant in the catalogue are of high energy efficiency, are designed to have a longer lifetime, less hazardous substances and are designed to be easier to repair, upgrade and recycle in comparison with regular devices in the market.

5.2.4 Infrastructure lighting

Local authorities can establish specifications for outdoor lighting and infrastructure lighting including standards for lighting fixtures and requirements for light levels.

Traffic Lights

The availability of compact LED packages on the market boosts the replacement of incandescent lamps in traffic lights with more energy-efficient and durable LED ⁽⁶³⁾ ones. This action yields a significant reduction of energy consumption. A LED array is composed by many LED unities. The main advantages of LED traffic lights are:

- The light emitted is brighter than the incandescent lamps, which make LED traffic lights more visible in adverse conditions.

⁽⁶¹⁾ Further information available at www.eu-energystar.org

⁽⁶²⁾ <http://ec.europa.eu/ecat/>

⁽⁶³⁾ LED – Light Emission Diode

- A LED's lifespan is 100 000 hours (about 10 times more than incandescent bulbs). This implies a significant reduction of maintenance costs.
- The energy consumption reduction is higher than 50 % with respect to incandescent bulbs.

Public lighting

Public lighting is an essential municipal service. It offers significant potential for energy efficiency ⁽⁶⁴⁾, in particular through the replacement of old lamps with more efficient ones, such as low pressure, high pressure lamps or LED. Over the years the efficiency of lamps has improved significantly. The high-pressure mercury lamp is the most frequent in public lighting. It has been used since 1960s and is extremely energy in-efficient. High-pressure sodium and Metal Halide lamps are very energy efficient ones and commonly used recently.

Replacing lamps is the most effective way to reduce energy consumption. However, some improvements, such as the use of more efficient ballast or adequate control techniques, are also suitable measures to avoid the excess of electricity consumption. In addition, the use of autonomous public solar street lighting systems powered by PV panels with energy storage battery is spreading across cities.

Luminous efficiency, CRI, duration, regulation or Life Cycle must be included in the set or design parameters for the choice of the most suitable technology. For instance, if a high CRI is required in a public-lighting project, the use of LED technology is recommended. This technology is a suitable solution to reach a good balance between CRI and Luminous efficiency. If CRI is not essential for a given installation, other technologies may be more appropriate. In the following **Table 35**, recommended lamps for public lighting are reported in case of either replacement or new installation.

Table 35. Recommended ended Lamps Direct substitution and new installation

Type of intervention	Original Lamp	Luminous efficiency	Recommended lamp	Luminous efficiency
Direct substitution	High pressure mercury lamps	32-60 lm/W	Standard high pressure sodium lamp	65-150 lm/W
	Arc lamps	30-50 lm/W	Metal Halide Lamp	62-120 lm/W
			LED	65-100 lm/W
New Lighting Installation		Less than 60	Low pressure sodium lamp	100-200 lm/W
			Standard high pressure sodium	65-150 lm/W
		More than 60	LED	65-100 lm/W

Arc discharge lamps, such as fluorescent and HID (High Intensity Discharge) sources, require a device to provide the proper voltage to establish the arc and regulating the electric current once the arc is struck.

Other measures may be implemented to achieve significant energy reduction:

⁽⁶⁴⁾ Further information available at www.eu-greenlight.org and www.e-streetlight.com (European project supported by Intelligent Energy Europe)

- Take into consideration the use of the public area (parking, pedestrian, dangerous intersection) in order to provide the appropriate kind of lamp and level of lighting.
- Ballasts: compensate voltage variation in the electrical supply. Since the electronic ballast doesn't use coils and electromagnetic fields, it can work more efficiently than a magnetic one. These devices allow a better power and light intensity control on the lamps. The energy consumption reduction caused by electronic ballasts has been estimated around 7% ⁽⁶⁵⁾. In addition, LED technology not only reduces the energy consumption, but also allows an accurate regulation depending on the needs.
- Electronic photo-switches can contribute to the electricity savings in public lighting by reducing night burning hours (turning on later and turning off earlier).
- A tele management system enables the lighting system to automatically react to external parameters like traffic density, remaining daylight level, road constructions, accidents or weather circumstances. Even if a tele management system doesn't reduce the energy consumption in lighting by itself, it can reduce traffic congestion or detect abnormalities. Tele management systems can be used to monitor failed lamps and report their location. Maintenance expenses can be reduced by considering the remaining life of nearby lamps that might be replaced during the same service call. Finally, data collected by the tele management system that tracks the hours of illumination for each lamp can be used to claim warranty replacement, establish unbiased products and supplier selection criteria, and validate energy bills.

5.2.5 Urban and Land Use planning

5.2.5.1 *Embedding Climate Change in land use planning*

There are many site-specific strategies that local authorities may adopt to face Climate Change and to reduce carbon emissions of cities. Land use and transport interaction, green infrastructures and local energy production are some of the main fields where urban planning may have a role to address Climate Change at local level. Furthermore, there is growing evidence and consensus that when local authorities act on these issues, there is a suite of economic, environmental and social 'co-benefits' which can fundamentally improve the liveability, sustainability and resilience of cities. As a consequence, Climate Change mitigation became a key pillar (alongside traditional economic, social and environmental aspects) in decision-making in cities.

Strategic planning decisions impact cities both in the way they function and in the behaviours of urban community. For this reason, these decisions need to be carefully and holistically considered, by taking into account the complex interdependencies among fields and potential trade-offs due to the implementation of different measures. Furthermore, sustainable urban planning is most effective when policy instruments are bundled and coordinated towards a common vision and strategy. When local policies are integrated within a regional framework (i.e. urban clusters), the definition of how and where building a new development provides resource efficiencies for the constituent cities. This type of approach can build economies of scale and offer opportunities to establish efficient public transport networks, shared infrastructure investment and overall improved use of capital.

The following sections reference the key aspects for both existing and new developments to be taken into account in urban planning oriented to improve the energy efficiency and sustainability of cities. Despite being treated separately, all these aspects are deeply interrelated.

⁽⁶⁵⁾ E-street project www.e-streetlight.com. Supported by Intelligent Energy Europe

5.2.5.2 Urban Form and Layout

GHG emissions at urban level are deeply influenced by the layout of neighbourhoods. In particular the key issues that influence carbon emissions are urban density and efficient urban mobility. New urban developments give the opportunity to apply and test existing best practices implemented, in the whole or in part, worldwide to create sustainable urban environments. Urban form, land use and characteristics of the building stock are strategic issues in improving energy performance.

Mixed-use development and sprawl containment:

Sprawl represents one of the key aspects where the correlation that lies between energy and urban layout appears. Compact cities and the promotion of mixed-use developments can reduce mobility demand within cities and create more sociable, equitable and economical urban environments.

Urban density and limiting sprawl can have significant benefits in terms of reducing the overall environmental impact of cities. In terms of GHG abatement, dense cities offer reduced travel distances and, hence, increase the feasibility for public transport and active travels; provide improved opportunities for district energy; and preserve surroundings, green and rural areas, which may also potentially provide carbon sequestration. Policies aimed at requiring minimum values for density (by unit or floor area) and promoting green areas (⁶⁶) can encourage low carbon developments with appropriate layouts when considered in context with other strategies for public and green areas (proper densities, mixed use, accessibility).

Mixed-use Development is a common approach to urban growth, especially in areas of higher urban density. There is significant evidence and consensus that creating high residential densities co-located with high commercial (employment) densities can lead to reduced commuting and mobility demand. This type of development needs to be considered closely with the public transport strategies and infrastructure to ensure that developments do not become isolated or difficult to service.

5.2.5.3 Transport and land use

The integration of land use and transport planning is one of the key elements of a long term strategy aiming at energy efficient districts. Moreover other options are available to improve the energy performance of urban developments.

Transit Oriented Development (TOD) (⁶⁷) is a planning strategy which aims at producing low carbon development, by considering public transport and transit stations as priorities. The development of housing, employment, activity sites and public services are placed around existing or new stations served by frequent and efficient service. TODs are characterised by medium to high densities, compact urban forms and mixed use. In this framework, both corridor and nodal approaches to development are considered with the goal of moving citizens as efficiently as possible. The main features of TODs are:

- rapid and frequent transit service
- high accessibility
- mixed use
- high quality public spaces and streets
- pedestrian and cycle routes
- medium- to high-density development within 800 metres of the transit station

(⁶⁶) Green belt application needs to be carefully managed as it can result in the outward migration of development (i.e. outside the green belt).

(⁶⁷) Further information available at: <http://www.tod.org/>

As a consequence, as well as optimising the infrastructure requirements for public and active travel, this type of development often provides other community benefits (i.e. creating mixed-use 'hubs').

Limiting vehicle infrastructure can reduce and control private vehicle travels and encourage the use of public transport. Similar measures to reduce the provision of parking spaces impose congestion charges and assign low speed zones can have similar impacts. See chapter 5.2.6 for more details on these options.

Providing infrastructure for active travel to encourage cycling and walking as alternative forms of commuting and travel can significantly reduce vehicular traffic. Conversion of inner-city areas and peripheral neighbourhoods to pedestrian zones has far-reaching effects in terms of reduced car-related accidents, improved air quality (especially in central areas), and socio-economic benefit for local retail and public transport ridership.

5.2.5.4 Green areas and heat island

The heat island effect is the phenomenon whereby atmospheric and surface temperatures are higher in urban areas than in the surrounding rural areas (typically by 1-3°C in larger cities) ⁽⁶⁸⁾. The issue is a result of the combination of low surface albedo (i.e. low reflectivity) of urban surfaces combined with high building density which can limit air circulation. This not only creates health problems and discomfort for urban citizens during extreme weather, but also increases the electricity demand for cooling buildings (by approximately 2-4% per 1°C). There is also a negative impact on air quality. The heat island effect is best mitigated by carefully considering the configuration of (especially high-rise) buildings and green spaces and by creating more reflective, high albedo (i.e. light) surfaces.

Urban green space provides also carbon sequestration. However, it is generally marginal in the context of overall urban GHG emissions. Parks, greenways, green roofs and community gardens have other indirect benefits in terms of Climate Change mitigation, for example reducing the heat island effect (and therefore cooling demand) and encouraging active travel. Green spaces can also have significant benefits in terms of air quality and human health and climate adaptation/resilience (i.e. reducing storm water run-off and the urban heat island effect)^(69, 70).

5.2.5.5 Informal settlements

Informal Settlements and urban informality are wide spread in developing countries. Coping with risk in these settlements requires major efforts, also because of the high share of population living there and the absence of infrastructures. Buildings are built from non-durable materials such as plastics, cardboards, metal tins, zinc sheets and timber. Usually service coverage in terms of potable water, sewerage, storm water drainage and electricity is not provided. Several planning policies have addressed this question with either efficacious or unsuccessful outcome, which are beyond the scope of this document. Climate Change mitigation and adaptation of these areas is challenging. In particular, people living "informally" are more vulnerable to climate related impacts being more sensitive and less able to adapt. Therefore, the coping with informal settlements, upgrading them and introducing infrastructure is highly important for climate change adaptation. Nevertheless, policies and actions on these areas shall be developed in an integrated way with mitigation. Providing good quality houses has benefits in reducing risks and improving resilience at the same time. Using local affordable building materials with environmental benefits, adopting a design that

⁽⁶⁸⁾ United States Environmental Protection Agency

⁽⁶⁹⁾ DG CLIMA Project Adaptation Strategies of European Cities (EU Cities Adapt); <http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change>

⁽⁷⁰⁾ For further guidance consult FEIX I., MARQUET S., THIBIER E., (2018) Aménager avec la nature en ville. ADEME, 100pages. Available at: <https://www.ademe.fr/amenager-nature-ville>

The guidance includes some examples focused on French study cases, that can be adapted to every context.

maximise natural ventilation imply mitigation co-benefits. Mitigation actions do not differ from other contexts (developing mass transit, energy-efficient buildings and renewable technologies are examples). On the contrary, the approach to be adopted, the timeline and the community involvement are the variables that change in this regard. In this perspective, strategic public investments and initiatives are crucial to develop mitigation strategies.

5.2.5.6 Energy production

Planning urban form to enable renewable, low carbon and smart energy can offer significant benefits in terms of reducing emissions, but also improving access to sustainable and secure energy supply and potential to reduce fuel poverty.

Heat mapping exercises can help determine where energy/heat surpluses and demands are and to create robust energy strategies. This can be further linked to plans for electric vehicle infrastructure or energy storage plans. Some cities have created municipal utilities to own, regulate and sell the energy produced, contributing to local authority revenue and local employment.

5.2.5.7 Strategies for new developments: Urban regeneration and Eco districts

One mechanism to reduce urban sprawl, while revitalizing brownfield sites and local economies is through urban regeneration initiatives. Former industrial or other economically redundant sites can be repurposed to make best use of available land without increasing the urban footprint on green land. Typically, there is a premium to pay to demolish, remediate and reconstruct brownfield sites (especially former industrial sites); however, this can have a positive impact on localised economies and for revitalising neighbourhoods.

'Eco Districts': District level approaches to resource efficiency are growing in application, especially in urban-regeneration of brownfield sites (particularly industrial). Large scale development sites offer the opportunity to create mixed-use districts which can adhere to all the latest approaches to urban sustainability. Developments are typically financed by public-private partnership and are focussed on using holistic approaches to create sustainable districts: efficient use of resources; vibrant communities; prosperity; liveability, health; equity, ecological enhancement. Usually "Eco districts":

- include buildings with low energy consumption (materials, orientation, insulation, ventilation);
- are based on renewable energy (solar, wind, biomass, geothermal) to meet the energy needs;
- consider waste and water management;
- are transit oriented, pedestrian and cyclist friendly;
- have active communities.

5.2.5.8 Implementing Effective Sustainable Urban Planning

The preparation of a SEACAP offers the opportunity for local authorities to bring together several departments and services and to redefine their approach to urban planning. For example, creating stronger connections between transport, planning, infrastructure, energy and economic development departments can foster a more cohesive approach to master-planning and urban form, which can further trickle down to intelligent application of localised infrastructure. To deliver climate mitigation policies this multi-disciplinary approach, paired with financial resourcing and political will should be aligned with the goal of reducing GHG emissions. As discussed, engagement between the local authority, private sector and academia, in a so-called 'Triple helix' approach, can provide added confidence to urban and land use planning decisions. In this context, the necessity of a linkage between planning instruments developed at local level (such as masterplans and land-use regulations, energy plans, building codes, urban mobility plans...) and SEACAPs

arises in order to achieve sustainable and low carbon communities towards the 2030 targets.

To fund relevant policy and infrastructure, traditional forms of financing for urban development can be used, such as municipal revenue, central government investment, public-private partnerships and various forms of borrowing. Increasingly innovative means of raising municipal funds to deliver Climate Change mitigation are continually being developed. For example, municipal green bonds, congestion charges, raising parking charges, levies etc. have all been successfully deployed at a sub-national scale (see chapter 8). Regardless of the source of financing, the business case for projects should be assessed not only in the context of Climate Change, but considering all the other potential economic, environmental and social benefits.

In summary, local authority should look at establishing the following measures to create more sustainable, low carbon urban areas:

- a multi-level, multi-departmental governance structure which empowers cities to coordinate effective urban transformations, including political will at the highest level;
- formalised institutional arrangements that ensure Climate Change mitigation is a key aspect in the decision making alongside other (more traditional) urban priorities;
- sufficient and diverse sources of finance (including incentives/disincentives) to support mitigation policies and actions.

Box 24. QUICK TIPS

Introduce energy and Climate Change criteria in planning (land use, urban, mobility planning).

Promote mixed use developments (housing, services and jobs).

Plan to avoid urban sprawl:

- control the expansion of built areas;
- develop and revitalize old (deprived) industrial areas;
- position new development areas within the reach of existing public transport lines;
- avoid 'out-of-town' shopping centres.

Plan car free or low car use areas by closing areas to traffic or introducing congestion charge schemes and provide more active transport infrastructure

Identify opportunities to increase and improve green spaces.

5.2.6 Urban Transport

Transport plays a key role in delivering on the Paris Agreement, the Sustainable Development Goals and the New Urban Agenda. While providing essential services to society and economy, transport is also an important part of the economy and it is at the core of a number of major sustainability challenges, in particular Climate Change, air quality, safety, energy security and efficiency in the use of resources.

In SSA public transport is a key sector, its shares range from 55% to 70% on a pkm basis. However, it is of utmost importance keeping the pace with the population growth and keeping updating the system and infrastructures to maintain a high quality level of performance.

There are key aspects to be taken into account when developing strategies in urban transport planning in SSA. As happened in South East Asia, motorcycle growth outstrips car growth in many SSA cities and these are also extensively used as paratransit. Paratransit plays a key role in the number and type of journeys. Therefore, motorcycles and paratransit are essential parts of a comprehensive urban transport strategy.

Bus Rapid Transit was firstly developed in South America. It offered mass transit at far lower capital cost than rail. The development of BRT systems in SSA has not reached high levels since the capital intensity is still too high for the SSA context, where the trend shows sprawling cities, poor road infrastructures and low income populations. There are some South African experiments that reframed BRT as IPTN – Integrated Public Transport Networks.

This part of the guidelines summarises key actions to decarbonise urban transport and to promote low-carbon solutions to contribute to sustainable cities and opportunities for synergies of sustainable development and Climate Change objectives. There are various levers where local authorities can shape the energy consumption and the sustainability of urban transport systems through infrastructure, service and policy decisions. In the following, key areas for local policy and planning interventions holistically focused on the urban transport system are reported. These address transport planning, transport activity, the modal structure, the energy intensity and the fuels and energy carriers.

Table 36 summarises actions and benefits of four general actions for low carbon mobility. The first two lines comprise actions that have influence on the transport demands by reducing the need of mobility. On the contrary, the second two lines regard vehicles and their efficiency, on which actions have no influence on the demand side.

Table 36. Summary of sustainable urban mobility actions and potential benefits

Mobility actions	Emission reduction potential	Benefits/synergies
Activity and flows (short distances, mixed use, compact cities)	Potential to reduce energy consumption by 10 to 30%	Reduced travel times; improved air quality, health, safety and access
Structure (shift to more energy efficient modes)	Potential for energy efficiency increases varies greatly, but for example Bus Rapid Transit (BRT) systems can deliver up to 30% reductions at a cost of \$1-27 M/km	Reduced urban congestion and increased accessibility
Intensity (vehicle fuel efficiency)	Efficiency improvement of 40-60% by 2030 feasible at low or negative costs	Improved energy security, productivity and affordability
Fuel (switch to other fuels)	Changing the structure of the energy consumption, but not necessarily overall demand.	Diversification of the fuels used contributes to climate, air quality and/or energy security objectives

More recommendations can be found on the website of the MobiliseYourCity initiative, which focuses on the development of sustainable urban mobility plans in developing countries at the national and local levels (http://mobiliseyourcity.net/?lang=en_us).

5.2.6.1 Urban mobility solutions

This section explores key strategies for sustainable urban mobility, including integrated urban planning, public transport, walking, cycling, pricing measures, urban logistics, intelligent transport systems and options to boost electric mobility.

There are a large number of possible interventions that local authorities can initiate in their jurisdiction to positively influence travel behaviour, vehicle choice and use. Local authorities have a key role to play in shaping urban form and planning local transport infrastructures. With integrated urban planning and the ability to regulate, fund and often even operate public transport services a local authority can shape the modal structure of its transport system substantially. These policies have further good implications on energy security, on the reinforcement of social and economy cohesion, on the improvement of the quality of life and on the reduction of externalities. A number of policies that manages the energy efficiency of the transport sector are driven at national (e.g. vehicle and fuel tax) or international level. However, several policies that have a similar effect on the choice and use of means of transportation are applicable at local level, such as road and parking pricing or access limitations. As further detailed in the following, the widely recognised standard "ASI" for transport planning (Avoid, Shift, Improve) has been adapted for SSA context, with the integration of "Enable" approach, becoming "EASI" (The World Bank, 2015). The "E" stands for the governance interventions required to enable the policies. The "EASI conceptual framework" aspires to become a powerful policy tool to improve accessibility and mobility in urban areas of Africa. Four levers of intervention are framed in the EASI approach:

ENABLE: to establish an efficient and responsible governance system, capable of anticipating needs, guiding action and ensuring integrated management and development of urban transport systems;

AVOID: to limit and minimize the need for individual motorized travel through adequate land-use and transport planning and management;

SHIFT: to orient transformations towards low impact transport models (public transport and non-motorized transport modes such as walking and cycling);

IMPROVE: to improve the efficiency and safety of transport modes while minimizing their environmental footprint (advancement in the technical and technological characteristics of vehicles).

Table 37 reports the policies recommended in the EASI framework, while

Table 38 provides an overview of good practices classified according to the type of strategy (enable, avoid, shift and improve) showing also potential benefits in other fields.

Table 37. Summary of EASI policy recommendations

ENABLE - To establish an efficient and responsible governance system, capable of anticipating needs, guiding action and ensuring integrated management and development of urban transport systems.	
E1	To define, adopt and implement, at central government level, a national urban transport strategy that ensures the sustained development and management of urban transport systems.
E2	To ensure that the main urban transport public responsibilities at urban / metropolitan level of government are assigned and carried out.
E3	To set up an entity in charge of urban transport planning and of guiding and coordinating public action aimed at the provision of the multimodal urban transport system.
E4	To provide all institutions and stakeholders in the urban transport sector with adequate human resources.
E5	To increase financial resources allocated to urban transport systems and to ensure the availability of long-term funding for urban transport
E6	To create the preconditions for continued civil society participation in the development of urban transport systems
E7	To enhance the involvement of the private sector in the provision of transport infrastructure and services
AVOID - To minimize the need for individual motorized travel through adequate land-use and transport planning and management.	
A1	To plan for urban forms and land use that minimize the need for individual motorized travel and promote public transport and non-motorized transport modes
A2	To deploy transport infrastructure and services in a manner that promotes sound urban forms and land use
A3	To strengthen land use management.
SHIFT - To maintain or increase the modal shares of public transport and non-motorized transport modes such as walking and cycling	
S1	To adopt and systematically introduce, at all levels and scales, a multimodal approach to the development and management of urban transport systems.
S2	To develop and maintain for each urban area a pedestrian network that is continuous, safe and accessible for all throughout the day; and to develop and maintain bicycle paths with similar characteristics.
S3	To provide an integrated and hierarchical public transport system that is efficient, reliable and capable of serving the needs of constantly evolving populations and the urban economy.
S4	To plan and implement mass transit systems that operate on exclusive infrastructure and can form the backbone of the urban public transport system.
S5	To enhance the level of service provided by paratransit operators by way of full integration in the public transport system, which requires restructuring, modernizing and promoting them.
IMPROVE - To improve the efficiency and safety of transport modes while minimizing their environmental footprint.	
I1	To improve planning, operation and maintenance of urban roads taking into account and balancing the needs of all transport modes, and keeping the use of individual motorized vehicles under check.
I2	To define and implement realistic and gradually more demanding requirements in terms of fuel components, energy efficiency and gas emissions.
I3	To promote safe and environmentally responsible behaviour by all urban transport stakeholders by strengthening technical control of vehicles and by keeping the public informed of the negative externalities of individual motorized transport.

Source: The World Bank (2015), "Policies for sustainable accessibility and mobility in urban areas of Africa"

Table 38. Examples for energy efficiency measures, their CO₂ emission reduction potential, and contribution to other sustainable development objectives

Strategy	Good practice cities/projects	CO ₂ emission reduction	Sustainable development benefits (and risks for trade-offs)		
			Economic	Social	Environmental
Enable					
Strong governance for public transport	regulatory systems that improve control over paratransit services		paratransit sector in the ownership and operation of new BRT systems		Reduced the individual transport load
Avoid					
Road user charging	Road user charge in Stockholm, London, Gothenburg	Example London: 25% CO ₂ reduction	Travel time reductions	Social costs : reduction: €144 million / year	Funds can be re-invested in e.g. public transport
Shift					
Bus Rapid Transit (BRT)	Trans Milenio Bogotá (2)	Reduction of carbon dioxide emission by 200.000 tons (in 3 years)	Rationalised bus system, 32% commuting times reduction, Increases employment	Access for disabled and poor, 90% lower accidents in BRT corridors	Air quality improvements
Non-motorised Transport (NMT)	Walking and Cycling in Copenhagen: Cycle-friendly city	Overall GHG emission reductions not quantified	Faster transport, Green jobs (650 full time in Copenhagen)	Improved mobility access (free / very low cost so affordable) Reduction of road accidents	Zero air pollutants, Less noise
Improve					
Fuel switch options for public vehicle fleets	Public Transport fuels switch from e.g. hybrid/electric bus (9)	Medium to high potential for CO ₂ savings		Emission reduction, reduce congestion delays	CO ₂ emission reduction potential depends on the electricity mix. SO ₂ , NO _x emissions may be reduced significantly if switch to hybrid/electric.

Within the framework of sustainable transport planning, a package of complementary measures is required to actively manage travel demand and improve transport energy efficiency. This includes improvements of the public transport system as reliable and affordable alternative to the car and measures targeting the efficiency of the vehicle fleet. This chapter will explore some of these measures and in doing so will focus primarily on measures that can be implemented at the local level.

Vital to the success of sustainable urban transport concept is a mix of measures that improves the efficiency of the vehicle fleet, reduce travel distances via integrated land-use planning and provide modal alternatives to the private vehicle. Whereas the vehicles fleet policies fall only partially in the jurisdiction of city councils, the land-use planning and modal efficiency are key areas of responsibility for local authorities.

5.2.6.2 Integrated urban planning

Integrated land-use planning focuses on higher densities, mixed use and the integration of public transport and non-motorised transport infrastructure ⁽⁷¹⁾. Combined, these factors can reduce travel distances, can enhance the role of non-motorised modes and can improve accessibility and efficiency of public transport. Smart land-use planning only takes effect over longer time scales, but impacts are lasting. Local authorities can largely influence future travel patterns.

Thereby, land-use planning decisions of today can ease the traffic management task in the future. Cities can limit the increase in car use with mixed use developments that play an important role in improving the efficiency of the transport system, by reducing the need to move. The integration of land use and transport is, indeed, a strategy that improves the connectivity and the accessibility, providing a better mobility service and making closer people and places. As part of this, cities may want to consider integrating fares, infrastructure and operations for integrated public transport planning, and create easy connections with non-motorised transport.

5.2.6.3 Sustainable Urban Mobility Planning (SUMP)

Sustainable Urban Mobility Plan (SUMP) can be strategic planning documents that guide the integration of all transport modes and work towards a sustainable transport system within a city. The development of a SUMP includes a number of steps from the identification of the main transport issues, in a city, to the development of a joint vision and the identification of specific measures and a process to implement actions. The European Commission provides detailed guidelines, addressed to cities in the development process ⁽⁷²⁾. A vital component of the process of developing a SUMP is the involvement of stakeholders and the active participation of the public.

5.2.6.4 Urban Access Regulation

Low Emission Zones

Restricting access to certain areas of a city, normally the city centre, can have a direct effect on local air quality noise pollutions and traffic safety in this area. The effect on greenhouse gas emissions depends on the design and complexity of the scheme and the provision and integration of modal alternatives. The main objectives are to reduce congestion and pressures, to improve safety, and to decrease noise and harmful emissions.

There are different types of access restriction schemes, including those that control access at specific points (e.g. when crossing a bridge), cordons or areas (e.g. around a specific location), which may differentiate further between different types of vehicles or times of the day. While these schemes can be very effective in managing congestion, noise and air pollution, they may have unintended consequences. Hence, access restrictions should be implemented in combination with other measures that minimise trade-offs.

⁽⁷¹⁾ Banister D. (2011). "Cities, mobility and climate change". Journal of transport geography, 19, 1538-1546

⁽⁷²⁾ <http://eltis.org/content/sump-process>

Box 25. Planning for sustainable transport solutions

The SUMP Guidelines developed under EU funded projects set out strategic planning process for local authorities, fostering the balanced development and integration of all transport modes while encouraging a shift towards more sustainable modes. A SUMP aims at solving urban transport problems and contributes to reaching local and higher-level objectives for environmental, social and economic development. A Sustainable Urban Mobility Plan can help reveal the real challenges that a city faces and explain how conditions will change if the city remains on its present course. It can help ensuring that transport proposals are based on a sound understanding of the existing transport system. The process of preparing a SUMP can also help a diverse group of stakeholders rally around a common vision and agree on packages of mobility measures to improve the transport system in their city. A successful SUMP can provide a feasible and powerful strategy to tackle urban mobility challenges. Developing a SUMP is an innovative, integrated planning process requiring intensive cooperation, knowledge-exchange and consultation between planners, politicians, institutions, and local and regional organisations and citizens. Traditional mobility planning follows an approach known as “predict-and-provide.” Even though there is an increasing awareness of the importance for more sustainable solutions around the globe, infrastructure development still dominantly follows the trend of increasing individual motorisation. Today, transport planning increasingly recognises that transport trends are far from inevitable—the infrastructural investment choices that a local authority makes have a profound impact on the travel behaviour of its residents.

SUMP Guidelines: <http://www.eltis.org/guidelines/sump-guidelines>

5.2.6.5 Urban Road Tolls/congestion charges

One very effective option to improve traffic flows and reduce overall travel demand by avoiding and shifting traffic to more sustainable transport modes is congestion charging, which is a pricing scheme for peak hours. Congestion charging lies at the intersection of traffic management and travel demand management, as information gained from real-time traffic information systems could be used to improve the pricing mechanisms of congestion charging by introducing real-time variable pricing systems, which can encourage more efficient travel behaviour.

Congestion charging systems have been operating in Singapore for several decades and were implemented more recently in London and Stockholm. As early as 1975, the road pricing was implemented in Singapore to manage the choked streets of the rapidly growing city. First, an Area License System was established, which required a permit to enter Singapore's central area. The city entry charge boosted public transport patronage almost immediately after its introduction and led to a 45% reduction in traffic, road site accidents decreased by 25% and average travel speeds increased from about 20 km/h to over 30 km/h (OECD & ECMT, 2007). The system resulted in a public transport share of over 60% in daily traffic, an increase of nearly 20% (SOLUTIONS, 2016). The success of the system in improving infrastructure capacity, safety and air quality and reducing travel demand, fuel use and greenhouse gas emissions inspired the congestion charge systems in London and Stockholm and provided the basis for several feasibility studies for similar schemes for cities around the world (Prud'homme and Bocarejo, 2005).

5.2.6.6 Public transport infrastructure, operation and vehicles

A reliable and affordable public transport system is a key element of a sustainable urban transport concept. While providing a similar level of mobility, public transport only requires a fraction of energy and space compared to the private car. Public transport not only contributes to lower energy consumption and emissions, it also reduces congestion, which improves traffic flows and decreases travel times. Moreover, provision of new infrastructures has the potential for revamping outdated and sectorial planning practices, towards a comprehensive approach of strategic and sustainable planning (La Greca and Martinico, 2018). As public transport is typically more than twice as energy-efficient per

passenger kilometres as individual motorised transport, enhancing the share of public transport in urban passenger transport yields the potential to mitigate rising energy consumption and emissions. Thus, it contributes to the objective of reducing congestion and at the same time is part of the wider concept of sustainable urban transport. Vital elements to shift transport demand from individual motorised transport to public transport are investments in capacity and reliability and physical integration with walking and cycling and park & ride facilities. Reliability is an important factor for modal choice. The predictability of travel times with metro (MRT), light rail (LRT) and/or bus rapid transit (BRT) compared to a journey in the private car may provide enough incentive to shift from individual to public transport. Public transport systems generally require substantial public investments and the operation often requires continued subsidies. Linking public transport investments with road user charging and parking pricing schemes can help to reduce the pressure on public funds and at the same time it creates disincentives to use the private car and encourage the use of public transport.

Box 26. Bus rapid transit and clean vehicles examples in SSA

New BRT systems and clean buses are in development in cities in Africa such as BRT in Lite Lagos, DART in Dar es Salaam, Addis Abbaba, Rea Vaja in Johannesburg.

The awarding of the 2010 (19th) FIFA World Cup event to Johannesburg stimulated an intense interest in improving the transport system in order to live up to the projected image of being a 'World Class City'. The Rea Vaja started in 2009, the key characteristics include: dedicated priority infrastructure, frequent and rapid services, a pre-board fare collection and fare verification, a fare-integration between routes, corridors, and services, secure enhanced stations, Clean Euro 4 vehicles. The project was financed through: National grant for infrastructure R 2.3 billion (US\$ 300 million), a structure developed by HSBC, including financing of vehicles by Brazilian development bank and German government grant for planning (BMZ/KfW/GTZ) € 2 million euros.

The project for DART aimed at ensuring orderly flow of traffic on the city streets and roads by increasing the level of mobility, improving public urban transport, promoting the use of non-motorized transport, and at meeting the ever increasing travel demand of the city residents with ultimate aim of increasing comfort and quality of life and urban development. In addition, DART system intends to generate jobs to residents by inviting people to invest in the DART bus operations, fund management and fare collection companies. The Dar BRT System comprises six phases, at the end of which a total 130.3 km network, with 18 terminals and more than 200 stations will be provided. Phase 1 has been completed with financing from the World Bank and the Government of Tanzania. The vehicles are modern and based on low emission engines according to international standards. Among the positive impacts of the project, improved drainage and traffic flow, reduction in emissions, improved Air Quality, direct and indirect employment generation.

Africa's First Full Rapid Bus System: the Rea Vaya Bus System in Johannesburg, Republic of South Africa- Heather Allen. Case study prepared for Global Report on Human Settlements 2013

Presentation of L. Wright at UN Forum on Climate Change Mitigation, Fuel Efficiency and Sustainable Urban Transport - Seoul, Republic of Korea, 16 March 2010

"Dar es Salaam Bus Rapid Transit: Environmental and Social Impact" (PDF). afdb.org. African Development Bank. March 2015.

5.2.6.7 Car sharing

Owning a car is recognized as increasingly uneconomical, considering the initial costs of buying a vehicle, insurance, registration, vehicle tax, parking space and maintenance. Car sharing schemes are becoming increasingly popular worldwide. Among the various providers of car-sharing schemes there are free floating and stationary systems. Users of stationary car sharing systems (such as Cambio and Zipcar) return the vehicle to designated parking areas, reservation and payments are normally also handled through

apps. Charges can be time based and/or kilometres driven and usually cover all costs including fuel. Most of the free-floating car sharing providers focuses on larger cities and, even there, focuses on the most densely populated areas. This may lead to a more competitive approach than to a complementarity with public transport. Many mid-sized cities work with providers of stationary sharing schemes, which often have a higher rate of replacing privately owned vehicles.

5.2.6.8 Parking management

Similar to road user charging, parking management and pricing can help discouraging the use of a privately owned car and raise revenue to fund public transport, walking and cycling infrastructure and improve public spaces. Parking management schemes lead to a reduction in the number of cars entering the city, which can reduce congestion and can encourage the use of public and non-motorised transport. The parking pricing structure and the level of enforcement are important aspects to consider. A structured fee that differentiates between different zones of a city or times depending on the demand is one aspect that needs strong enforcement to be meaningful. Coordination of parking pricing and zoning among relevant local authorities is another vital aspect. Parking management can be a powerful tool for local authorities to manage car use and to raise revenue. Parking management also includes time restrictions and a control of the number of available parking spaces.

Parking time restriction for non-residents, e.g., to two hours, is a proven tool to reduce commuting by car without affecting accessibility to urban shops. In fact, in many cases shops and other local businesses become more accessible when public space is freed up by a reduced number of parking spots.

5.2.6.9 Supporting Walking and Cycling

Non-motorised modes, i.e. cycling and walking, can take a substantial share of the urban transport sector, in particular on short distances. As a consequence, soft mobility contributes in the reduction of emissions, energy consumption and congestion. Walking and cycling are suitable for urban transport as in cities the majority of trips covers short distance (below 5 km). The fundamental advantage of non-motorised modes is that they are low cost compared to other transport options, not only for the individuals, but also for public authorities. Moreover, cycling and walking leads to further benefits, such as health benefits for the cyclists or pedestrians, environmental and economic benefits resulting from zero emissions and energy consumption. While taking up a noticeable share of the transport task, walking and cycling infrastructure consumes less space than roads, yet this kind of infrastructure is often neglected in transport planning. The provision and maintenance of infrastructure for pedestrians and cyclists is crucial to make these modes more attractive and, hence, an alternative to private motorised transport.

Frequently, citizens are discouraged from cycling because of safety issues. However, not only infrastructure must be safe, it must be perceived to be safe by the users. Separate crossing signals, cycle lanes, well-marked lanes and crossing, and buffers between road and lane can reduce the risk of accidents. Well maintained routes, free from litter and with appropriate lighting increase the feeling of safety. Moreover, beyond these measures, creating a cycle friendly environment may boost the cycle use. In this perspective, users may consider cycling convenient (e.g. networks should be more advantageous in terms of directness than roads, covered and safe cycle parking should be provided); the routes must be accessible and integrated with the transit network; the routes and surroundings should be attractive, with pleasant settings, and linked to well-designed public spaces, allowing users to stop, chat and rest in a pleasant environment.

These measures may be applied in case of both existing and new infrastructure for pedestrians and cyclists. However, cycling policies are successful when developed as part of an integrated transport policy for all modes of transport, which may be also reinforced

by other policies such as land use policies, urban development policies and socio-economic policies.

5.2.6.10 Supporting the up-take of clean vehicles

Local authorities have a number of options to encourage the purchase and use of electric vehicles, which can start with an active dialogue with stakeholders, such as electricity suppliers, car-park operators and where applicable vehicle manufacturers and continues with concrete actions. For examples introducing reduced or free parking for EVs (as in Oslo, Norway), exemption from road user charges or city tolls (e.g. London, UK), allowing access to high-occupancy vehicle lane, and giving priority to electric vehicles in municipal and car sharing fleets.

5.2.6.11 Registration management

A managed approach to vehicle registrations can help limiting the amount of cars in a city by differentiating registration fees for vehicles e.g. according to their CO₂ emissions or engine size. This can guide purchasing behaviour and can encourage people to opt for cleaner vehicles or more sustainable modes such as public transport and non-motorised modes. This approach has been implemented very successfully in several cities in Asia, e.g. Singapore and Shanghai. Vital to this approach is that the authority to register vehicles lies with the local authority. This would be feasible for the purchases of new cars, while it will be less practical for second-hand vehicles.

5.2.6.12 Implementing urban mobility solutions

The transport sector is unique in its complexity with regard to the number and diversity of its users and the various types of mobility solutions. Accessibility and mobility are vital components of city life and its economy. Moreover, addressing urban mobility in an integrated way can make the essential difference to the success and the liveability of a city. If applied in combination, sustainable transport interventions can be mutually reinforcing and create synergies between policy objectives. **Table 39** reports the combination of potential measures.

Table 39. Measures combination and complementarities

Examples for urban mobility measures	Complementarity of measures
Compact city design and integrated planning	The planning of compact and mixed use areas enables to reduce the length of trips and therefore, modal alternatives and accessibility are provided.
Provision of public transport, walking and cycling infrastructure and services	Reliable and affordable public transports in a compact city allow reducing the car dependence for daily activities. Moreover, with a high-quality environment, also walking and cycling modes expand.
Road User Charging, parking pricing, access restrictions, registration restrictions and number plate auctions, eco-driving schemes, urban logistics	Complementary measures at the local level help managing travel demand and can generate funds that can be re-distributed to fund low-carbon transport modes

5.2.6.13 Sustainable sources for Transport

Vegetable oil methyl esters (biodiesel) can be used for transport applications, either in pure form or blended with fossil diesel. Use in blends below 7% does not require any modification of the engine. Pure vegetable oils can also be used but engines have to be adapted. Ethanol can be used in gasoline engines either at low blends (up to 10%), in high blends in Flexible Fuel Vehicles or in pure form in adapted engines. Ethanol can also

be processed into ETBE (ethyl tertio butyl ether) and blended in gasoline. Biomethane can also be used by vehicles equipped for natural gas. Advanced biofuels from wood, lignocelluloses and waste, such a biomass to liquid (BTL), Dimethyl ether (DME) or ethanol are subject to intense R&D efforts.

Box 27. Bio fuel production in Zimbabwe

The launching of the biofuels projects was a political response by the government of Zimbabwe to the fuel crisis. A plan of a National Bio-diesel Feedstock Production Programme that sought to promote the planting of *jatropha curcas* in all the ten provinces of Zimbabwe was rolled out. The programme was launched in Mutoko in October 2005 while a Bio-diesel Plant was constructed to process *jatropha* into biodiesel. The Cabinet White Paper on the Principles for Biofuels Development and Use in Zimbabwe that was presented to Cabinet by the Minister of Energy and Power Development on the 18th of December 2007 is the only policy document that gives insight into government's intentions on the production, distribution and marketing of biofuels in Zimbabwe. Although, the document indicates the policy direction of the government it cannot in the strictest sense be called a national policy as it has not yet been published and publicised and adopted as a national policy.

In pursuance of the policy objectives and intentions outlined in the Cabinet White Paper on Biofuels Development and Use, the government started to implement some biofuels projects around the country focusing on *jatropha curcas* growing. In 2007, the government launched the National Biodiesel Feedstock Production Program in Mutoko District which saw *jatropha* seeds and planting material being distributed by the National Oil Company of Zimbabwe and other government departments to different provinces and districts around the country. The programme goal is to improve Zimbabwe's self-sufficiency in fuels and related products by producing enough *Jatropha curcas* seeds to contribute at least 10% of the country's annual diesel consumption.

As part of effort to promote biofuels production government constructed a Biodiesel Processing Plant at Mt Hampden a few kilometres outside Harare. To show support at the highest political level, the Plant was commissioned by President Mugabe. The Biodiesel Processing Plant has an operating capacity of around 90- 100 million litres of bio-diesel per year when operating at full capacity.

To produce such an amount of diesel the plant would require to be fed with at least 500 tonnes of seed oil annually. In terms of its specifications, the Plant is reported to be capable of processing *jatropha*, cotton seed, sunflower and soya, among others into biodiesel. The Plant was acquired as a joint venture between the Reserve Bank of Zimbabwe and a Korean company called Youn32 Woo Investments.

Shamiso Mtisi, Gilbert Makore, COMMUNITY PARTICIPATION IN BIOFUELS CROP PRODUCTION IN ZIMBABWE. A focus on the Policy and Practical Aspects. 2010. Zimbabwe Environmental Law Association (ZELA)

5.2.7 Local Energy Generation

Local energy generation and distribution systems are an important area of intervention within the Covenant of Mayors that concerns effective action at the local level within the competence of the local authority (Kona et al., 2017). Local authorities usually control or have influence over the local energy supply system as the owner or a partner in the local energy utilities, which can effectively enhance the opportunities by which renewable energy sources can be effectively integrated to support CO₂ mitigation targets.

This chapter aims at providing an overview of the key municipal policies and strategies to promote local energy generation, ranging from decentralised renewable energy in buildings to centralised options for promoting integrated and sustainable energy

systems at the urban level ⁽⁷³⁾. Well-rounded policy support from a synthesis of urban climate governance options, including those that relate to municipal self-governing, governing by provision, governing by regulation and planning, and governing through enabling (Kern et al., 2009) is required to transform the local energy structure. In turn, such policies have a crucial role in demonstrating, guiding and influencing key measures for achieving emission reductions through efficient electricity and local heat/cold production.

A holistic understanding of the key measures and technological options that are available at the local level is required to support the design and implementation of policies to promote local energy generation. For this reason, key measures are described with the aim of providing guidance towards potential application areas. Insight from signatories that have already undertaken the technological options is summarized to underline the rapid transition that is taking place at the local level based on the promotion of local energy generation with renewable energy.

Box 28. LuMa Sustainable Energy Project – 2016 to 2018, Lusaka Zambia

The Lusaka City Council and the City of Malmo in Sweden has partnered to embark on sustainable energy project which will last for three (3) years whose main aim is to promote sustainable energy solutions through municipal partnerships. The project was conceived to help tackle unsustainable energy use among the citizens which was identified as the main problem during an inception project meeting held in 2015. The unsustainable energy use in Lusaka is mainly due to limited knowledge of sustainable energy alternatives, lack or limited contact amongst the different stakeholders in the communities, lack of resources to promote sustainable energy use and business as usual style of living where people tend to stick to the same solutions when it comes to energy choices.

The use of unsustainable energy such as charcoal has different effects which include but not limited to health problems due to bad air quality and smoke from charcoal used for cooking and depletion of natural resources bringing about climate change impacts both locally and globally.

Sustainable development is the way most nations globally want to proceed. The United Nations has set out Sustainable Development Goals (SDGs) to be achieved by 2030. Lusaka City Council is actively working to achieve SDGs. This pilot project will be implemented in Matero compound where charcoal is mostly used as energy source. Different local stakeholders working in this space have been identified and are part of the project. Among the stakeholders working on the project include Emerging Cooking Solutions, NECOS, WWF, University of Zambia, local drama groups and many more.

Lusaka City Council will benefit from the project as it will help promote sustainable energy instead of using charcoal for cooking. Charcoal is highly used especially in peri-urban areas where over 70% of the population in Lusaka lives. There will also be knowledge transfer between the two participating cities as implementation will be done both in Lusaka – Zambia and in Malmo- Sweden.

The project will also help Lusaka City Council develop a Sustainable Energy Access and Climate Action Plan (SEACAP) which currently does not exist. It is important that a city like Lusaka develops a SEACAP for effective monitoring of gains made towards climate change adaptation and mitigation.

<https://www.lcc.gov.zm/luma-sustainable-energy/>

Policy measures give direction to increasing the valorisation of local opportunities in the context of local characteristics and available measures. This section is intended to

⁽⁷³⁾ IRENA (2016). Renewable energy in cities. International Renewable Energy Agency (IRENA). Abu Dhabi, <http://www.irena.org/publications/2016/Oct/Renewable-Energy-in-Cities>

provide a collection of key measures to promote the uptake of renewable sources and integrated urban energy systems. The options for the transition to sustainable local energy generation systems range from decentralised renewable energy options to centralised solutions, such as cogeneration ⁽⁷⁴⁾.

In this context, there is increasing interest in the decentralisation of the energy supply with more local ownership. Local energy supply options can take the form of local power generation utilities and energy services companies (ESCo). Local authorities can be in whole or partial owners of these utilities and promote community partnership.

Decentralised renewable energy technologies offer the possibility to produce energy with a much lower impact on the environment when compared to conventional energy technologies. Distributed electricity generation allows to reduce electricity transport and distribution losses and to use micro-cogeneration technologies while increasing the penetration of low-scale renewable energy technologies. The electricity grid must be able to distribute this energy to the final consumers when the resources are available, and rapidly adapt the demand, or cover the energy that is required using more adaptable technologies when the former are not available, such as hydropower or biomass.

Centralised options include cogeneration power plants. Cogeneration (or CHP – Combined Heat and Power) offers an efficient way of producing electric power and thermal energy for cities. Cost-effective policies that maximise efficiency benefits should focus on measures targeting areas with high heating and cooling densities.

Table 40 summarizes the key measures to promote local energy generation by renewable energy source or technology. The relevant modes of urban climate governance that are involved are marked to showcase the integrated approach that is needed for supporting particular renewable energy solutions.

Table 40. Policy measures to promote local energy generation by renewable energy source

Area of intervention	Policy measure
Local electricity generation:	Municipal financing and ownership of PV pilot plants on public buildings (rooftop PV and building-integrated PV systems)
Photovoltaics	PV installations on the roofs of bus sheds or parking lots
	Construction of a PV park on ground of municipal property at a former landfill site
	Concession of surface rights and renting of rooftop areas in public buildings for PV
	PV installations in public buildings based on collaboration with the ESCo and third-party financing for PV systems in school buildings
	Public-private partnership for Photovoltaic Solar Park
	Mandate for PV system installations equal to a given share of the total installed power in the city
	LAs bonus for photovoltaic and solar thermal installation on citizen's roof
	Interest-free loans for associations or schools for PV panel installations
	PV systems that supply electric vehicle charging stations
	Awareness building and supporting tools

⁽⁷⁴⁾ <https://www.eacreee.org/>

Local heat generation: Solar thermal	Solar land registry for roof-top photovoltaic or solar thermal installations
	Solar chart for identifying preferable areas for solar energy technologies
	Solar roof cataster
	Real time electricity generation data on PV systems of the City Council and visual consoles on CO ₂ reductions
	Public awareness to reach annual increase targets for PV in the private buildings
	City supported photovoltaic campaign
	Land use planning for utility-scale photovoltaic plants in the city
	Solar collectors on rooftops of municipal buildings, swimming pool facility, sport buildings and schools (including flat-plate and parabolic solar collector installations)
	Replacement of electrical heaters and boilers in public buildings
	Ordinance for installing solar collectors
Local electricity generation: Wind energy	Solar collectors in all buildings in the health care sector
	Solar thermal systems in 100% of schools that include south-facing facades and terraces
	Purchasing groups to allow widespread diffusion of solar thermal technology
	Targets to increase the area of solar thermal in the city
	Wind and solar farm with citizen cooperation
	Installation of wind power farms
	Promotion of locally owned wind turbines
	Public procurement of municipal wind turbines
	Co-ownership of wind-power plants (municipal company)
	Attraction of companies that want to generate electricity from wind energy
Local electricity generation: Hydroelectric power	Prioritized case handling and licencing of wind turbines
	Land use planning for wind turbines
	Mini-hydro plants on municipal waterworks
	Attraction of investment to realize an in-stream tidal hydro power plant
	Run-of-river hydroelectric plants
	Produces the amount of electricity needed for public building and public lighting loads
	Hydroelectric power plant construction
	Biogas cogeneration plant for electricity and thermal energy provision based on anaerobic digestion
	Biogas cogeneration based on zootechnical wastewater and silage cereals
	Biogas driven district heating network
Bioenergy	New anaerobic digestion plant in public waste recovery and treatment company
	Public-private partnership between the local authority and waste management utility for anaerobic digestion of biowaste
	Recovery of methane gas from landfills to produce electricity based on gas engines

	Consortium for a cogeneration plant based on biomass certified as sustainable (waste produced locally or from local consortium companies)
	Installation of wood chip boilers
	Collection and recycling of used cooking oil for biodiesel production
Geothermal energy	Construction of a geothermal power plant
	Low enthalpy geothermal heating for municipal residential building
Renewable energy (other)	City Council grants and subsidies for renewable energy (PV, solar thermal, biomass, ground source heat pumps)
	Subsidy per square meter of solar thermal collector area
	Grants for solar collector and heat pump installations
	Subsidy to renewable heat sources in residential buildings
	Clean technology funds for renewables
	Promotion of distributed energy generation based on Urban Building Regulations and simplified building authorization procedures
	Public buildings that are self-sufficient based on on-site renewable energy
	Self-sufficient town hall based on bioenergy and PV
	Demonstrations of net or nearly zero energy building with renewable energy
	Net zero energy schools
	Pilot public school built according to the Nearly Zero Energy (NZE) Standard
	Co-financing of a near zero energy school building with local and national funds
	Public buildings with bioclimatic design principles and renewable energy utilization
	Public social building complex
	Energy renovation of public buildings including solar thermal collectors
	Brownfield urban development with renewables and sustainable districts
	Transformation of former port and industrial area into a new sustainable district
	Co-financing between local and regional authorities for public energy upgrading
	Co-financing of solar thermal systems on public buildings
	Purchasing of certified renewable power for public buildings and public lighting
	Joint framework agreement for purchasing 100% green electricity
	Onshore Power Supply with high-voltage
	Awareness building actions
	Experimental sessions on renewable energy for students
	Training campaigns organized by the local energy utility/agency

Source: Compiled from good practices of Covenant of Mayors EU

In addition to the energy sector, opportunities for local energy generation exist within the water and waste sector. A cross-sectoral perspective that is not limited to only one sector is therefore necessary. **Table 41** complements this aspect based on a compilation of policy interventions for measures involving waste management, wastewater treatment plants, and water management. The relevant modes of urban climate governance are marked to emphasize the integrated approach that is needed also in these areas of intervention.

Table 41. Policy measures for waste and water management including wastewater treatment

Area of intervention	Policy measure
Waste management	Separate waste collection to increase the recycling of municipal solid waste and the use of organic waste for biogas production
	Use of green waste for the production of compost and pellets
	Utilization of organic waste for composting rather than waste-to-energy incineration
Wastewater treatment plants	Self-sufficient wastewater facility based on methane driven combined heat and power plant
Water management	Integration of renewable sources for supplying power to pumping tapwater
	Reduction in electricity usage for pumping based on reductions in water losses in the drinking-water distribution network
	Information system for energy and water use in the public sector

5.2.7.1 Renewable energy in buildings

Renewable energy will play a major role in tackling Climate Change and can provide an affordable and secure source of energy, including in the building stock. Renewable energy is cheaper now than ever due to technological developments, mass production and market competition. In the case of photovoltaic (PV) electricity generation, the technology has reached or on the verge of matching household electricity prices for grid-parity in certain contexts (Haas et al. 2013). Key measures for the deployment of decentralised renewable energy in buildings consist of photovoltaic electricity generation, solar thermal systems, biomass systems, and geothermal heat pumps.

5.2.7.1.1 Solar thermal systems

Solar thermal systems convert sunlight directly into heat and make this heat available for various applications. Solar thermal energy, together with biomass and geothermal energy, can be a major source of heating and. Currently, solar thermal applications are mainly used for domestic hot water (DHW) and space heating in single and multi-family homes although large-scale uses of solar thermal systems are increasing. Heating DHW during the summer is one of the easiest and therefore cheapest ways of using solar thermal energy. In addition, solar thermal heat can be used to drive a thermal cooling machine and can be used as an energy source for cooling ⁽⁷⁵⁾.

A relevant contribution of solar energy to space heating requires an increase of the solar fraction per building, which is the share of solar energy on the overall heat demand for DHW and space heating. Combi systems for DHW and space heating have a size of typically 10 to 15 m² of collector area and can provide a solar fraction of about 25%, depending on the size, efficiency of the building, and on-site climate conditions ⁽⁷⁶⁾.

In addition to solar thermal systems, photovoltaic/thermal (PV/T) systems are an option for the utilization of solar energy to produce both electricity and thermal energy. Typical electrical conversion efficiencies are found to vary from 10% to 20% while those for thermal efficiencies range around 50% or more so that it is possible for PV/T systems to reach higher efficiencies (Al-Waelia et al. 2017). The comparison of building integrated

⁽⁷⁵⁾ European Technology Platform on Renewable Heating and Cooling, Strategic Research Priorities for Solar Thermal Technology, http://www.rhc-platform.org/fileadmin/Publications/Solar_thermal_SRP.pdf

⁽⁷⁶⁾ Solar-Activehouse, <http://www.activehouse.info/cases/solar-activehouse/>

PV/T systems with building integrated PV (BIPV) systems indicated similar results (Agraval et al., 2010). The use of phase change materials (PCM) can further increase performances.

The JRC has created a database ⁽⁷⁷⁾ that contains solar radiation data all over Africa. These data may be used by the designers for the evaluation of the necessary collector's surface by using, for example, an f-chart or direct simulation model. The database is focused on the calculation of photovoltaic installations, but data linked to the solar radiation may also be used for solar thermal installations designs.

5.2.7.1.2 Bioenergy for bioheat and/or bioelectricity in buildings

Currently, the use of bioenergy for heating as bioheat in the residential, services, and industry sectors exceeds the use of bioenergy in the power and transport sectors as bioelectricity and biofuels ⁽⁷⁸⁾. In the case of biomass, sustainably harvested biomass is considered a renewable resource. However, while the carbon stored in the biomass itself may be CO₂ or greenhouse gas neutral, the cropping and harvesting (fertilisers, tractors, pesticide production) and processing to the final fuel may consume an important amount of energy and result in CO₂ releases, as well as N₂O emissions from the field. Therefore, it is imperative to take adequate measures to make sure that biomass, used as a source of energy, is harvested in a sustainable manner and used in the most efficient manner possible, including in systems for both bioheat and bioelectricity.

Biomass is considered as a renewable and carbon-neutral energy source when the territorial approach is used for the CO₂ accounting. If the Life Cycle Analysis (LCA) approach is chosen for the CO₂ emissions inventory, the emission factor for biomass will be higher than zero so that differences between both methodologies in the case of biomass may be very important.

Biomass systems are available on the market from 2 kW onwards. During a building refurbishment, fossil fuel boilers (in particular coal) can be replaced by biomass systems. The heat distribution installation and radiators are the ones used with the previous installation. A biomass storage room must be foreseen for the accumulation of pellets or wood chips. The performance of the combustion and the quality of the biomass are critical to avoid the emissions of particles into the atmosphere and the system must be adapted to the type of biomass that is to be used.

5.2.7.1.3 Heat pumps and geothermal heat pumps in buildings

Heat pumps ⁽⁷⁹⁾ combine high energy conversion with the capability of utilising aerothermal, geothermal or hydrothermal heat at useful temperature levels. Heat that is extracted from the environment by a heat pump (ambient heat) is considered renewable as long as a minimum Seasonal Performance Factor (SPF) for the unit is met. Heat pumps present a versatile energy technology that can provide both heating and cooling in a great variety of building contexts and applications, which can be combined with smart technologies and storage. Heat pumps can also provide for flexibility in the electricity system and contribute to the management of the variability of heating and cooling demand. For these reason, heat pumps have the potential to become a mainstream technology in the heating and cooling sector, including at the building level.

Heat pumps are composed by two heat exchangers. In winter the heat exchanger located outdoors will absorb heat from the environmental air. The heat is transferred to the indoor exchanger to heat the building. In summer the role of each part is inverted. The outdoor unit must transfer heat in summer and absorb it in winter so that a heat pump's performance is highly influenced by the outdoor temperature. In winter (summer), the

⁽⁷⁷⁾ Photovoltaic Geographical Information System, http://re.jrc.ec.europa.eu/pvg_tools/en/tools.html

⁽⁷⁸⁾ Bioenergy insight – Bioheat, Biopower, Biofuel,
<http://www.aebiom.org/bioenergy-insight-bioheat-biopower-biofuel/>

⁽⁷⁹⁾ Further information available at <http://www.egec.org> and <http://www.groundmed.eu>

heat pump's performance will decrease according lower (higher) temperatures. Since the performance of heat pumps depends on both the indoor and the outdoor temperatures, it is convenient to reduce the difference between them as much as possible to increase performance. Accordingly, in the winter season, an increase of temperature in the heat pump's cold side (outside) will improve the performance of the cycle. The same reasoning can easily be applied to the hot (outside) side in summer.

In addition, a possible solution to increase typical performance values is to use ground water as a source of heat in winter and source of cold in summer. This can be done due to the fact that, at a certain depth, the ground temperature does not suffer significant fluctuations throughout the year. Generally, the coefficient of performance (COP) or energy efficiency ratio (EER) values can be improved by 50%. Seasonal Performance Indicators can be improved by 25% ⁽⁸⁰⁾ with respect to an air-water cycle. This leads to the conclusion that the electricity consumption in this case could be 25% lower than the case of an air-water conventional heat pump.

The heat transfer process between the Ground Heat Exchanger (GHE) and surrounding soil is dependent on local conditions such as the local climatic and hydro-geological conditions, the thermal properties of soil, soil temperature distribution, GHE features, depth, diameter and spacing of borehole, shank spacing, materials and diameter of the pipe, fluid type, temperature, velocity inside the pipe, thermal conductivity of backfill and finally the operation conditions such as the cooling and heating load and heat pump system control strategy. Geothermal energy systems can be used with forced-air and hydronic heating systems while also designed and installed to provide "passive" heating and/or cooling. Passive heating and/or cooling provide cooling by pumping cool/hot water or antifreeze through the system without using a heat pump to assist the process.

5.2.7.1.4 Local electricity production

Local electricity production can be supported by photovoltaic electricity generation, wind power, hydroelectric plants and mini-hydro, as well as the power output of cogeneration. (**Table 42.**) These options are overviewed based on technical aspects to guide policy support and the key measures that are being used to promote these options based on best practices.

Table 42. Technologies available for local authorities

Photovoltaic (PV)	Conversion of solar radiation to electricity by using solar cells
Wind Power	Electricity generated by wind power through wind turbines
Hydroelectric	Powered by the kinetic energy of flowing water. Electricity converted by turbines and generators
Combined heat and power	simultaneous generation of thermal energy and electricity from a single input of fuel

5.2.7.1.5 Photovoltaic electricity generation (PV)

Photovoltaic modules permit the conversion of solar radiation to electricity by using solar cells. The majority of photovoltaic modules are used to generate power connected to an electricity grid while there is also a smaller market for off-grid power, particularly in remote areas and developing countries. The integration of renewable energies in cities, in particular building integrated photovoltaics (BIPV), represents significant opportunities in

⁽⁸⁰⁾ Geotrainet Project Webpage, <http://www.geotrainet.eu>

combination with increased energy efficiency ⁽⁸¹⁾. The integration of solar modules has been improved by manufacturers. In addition to roofs and bricks, modules are integrated to external building walls, semi-transparent façades, skylights, and shading systems ⁽⁸²⁾.

A European solar radiation database was developed using a solar radiation model and climatic data integrated within the Photovoltaic Geographic Information System (PVGIS). PVGIS is a web application for the estimation of the performance of photovoltaic (PV) systems in Europe and Africa, as well as a large part of Asia, which has become widely used by the PV community. The online interface to the PVGIS database lets the user estimate the long-term energy performance of different types of PV systems (Huld et al., 2012). The database, with a resolution of 1 km x 1 km, consists of monthly and yearly averages of global irradiation and related climatic parameters, representing the period 1981–1990. The lifespan of PV modules can reach about 25 years, after which material recovery may be an option to improve security of critical raw materials (Latunussa et al., 2016).

The calculation of electricity generation potential by contemporary PV technology is a basic step in analysing scenarios for the future energy supply and for a rational implementation of legal and financial frameworks to support the developing industrial production of PV.

Policy measures include municipal financing and ownership of PV pilot plants on public buildings, concession of surface rights and renting of rooftop areas in public buildings, PV installations on the roofs of bus sheds, and the construction of a PV park on municipal property at a former landfill site. Policy measures further include PV installations in public buildings and third-party financing for PV systems in school buildings, public-private partnerships for Photovoltaic Solar Parks, energy supplier obligations for PV systems, the provision of a bonus from local authority for photovoltaic installations on citizen's roof, interest-free loans for associations or schools for PV installations, PV systems that supply electric vehicle charging stations, solar land registry for PV installations, real time electricity generation data on PV systems of the City Council, and supported PV campaigns.

Given the key role of PV technology in future energy systems, strategies are needed for dealing with large future volumes of end-of-life PV panels. Reuse and recycling technology is available today although the short term lack of waste volume means that economies of scale often can't be realised. For further information on this aspect, consult the Annex 9 of this document and contact IEA Task 12, which focuses among other activities on recycling of manufacturing waste and spent modules ⁽⁸³⁾.

5.2.7.1.6 Wind Power

Similar to PV systems, the use of electricity that is generated based on wind power systems displaces the electricity demand that would have otherwise been supplied by the local utility. Since no emissions are associated with the operation of wind turbines, the emission reductions from this mitigation measure are equivalent to the emissions that would have been produced had electricity been supplied by the local utility.

For this reason, local authorities are mobilizing resources to enable the use of a greater share of electricity from wind turbines in the local energy mix. Other policy measures in support of wind power include wind farms with citizen cooperation, promotion of locally owned wind turbines, public procurement of municipal wind turbines, co-ownership of wind-power plants, attraction of companies to generate electricity from wind energy,

⁽⁸¹⁾ IRENA (2016). Renewable energy in cities. International Renewable Energy Agency (IRENA). Abu Dhabi, <http://www.irena.org/publications/2016/Oct/Renewable-Energy-in-Cities>

⁽⁸²⁾ Building integrated photovoltaics. A new design opportunity for architects, http://www.aie.eu/files/RES%20TF/BIPV_web.pdf

⁽⁸³⁾ Some good quality documents and reports are found on its website (<http://www.iea-pvps.org/index.php?id=56>).

prioritized case handling and licencing of wind turbines, and land use planning for wind energy among other measures.

5.2.7.1.7 Hydroelectric plants and mini-hydro

Hydropower represents an essential example of the energy-water nexus in which the availability of water resources based on rainfall affects the amount of energy production. Different types of hydroelectric plants have different capacities, including run-of-the-river hydro plants that do not require a dam, or if so, only a very small one. While large-scale hydropower technology is one of the most mature renewable energy technologies, research is ongoing to better adapt turbines and facilities to the head flow to optimize the techno-economic performance of small hydropower applications (Manzano-Agugliano et al., 2017). Best practices that involve hydropower technologies include those to attract or allocate investment.

5.2.7.1.8 Bioenergy for electricity generation (biomass, biogas)

Combustion followed by a steam cycle is the main technology for utilizing biomass for electricity generation. Newer technological alternatives include the use of biomass in organic Rankine cycle (ORC) plants and gasification systems. Biomass is used as the main fuel but can also be co-combusted with coal or peat. Biogas from anaerobic digestion is mainly used on-site for co-generation applications while biogas can also be upgraded into biomethane towards injection into the existing natural gas grid.

Best practices for the use of bioenergy for electricity generation include biogas cogeneration based on anaerobic digestion, anaerobic digestion in the public waste recovery and treatment company, biogas cogeneration based on zootechnical wastewater and silage cereals, and biogas driven district heating networks. Other best practices include public-private partnerships between the local authority and waste management utility for anaerobic digestion of biowaste for CHP-based district heating, the recovery of methane gas from landfills to produce electricity based on gas engines, and consortiums for cogeneration plants driven by sustainable certified biomass based on waste produced locally or from local consortium companies.

A clear political framework may be of great support for the development and increase of biofuels in the market of SSA countries. Several African countries are making efforts to introduce biofuels specific policies. The policies differs in the engagement and the role played by stakeholders. In Nigeria and Uganda the government facilitates development, provides stimulus for private sector investment, and monitors and co-ordinates the energy sector activities. In South Africa, Tanzania, Zambia and Malawi where the private sector, foreign companies and non-governmental organizations are responsible for biofuels strategy and policy recommendation and formulation (Amigun et al., 2011).

5.2.7.2 CHP – Combined heat and power generation

A cogeneration or CHP plant is an energy production installation that simultaneously generates thermal energy and electrical and/or mechanical energy from a single input of fuel. Signatories have implemented measures towards high-efficiency cogeneration power plants in close collaboration with local utilities for sustainable energy systems⁽⁸⁴⁾.

CHP plants are usually very close to the electricity consumer, thereby avoiding network losses during transmission and distribution to the end-users. CHP plants can be part of distributed generation schemes in which several smaller CHP plants produce energy being consumed nearby. Cogenerated heat may also be used to produce cold through absorption refrigeration chillers. Other types of thermally driven chillers are commercially available although their market presence is more limited than that of absorption chillers.

⁽⁸⁴⁾ Kona et al. 2017

Plants that simultaneously produce electricity, heat and cooling are known as trigeneration⁽⁸⁵⁾ plants. A part of the trigeneration units offer significant relief to electricity networks during the hot summer months. Cooling loads are transferred from electricity to gas networks.

CHP leads to a reduction of fuel consumption by approximately 10 - 25% compared with conventional electricity and separate heat production. The reduction of atmospheric pollution follows the same proportion. The power range and efficiencies of CHP technologies are summarized in **Table 43**. CHP may be based on gas turbines, reciprocating engines, Stirling engines, or fuel cells. The electricity produced in the process is consumed by the users of the grid and the useful thermal energy may be used in industrial processes, space heating or in a chiller for the production of cold water.

Table 43. Power Range and Efficiencies of Cogeneration Technologies

Technology	Power range	Electric Efficiency	Global efficiency
Gas turbine with heat recovery	500 kWe - >100 MWe	32 – 45%	65 – 90%
Reciprocating engine	20 kWe -15 MWe	32 – 45%	65 – 90%
Micro gas turbines	30 - 250 kWe	25 – 32%	75 – 85%
Stirling engines	1 - 100 kWe	12 – 20%	60 – 80%
Fuel cells	1 kWe - 1 MWe	30 – 65%	80 – 90%

Source: COGEN⁽⁸⁶⁾ Challenge Project

Small-scale heat and power installation can play an important role in the energy efficiency improvement in public, residential and commercial buildings, including hotels, swimming pools, hospitals and multi residential dwellings. As compact systems, they are convenient to install. The dimensioning of the micro-cogeneration installation will depend on the heat loads. Combined electrical and thermal efficiency varies between 80% and well above 90%. Similar to electrical efficiency, unit capital costs per kW_{el} depend on the electrical capacity of the system. A significant decline of capital costs due to scale effects are observed particularly as systems reach the 10 kW_{el} range (Pehnt et al.,2006) . CO₂ emissions of natural gas driven micro-cogeneration systems are in the range 300-400 g/kWh.

5.2.8 Waste and water management

According to the African Waste Management Outlook (2018, UNEP), Waste collection services in most African countries are inadequate, only 55% of solid waste are collected in Africa. More than 90% of waste generated in Africa is disposed of at uncontrolled dumpsites and landfills, often associated with open burning. Local waste management systems are to be encouraged, with a systemic vision (3R: reuse, reduce, recycle), towards circular economy.

New challenges related to waste management arise from the increasing use of equipment used for mini-grids and SHS, electrical and electronic devices, as well as PVs. These waste types require special treatment and disposal. For further information on this aspect, consult the Annexes 9 and 11 of this document and contact the International Energy Agency Task 12, which focuses, among other activities, on recycling of

⁽⁸⁵⁾ POLYSMART - Polygeneration with advanced small and medium scale thermally driven air-conditioning and refrigeration technology, http://www.cordis.europa.eu/project/rcn/85634_en.html

⁽⁸⁶⁾ <http://www.cogeneurope.eu/challenge/>

manufacturing waste and spent modules. Some good quality documents and reports are found on its website (<http://www.iea-pvps.org/index.php?id=56>).

Local waste management strategies are particularly crucial for enabling the minimization of the amount of waste generated through waste prevention, the diversion of waste from landfills through recycling, reuse, and composting, and the utilization of environmentally-conscience waste-to-energy options ⁽⁸⁷⁾. Water management also has a direct impact on energy usage at the local level through the electricity that is used for the preparation of tap water and its pumping through pressurized water distribution systems to reach end-users. Minimizing water leakages in the water distribution system and reducing water usage through conservation can thus reduce the level of energy usage for water services. In addition, the selection of water supply reservoirs in proximity to the city, which can reduce extraction and transport costs, can be directly affected by the effectiveness of water management practices at the local level. Especially in cases where desalination may be required for water supply, including those in islands, the integration of renewable energy sources can support the energy loads of the energy intensive infrastructure (Duic et al., 2008).

There are references of projects led in African English speaking countries, on local solid waste management https://wedocs.unep.org/bitstream/handle/20.500.11822/7730/ISWMPlan_Vol3.pdf?sequence=3).

In African French speaking countries, the Re-sources platform (<https://www.platforme-re-sources.org/>) also list references.

In the aspect of wastewater treatment, opportunities for local energy generation involve the combustion of digester gas or its use for cogeneration as well as the extraction of residual heat from wastewater based on heat exchangers and heat pumps. The integration of renewable energy, such as solar and geothermal energy to assist in covering the energy requirements of the wastewater treatment plant, is another option. Cases in which wastewater treatment plants (WWTPs) have reached energy self-sufficiency based on the utilization of such options take place among the best practices. At the same time, the heat generation potential in WWTPs often exceeds the amount that is required on-site, which provides opportunities to satisfy other local heat demands in the vicinity, including those of buildings and industries (Kollmann et al., 2015). In the context of the energy system as a whole, WWTPs can offer opportunities for demand response, particularly in the sludge processing equipment, thereby assisting in any power load levelling (Aghajanzadeh et al., 2015).

Box 29. South Africa's first solar-powered desalination plant at Witsand in the Hessaqua municipality.

Plans are underway to build South Africa's first solar-powered desalination plant at Witsand in the Hessaqua municipality. The desalination plant will be installed using the osmosing technology. This is reported to be the world's first reverse osmosis desalination technology coupled with photovoltaic solar energy without batteries. It is designed to supply coastal or borehole-dependent communities with drinking water.

<https://www.esi-africa.com>

⁽⁸⁷⁾ Waste Framework Directive 2008/98/EC, <http://ec.europa.eu/environment/waste/framework/>

Box 30. Sustainable Urban Resilient Water for Africa

SURewater4Africa project was part-funded by EuropeAid and works with local governments in six African countries in the Southern African Development Community (SADC). The project aims to contribute to sustainable climate change (CC) resilient urban water planning mechanisms and action based on international benchmarking within local authorities while ensuring multiplier effects to the region.

<http://africa.iclei.org/activities/agendas-projects/resource-efficient-productive-city/surewater4africa.html>

5.2.8.1 Utilization of biogas resources at the local level

Biogas is a naturally occurring by-product of the decomposition of organic waste in sanitary landfills or from sewage and residual waters. It is produced during the degradation of the organic portion of waste. Biogas essentially contains methane (CH₄), which is a highly combustible gas. Therefore, biogas is a valuable energy resource that has wide range of uses for biogas for heating, electricity, and transport fuel (Achinas et al., 2017). Biogas can be used as in a gas turbine or a reciprocating engine, as a supplementary or primary fuel to increase the production of electric power, as a pipeline quality gas and vehicle fuel, or even as a supply of heat and CO₂ for nearby greenhouses and various industrial processes. Biogas is mostly produced based on sewage sludge while production from landfill, food-processing residues and wet manure are expected to increase ⁽⁸⁸⁾. In contrast, methane is a greenhouse gas (GHG) with a global warming potential (GWP) that is 21 times higher than CO₂. The use of methane content that would otherwise be released without being utilized as an energy source is a valid climate mitigation option.

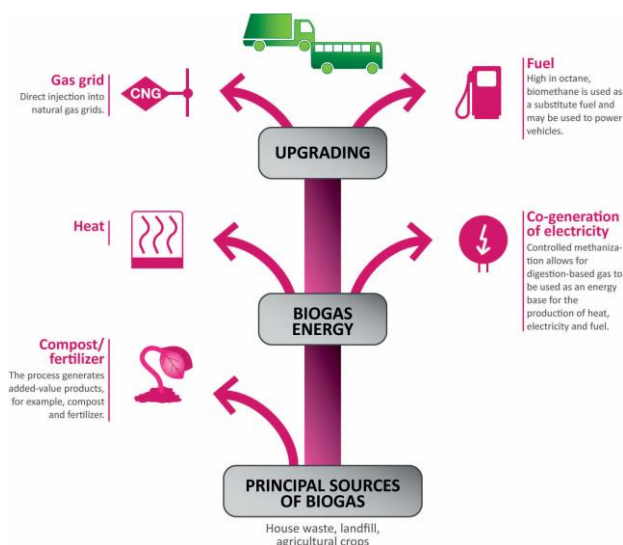
Local policies can promote low-carbon waste practices and the recovery of its energy content when appropriate either as biogas or incineration. Through municipal initiatives or private-public partnerships, waste-to-energy can be promoted as a potential source for heat and electricity, including possible interventions is wastewater treatment plants (Box 31). The use of biogas as an energy source has a role in upholding circular economy principles in which outputs are streamlined to provide inputs for other systems.

Box 31. Biogas Options from Waste and Wastewater

- Organic waste streams used in bioenergy gasification or composted
- Landfill gas capture
- Upgrading of biogas to biomethane for distribution via the exiting natural gas grids
- Methane recovery from the wastewater for reuse
- Integration of low enthalpy geothermal sources for the digestion of the sewage sludge in the wastewater systems in the process of producing biogas

⁽⁸⁸⁾ European Environmental Agency, (2006). How much bioenergy can Europe produce without harming the environment? Copenhagen: EEA, https://www.eea.europa.eu/publications/eea_report_2006_7

Figure 20. Biomethane Chain Involving Compost, Cogeneration and Upgrading



Source: Achinas, S., Achinas, V., Euverink, G., 2017.

5.2.8.2 Landfill biogas recovery

Waste disposal in landfills can generate environmental problems, such as water pollution, unpleasant odours, explosion and combustion, asphyxiation, vegetation damage, and greenhouse gas emissions ⁽⁸⁹⁾. Landfill gas is generated under both aerobic and anaerobic conditions. Aerobic conditions occur immediately after waste disposal due to entrapped atmospheric air. The initial aerobic phase produces a gas mostly composed of CO₂. Since oxygen is rapidly depleted, a long-term degradation continues under anaerobic conditions, thus producing a gas with a significant energy value that is typically 55% CH₄ and 45% CO₂ with traces of certain volatile organic compounds (VOC) ⁽⁹⁰⁾.

Practices for sustainable landfilling can monitor such indicators as leachate composition, methane production, landfill settlement and in situ waste temperature (Van Vossen, 2010). Emissions are relatively greater in operating landfills than in closed landfills due to the time of decay and degradation of the landfilled waste (Lou and Nair, 2009). The economic viability of utilizing landfill gas for local energy generation depends on the methane content of the available gas, local energy prices, and the selected equipment based on the engine and turbine (Zamorano et al., 2007).

Globally, landfills are estimated to account for 8% of anthropogenic CH₄ emissions as an important source of anthropogenic CH₄ emissions. As mitigation options, landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared" ⁽⁹¹⁾. Similarly, the Environmental Protection Agency (EPA) of the US presents a method for calculating GHG emissions associated with three different landfill management systems ⁽⁹²⁾. These are landfills that do not capture landfill gas, those that recover methane and flare it, and those that recover methane and combust it for cogeneration. A conservative value for the percentage of methane that is chemically or biologically oxidized is 10% for landfills with low permeability cover while the default efficiency of methane capture systems is 75%.

⁽⁸⁹⁾ The information given may not be relevant for countries where landfills are no longer allowed.

⁽⁹⁰⁾ IEA Bioenergy – Task 37 Energy from Biogas and Landfill Gas, Methane emissions in biogas plants - Measurement, calculation and evaluation, http://www.iea-biogas.net/files/member-upload/DRAFT_Methane%20Emissions.pdf

⁽⁹¹⁾ Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31999L0031>

⁽⁹²⁾ US EPA, (2006). Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, Section 6.

5.2.8.3 Renewable energy in wastewater treatment plants

Another possibility to produce biogas is through the installation of a biodigester in sewage and residual waters facility. The residual waters are conducted to the sewage plant where the organic matter is removed from the wastewater. Organic matter then decays in a biodigester in which the biogas is produced through an anaerobic process. Around 40% to 60% of the organic matter is transformed in biogas with a methane content of around 50% to 70% (Bruno et al., 2009). The biodigester can also be fed by vegetable or animal wastes. Modern plants can be designed to reduce odours to a minimum extent. Biogas plants may be designed to fulfil the prerequisites for approval by the food industry to use the bio-fertilizer in agriculture.

Other best practices include the integration of renewable sources for supplying power to pumping tap water, including photovoltaic electricity generation, while reducing electricity usage for pumping based on reductions in water losses in the tap water distribution network and an information system for energy and water use in the public sector.

Box 32. Factors influencing waste management in Jinja municipal council (JMC) Uganda

Background: Proper waste management as a preventive measure against diarrhoeal diseases has not been addressed. The study seeks to establish factors that drive and facilitate waste management in JMC.

Methods: The study used a sample of 400 respondents. FGD sessions were held between vendors and restaurant attendants, in-depth interviews with apartment dwellers and industrial workers, key informant interviews with local leaders and JMC officials. Structured observations were conducted to expose restaurant attendants and vendors' waste disposal behaviour within their localities.

Results: JMC generates 149 tonnes of solid waste per day and is only able to collect 40%-60% of the total waste generated hence leaving 59 tonnes uncollected. Among respondents interviewed, 60% disposed of their waste anyhow while 35% used waste bins. 12% expressed ignorance of proper disposal channels. Findings further showed that barriers ranged from physical (distance to the bins), biological (fatigue due to the frequency of disposal rounds), cognitive (ignorance and cultural beliefs) and socio-economic (impoverished people perceive proper waste management through private collection firms to be costly, politics compromises the work of health assistants and lastly attitude to urban authorities). Disgust, comfort and safety were observed as the best motivators for proper waste management. Disgust referred to dirt, contamination and stench while comfort referred how Individuals feel when their localities are free of garbage. Safety refers to avoidance of diseases induced by poor waste management.

Conclusion: Industrial wastes have greatly depleted the source of River Nile where waters are dwindling and turning green.

Additional Resources

PV-GIS is a web-based solar radiation database for the calculation of PV potential in Europe, Africa and Asia: <http://re.jrc.ec.europa.eu/pvgis/>

Comoros Adopts Integrated Water Management Plan: <http://aio-iwrm.org/news/comoros-adopts-an-integrated-water-management-action-plan/#.W0cm0tUzbuo>

Sustainable Urban Resilient Water for Africa: SUREWater4Africa

<http://africa.iclei.org/activities/agendas-projects/resource-efficient-productive-city/surewater4africa.html>

Desalination plant in South Africa solar-powered

https://www.esi-africa.com/s-africas-first-solar-powered-desal-plant-could-produce-affordable-water/?utm_source=Spintelligent+Publishing+mailer&utm_medium=email&utm_campaign=ESI+Daily+Enews+19+July+2018&utm_term=https%3A%2F%2Fwww.esi-africa.com%2Fs-africas-first-solar-powered-desal-plant-could-produce-affordable-water%2F

Sustainable sanitation alliance: <https://www.susana.org/en/>

EAWAG SANDEC:

https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/schwerpunkte/sesp/CLUES/Compendium_French/compendium_fr_2016.pdf

PS-EAU guidance (available in French and English)

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_1_how_to_develop_a_concerted_municipal_strategy_for_water_and_sanitation_2012.pdf

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_2_how_to_create_a_regional_dynamic_to_improve_local_water_supply_and_sanitation_services_in_small_towns_in_africa_2010.pdf

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_3_how_to_analyze_the_demand_of_current_and_future_users_for_water_and_sanitation_services_in_towns_and_cities_in_africa_2010.pdf

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_3_how_to_analyze_the_demand_of_current_and_future_users_for_water_and_sanitation_services_in_towns_and_cities_in_africa_2010.pdf

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_5_how_to_manage_public_toilets_and_showers_2010.pdf

https://www.pseau.org/outils/ouvrages/pdm_ps_eau_cms_guide_n_3_how_to_analyze_the_demand_of_current_and_future_users_for_water_and_sanitation_services_in_towns_and_cities_in_africa_2010.pdf

5.3 Elaboration of the plan: Adaptation actions

Adapting to Climate Change is a relatively new topic for most cities and increasing their resilience to Climate Change impacts is an urgent challenge. The sub Saharan region is particularly vulnerable to Climate Change impacts. It suffers from water scarcity and droughts and people and economy are highly dependent on climate sensitive sectors, such as agriculture, fishery, and forestry.

Adaptation to Climate Change requires a multilevel approach involving local, regional, national levels. In particular, adaptation to Climate Change is a shared competence between local and regional authorities and should be defined according to a city's peculiarities and needs, which might be neglected by a solely large-scale national framework.

Table 44. Goals and indicator of the three post 2015 Agendas

	UNFCCC and Paris Agreement	Agenda 2030 and SDGs	Sendai Framework for Disaster Risk Reduction 2015-2030
Level	Global	17 global goals, with SDG 13 to take urgent action to combat climate change and its impacts Several targets for each goal. 232 indicators as part of the global indicator framework for the SDGs and targets of the 2030 Agenda for Sustainable Development	Objective of substantially reducing disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries 7 targets 38 indicators were identified to measure global progress
	National	Countries have reported on progress made towards national goals and indicators through their national communications, their national adaptation plans or nationally determined contributions	Countries may define national SDG indicators (based on the global framework), set baselines and assess progress through scorecards
	Sub-national / local	Variety of indicators used across different sectors and funders of programmes and projects	Variety of indicators used across different sectors and funders of programmes and projects

At the UNFCCC COP7, it was acknowledged that Least Development Countries (LDCs) are not equipped to deal with problems of adaptation to climate change, and established an LDC work programme. This programme includes the preparation and implementation of National Adaptation Programme of Action (NAPAs).

Article 4.9 of the United Nations Framework Convention on Climate Change (UNFCCC) recognizes special situations of the LDCs and states: "The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology". 33 out of total of 49 are African countries.

Of the ten countries that have submitted a NAPA by July 2018, only Brazil, Kenya and Togo have integrated the SDGs into their national adaptation policy framework.

5.3.1 Africa commitment to adaptation

The African Union Agenda 2063 is a Pan African roadmap for the continent's development in the next fifty years from 2013 when it was launched. The Agenda 2063 has seven aspirations with about 55 goals. Particularly interesting in the Agenda 2063 is its climate change and environmental plans owing to the huge vulnerability of the continent

The plans are captured in the **Aspiration 1** of the Agenda 2063, "*A Prosperous Africa, based on Inclusive Growth and Sustainable Development*".

Box 33. Programme on Climate Action in Africa – Agenda 2063

"We hereby adopt Agenda 2063, as a collective vision and roadmap for the next fifty years and therefore commit to speed-up actions to: (...)

Act with a sense of urgency on climate change and the environment, implementation of the Programme on Climate Action in Africa, including:

- Identification of five regional technology centres, linking with national;
- Designated climate technology entities;
- Programmes on climate change targeting women and youth;
- A climate resilient agricultural development programme such as CAADP;
- Sustainable forest management programmes;
- National adaptation plans, systems and structures (National Designated Authorities and Implementation Entities);
- Sustainable exploitation and management of Africa's diversity for the benefit of its people."

Source: <http://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf>

The **Climate for Development in Africa (ClimDev-Africa)** Programme is an initiative of the African Union Commission (AUC), the United Nations Economic Commission for Africa (ECA) and the African Development Bank (AfDB).

The **Africa Adaptation Initiative** ⁽⁹³⁾ was established in June 2015 by African Heads of State at the 25th African Union Summit, to support Africa on adaptation and on loss and damage, in the context of the Framework Convention on Climate Change and the Green Climate Fund. The Vision of the African strategy is to provide the AU as a whole, the Regional Economic Communities, Member States and other stakeholders with a reliable source of strategic guidance to enable them effectively address climate change challenges. It is organized around four thematic pillars:

1. Climate Change Governance
2. Promotion of research, education, awareness raising and advocacy
3. Mainstreaming and integrating climate change imperatives in planning, budgeting, and development processes; and
4. Promotion of national, regional, and international cooperation.

The strategy also proposes to carry out other interventions to address some specific priority areas including adaptation and risk management, Nationally Appropriate Mitigation Actions (NAMAs) and as well as some specific cross-cutting issues. The strategy also identifies specific goals for each thematic area. For each of the goals, several actions are identified. These are used in defining an implementation matrix.

⁽⁹³⁾ <https://www.africaadaptationinitiative.org/>

A new centre has been created under the auspices of the Africa Union and the UN's Economic Commission for Africa, the **Africa Climate Policy Centre**, based in Addis Ababa and has potential to bring some level of coordination and cross-sectoral inputs to climate change. The African Climate Policy Centre (ACPC) is a hub for knowledge generation on climate change in Africa. It addresses the need for greatly improved climate information for Africa and strengthening the use of such information for decision making, by improving analytical capacity, knowledge management and dissemination activities. The ACPC is an integral part of the Climate for Development in Africa (ClimDev-Africa) programme, which is a joint initiative of the African Union Commission (AUC), the United Nations Economic Commission for Africa (UNECA) and the African Development Bank (AfDB). ClimDev-Africa has been mandated at regional meetings of African Heads of State and Government, as well as by Africa's Ministers of Finance, Ministers of Planning and Ministers of Environment.

5.3.2 Multi-level governance of urban adaptation action

Regional policies and strategies for adaptation, as well as transboundary adaptation, are still in their infancy (Niang et al., 2014). At the regional level, SADC Region has responded to the impacts of climate change by initiating the development of a regional programme on climate change which is still in the development phase. The development of this programme was guided by the report on the **Southern Africa Sub-regional Framework of Climate Change Programmes**. The report was an assessment of the stop gap measures being undertaken in the region to combat climate change.

In the case of the East African Community (EAC), the **EAC Climate Change Policy** aims at guiding Partner States and other stakeholders on the preparation and implementation of collective measures to address Climate Change in the region while assuring sustainable social and economic development. The Policy prescribes statements and actions to guide Climate Change adaptation and mitigation to reduce the vulnerability of the region and enhance adaptive capacity and build socioeconomic resilience of vulnerable populations and ecosystems. Other climate change documents include the EAC Climate Change Master-Plan and the Climate Change Strategy. The Master Plan's Vision is to ensure that: "The People, the Economies and the Ecosystems of the EAC Partner States are climate resilient and adapt accordingly to Climate Change". The EAC Climate Change Strategy guides the implementation of the EAC Climate Change Policy.

It is also important to acknowledge the production of knowledge on climate change by African Universities and research to support cities' climate action.

Table 45. Recommended measures to improve multi-level governance, according to the main gaps emerging in the previous chapter.

Actor	Recommended Measures
International level	Define a coherent framework to help mainstream adaptation into national and regional policies, helping to optimize possibilities of synergies with other policy areas and exploiting co-funding opportunities.
	Develop a common reporting system for national, regional and urban projects on adaptation to Climate Change by defining the list of indicators, criteria and standards for reporting and assessment, among others
	Further explore the possibility of leveraging private sector investments within cities
National level	Establish clear coordinating procedures between national and subnational governments (vertical governance) and coherent national legal frameworks in order to enable local adaptation actions
	Include the spatial aspect of Climate Change impacts (e.g., according to administrative units) in national strategies (usually shaped according to policy sectors)
	Use national budgets to support local adaptation and provide technical support to access financing mechanisms
	Establish national communication programmes on Climate Change and support national data sharing and good-practice exchange on adaptation issues

	Improve mainstreaming adaptation into country sectoral strategies (e.g., health, transport, water management, among others), in order to optimize synergies and explore further funding opportunities (horizontal governance across sectors)
Regional level	Define a regional legal framework to coordinate inter-municipal adaptation strategies Support smaller cities to develop their adaptation strategies through capacity building, regional data sharing and participatory processes with a broad range of local and regional stakeholders from public and private sectors thus pooling capacities and resources ⁽⁹⁴⁾
City level	Define a horizontal governance to foster inter-agency and cross-sector collaboration on adaptation, define accountability and leaderships, avoiding policy trade-offs and spill-over effects, and improve use of resources Create a local/regional platform (or/and communication channels) to share knowledge and data about Climate Change impacts and vulnerabilities across different sectors, with higher resolution available (downscale to local context) Foster participatory processes with local communities (especially the most affected and vulnerable by Climate Change impacts) and private sector actors increasing their engagement in decision-making processes and data/knowledge exchange

Source : JRC Own elaboration.

5.3.3 Key adaptation measures for climate hazards

The adaptation pillar of CoM covers the following types of climate hazards that could potentially affect negatively societies, its economies and the environment: extreme heat, extreme cold, extreme precipitation, floods, sea level rise, droughts, storms, landslides, and forest fires. However, other hazards may also be listed (such as vector-borne diseases, water scarcity) according to the specificities of the city. Floods and droughts are the most frequent types of disasters in Sub-Saharan Africa, followed by wind storms. However, droughts tend to affect a much larger number of people. Among the problems that will be exacerbated by climate change, particular attention should be paid to the highly interrelated issues of desertification, food security, and water supply (Chhibber and Laajaj, 2008).

Since 2007, Africa has gained experience in conceptualizing, planning, and beginning to implement and support adaptation activities, from local to national levels and across a growing range of sectors (Niang et al., 2014). This section includes case studies found in the literature. The goal is to frame lessons in a manner that will facilitate learning from experience.

Flooding: Increasing temperatures and elevated atmospheric temperature are projected to shift the frequency, intensity, duration, and timing of storms worldwide. Although much of Africa will actually have less precipitation, the intensity of storms is projected to increase. This means that extreme heavy rainfall that previously occurred once every 20 years will now occur once every 15 years (Field et al., 2012). In terms of regional differences in exposure, projections show increased precipitation in areas of western Africa and eastern Africa. This rain will likely be concentrated during current heavy-rain periods. Coastal areas are especially subject to flooding as a result of both precipitation events and sea level rise. An estimated 54 million Africans live in vulnerable Low Elevation Coastal Zones (LECZ)—defined as areas 10 meters or less above sea level—and this figure is projected to rise (UN Habitat, 2014). Areas around rivers and creeks are also susceptible to riverine flooding, though localized flooding occurs outside these areas as well, especially in more heavily developed settings.

⁽⁹⁴⁾ Create hubs and knowledge exchange platforms at the regional level such as the Compact of KZN in Durban, South Africa: <http://www.durbanadaptationcharter.org/news/the-central-kwazulu-natal-climate-change-compact-meeting>

Box 34. Floods and urban planning. Freetown, Sierra Leone.

Kroo Bay, one of the largest coastal slums with an estimated population of 6,000, has flooded every year since 2008. Freetown's population is now over one million, a tenfold increase since independence in 1961. During the 1990s, many fled towards the capital as civil war engulfed the country. There they began to build on pockets of land previously unused for housing – and the majority stayed. The city extended outwards to accommodate this influx, but it did not do so with any urban strategy or plan in place.

During heavy rainfall blocked drains deposit huge amounts of debris – including medical and other perilously unhygienic waste material – in the city's coastal slums. So flooding brings not only the immediate risk of death and loss of property but also heightened risk of disease. Already the frequent flooding of August and September gives way to severe water shortages in March. In informal settlements, water pipes are cut as people desperately seek access to this basic service while those who can afford it 'negotiate' with Guma Valley, the main water company, to have water delivered to tanks. A seasonal threefold escalation in price is not uncommon.

Developing a long-term plan for the city that is climate-sensitive, addresses waste disposal, appropriately financed and designed in consultation with residents of informal communities should be a priority. In the short term, efforts to resolve political wrangling over unblocking drains, to implement and uphold a moratorium on building in the Peninsula forest and to improve weather forecasting could help to protect life and property for those who have little to begin with.

Presently, the EU support to the Freetown Development Plan include the following actions: An institutional strengthening project to assist with the capacity building, Urban Roads Rehabilitation Project, The Risk Mitigation Project, The Peri and Urban Community Action for Food Security Programme and The Conservation of the Western Peninsula Forest Reserve and its Watersheds.

Source and more information: (Hitchen, 2015)

http://www.eeas.europa.eu/archives/delegations/sierra_leone/eu_sierra_leone/tech_financial_cooperation/infrastructure/the_freetown_development_plan/index_en.htm

Droughts: Despite projections for increased exposure to flooding in many parts of Africa, many regions are also at risk of water scarcity and drought. Annual variation in precipitation and heavy but short precipitation events mean that the same areas that are subject to flooding can also be subject to drought. Different climate models predict a 20% decrease in overall rainfall along the Mediterranean coast of North Africa, northern Sahara, and west coast of Africa by 2099. Additionally, southern Africa is estimated to see a 30% decrease in rainfall during the already dry winter period. These projections suggest increased frequency of droughts as well as heightened water scarcity (Boko et al., 2007). Drought is already a major issue in Africa, with one-third of the population living in drought-prone areas (Niang et al., 2014).

In regions where droughts are more likely to occur, improved water saving and water management measures may be required. Of equal, if not greater importance to such physical and infrastructural adaptations are a broad range of measures that reduce vulnerabilities and increase community resilience to climate change⁽⁹⁵⁾. These could include: local economic development strategies, community early warning systems, better shelter options and participatory in-situ slum upgrading, relocation of urban populations to appropriate or improved locations (when in-situ upgrading is not feasible), improved public health interventions and urban and peri-urban agriculture that takes into consideration a changing climate

Sea Level Rise: Sea level rise is due primarily to melting of land-based ice and thermal expansion, or the expansion of water as it warms. In addition to inundation of low-lying

⁽⁹⁵⁾ <https://unhabitat.org/urban-themes/climate-change/>

areas, sea level rise can lead to coastal erosion and damage of infrastructure and built areas along the coast. Given these population concentrations and current projections for sea level rise, the homes of an estimated 16 to 27 million people across the continent could be flooded annually by 2100, amounting to 5 to 9 billion dollars per year in damage (UN Habitat, 2011). Sea level rise can also contribute to water scarcity since saltwater intrusion can contaminate underground aquifers that serve as an important source of drinking water, especially for poorer populations not connected to water networks. Similar to water scarcity, sea level rise tends to have a slower onset time, though its effects are localized and visible.

Box 35. How to stop a city from sinking. Dar es Salaam, Tanzania.

The Adapting to Climate Change in coastal Dar es Salaam project is aimed at improving the effectiveness of municipalities supporting coastal peri-urban dwellers who depend on natural resources in their efforts to adapt to climate change). The project was co-funded by the European Union and implemented between 2010 and 2014. It focused on communities in the coastal plain where groundwater salinization, due to the combined effects of urban expansion and climate change, seriously affects local communities because they depend heavily on boreholes for accessing water for domestic and productive purposes.

Addressing the salinization of the coastal aquifer in connection with seawater intrusion and urban sprawl, the project carried out a detailed analysis of the current situation and future scenarios.

Source and more information: (Urban Climate Change Research Network, 2015)

<https://www.unenvironment.org/news-and-stories/story/rising-sea-levels-how-stop-city->

Box 36. Public Awareness Raising, Stakeholder Consultations, and Community Participation. Dakar, Senegal.

This sprawling urban conurbation represents less than 1 percent of the national territory but shelters 25 percent of the national population. The city is exposed to various natural hazards, most prominently recurrent floods, coastal erosion, and sea-level rise. In June 2009, a pilot study on a spatial and institutional approach of disaster risk management titled Preparing to Manage Natural Hazards and Climate Change Risks in Dakar, Senegal: A Spatial and Institutional Approach was carried out with support from the World Bank's Spatial and Local Development Team.

Initial consultations with the municipality led to the study's launch. Results from the study were later disseminated through workshops and public consultations to increase awareness of and sensitize local agencies and communities.

Recommendations: Implement a general-awareness campaign targeting local public agencies and communities; Strengthen local institutional capacity and interagency coordination by identifying a viable and well-recognized institutional champion at the metropolitan level; Strengthen local land-use planning and management and Strengthen the resource base for local authorities, including through proposed betterment taxes that take advantage of improved land-management plans and corridor development.

Source and more information: (Wang et al., 2009)

Table 46. Adaptation actions listed in seven completed Climate Adaptation Plans of Action in three South African Municipalities.

Sector	Measures
Catchment, River & Stormwater Management	Revise floodlines along inland watercourses and coastal estuaries Implement water sensitive urban design (WSUD) principles in all new developments Established buffers along rivers or around wetlands that are located adjacent to new developments Encourage formation of internal/external multi-stakeholder partnerships to facilitate rehabilitation of rivers and wetlands Reduce flood risk of informal communities by: Relocation of informal households found to be subject to increased flood risk. Provision of adequate stormwater systems if the informal settlement are to be upgraded
Coastal	Designate Coastal Protection Zone Develop City Decision Support Tool for coastal development and investment decisions
Disaster Management	Develop and implement early warning systems so that residents of Cape Town are informed timeously of climate change related hazards, especially: Fire Risk, Heat Waves, High UV, Extreme rainfall, Extreme wind, Storm surges, Cold snaps, Flooding Regularly assess climate sensitivity of emergency response arrangements (e.g. access routes, communications, location of emergency shelters) Run education and awareness-raising programme city-wide on early warnings, preparedness and responses to reduce vulnerability and increase resilience (with focus on youth)
Health	Ensure City Health facilities have capacity to deal with an increased number of cases of climate-related health conditions (including heat stroke, dehydration, burns and smoke inhalation, water-borne diseases, diarrhoea, respiratory tract agitation due to poor air quality) Monitor and manage the incidence and spread of climate-related water-borne disease vectors, working with City departments, Scientific Services, Catchment, River and Stormwater Management and Sports and Recreation Approach and encourage academic and research institutions to research the interrelationships between air quality and climate change and the likely impacts of extreme events (including the mortality and morbidity rates associated with a drought or heat waves) Leverage more budget to maintain and expand the ambient air quality monitoring network in order to monitor changes in ambient air quality status and profile linked to climate change
Housing	Ensure climate change considerations are taken into account in City's low-cost housing programme and land identification Review low-cost housing designs and selection of materials with projected climate changes in mind research design options that increase the resilience to climate change Examine mechanisms for the top-up funding required to increase climate resilience of low cost housing Request climate change training programme for the housing department to consider climate in their day-to-day activities and ensure a commitment to implementation
Planning	Ongoing research to ensure City is abreast of advancements in climate science and knowledge on functional ecosystem services in Cape Town and the spatial implications of these to inform the development and/or review of plans and planning policies Factor climate change risks into City Spatial Development Framework, Integrated District Spatial Development Plans and Environmental Management Frameworks and local area plans and policies to increase City resilience and protect key City ecosystem services
Water and Sanitation	Model future water supply in the face of projected climate changes include further detail into existing climate change scenarios modelled in the WCWS Reconciliation Strategy Complete feasibility studies that consider alternative water resources to surface water supply (e.g. desalination, groundwater, water reclamation) Monitor groundwater recharge rates continue with baseline data collection to determine any changes to aquifer recharge rates and water quality Update response plan that addresses infrastructure failure as it relates to water reticulation and wastewater treatment and disposal Improve the efficiency of water use in residential and commercial development by changing consumer behaviour. Build an element on climate change into the Water Saving Campaign

Source: (Taylor et al., 2014)

Box 37. Housing and informal settlements. Dar es Salaam, Tanzania.

More than 70% of Dar es Salaam's 5 million residents live in informal, unplanned settlements that lack adequate infrastructure and services, and over half of them survive on roughly a dollar per day. Since 1983 and until 2014, more than ten severe flood incidences were recorded. The latest floods in April 2014 and May 2015 resulted not only in material and agricultural losses but also caused dozens of human losses.

Multidimensional aspects of vulnerability in Dar es Salaam are related to the urban morphology and existing infrastructure of the city. Unplanned and informal settlements play a major role in this regard. These settlements as well as the city center, are often prone to flooding. Vulnerability in terms of housing is high, with more than fifty-five unplanned settlements accommodating 70% of the city's population. These settlements show limited access to health services, solid waste management, sanitation, and clean water. This situation could worsen with a changing climate in the region. This would imply further cases of waterborne diseases. Drainage, particularly during flood events, is a mayor challenge. The city possesses 1,100 kilometres of ditches as well as 600 kilometres of piped stormwater drainage, all lacking maintenance.

Adaptation to climate change at a national level through the National Adaptation Program of Action (NAPA) remains weak. In Dar es Salaam, concrete plans include tree planting along beaches, roadsides, and open spaces with a particular focus on managing exposed coastal areas. Initiatives regarding formalization of properties are ongoing in Dar es Salaam. These include provisions of land or property licenses as well as rights of occupancy. This will ultimately allow the provision of basic infrastructure services including stormwater drainage, water supply, waste collection, and tenure rights

Source and more information: (Dickson et al., 2012; Urban Climate Change Research Network, 2015)

Box 38. Tanzania – Drones Help Communities Map Flood Risk in Dar Es Salaam Slums

With almost 70 percent of its inhabitants living in informal settlements, Dar es Salaam is highly vulnerable to flooding, but drones can help communities map the flood risk.

With the help of drones, city authorities are drawing up plans to protect and assist suburbs at risk of flooding.

Officials in Tandale are also using the maps to work out where flooding could trigger disease outbreaks

<http://floodlist.com/africa/tanzania-drones-help-communities-map-flood-risk-dar-es-salaam-slums>

A preliminary list of adaptation actions identified from the international literature and the best available practices are presented in **Table 47** for five main sectors. Actions could be framed as strategic actions, related to alert and communication and as technical measures. With time, this list will be progressively completed with examples from CoM signatories. Additional measures, depending also on the local needs and the national situation, would be necessary. However, these actions represented in the table below can be considered as a very good starting point.

Table 47. Adaptation actions by sector.

Sector	Actions	
Public health and quality of life	Strategic actions	Regularly improve monitoring systems in order to ensure that any disease development or any strong disturbance in public health shall be detected and efficiently addressed in its early stages. Improve sheltering capacities by ensuring that the cities have well established air conditioned facilities such as hospitals, city halls, mosques ... etc. that can protect citizens who does not have the necessary infrastructure to protect themselves from extreme weather events such as heat waves, storms or floods
	Alert and communication	Develop and regularly maintain an early warning system that can alert citizens ahead in case of extreme weather events. Such systems should be set up as early as possible and connected to National systems to be able to transmit the message in the most efficient and quick way to the citizens Regularly conduct educational and awareness raising campaigns to inform people about possible health impacts of heat waves, floods, vector borne diseases and how to address them
	Technical measures	Regularly improve water quality that can serve to cover the basic needs of citizens during heat waves Improve the quality control of sewage, waste dumps, dormant waters and draining systems to avoid their high risk of being serious diseases reservoirs Identification of potential hot spots for the development of vector borne diseases
Infrastructure management	Strategic actions	Develop good systems to ensure the proper management of water flux especially in case of heavy waves that might overpass absorption capacities of cities Improve infrastructure monitoring to anticipate problems related to extreme events such as floods and heat waves and quickly fix problems that may arise Develop smart models to predict demand and electricity supply to avoid blackouts in times of heat waves New specifications for bridges, according to maximum expected flow during floods or sea level rise and highest temperatures
	Alert and communication	Develop early warning systems to alert citizens in case a part of the infrastructure has been or expected to be severely damaged Regularly conduct awareness raising campaigns to increase people's awareness and advise them on how to save water and use the electricity efficiently
	Technical measures	Develop efficient and sustainable drainage systems Establishment of underground water reservoirs Building desalination plants based on the best available technologies Establish or upgrade flood defence systems near affected facilities
Buildings management	Strategic actions	Modify the building codes to promote more energy efficient and heat tolerant structures Set up incentives for innovative climate friendly buildings Develop integrated land use planning with zoning system depending on the different areas
	Technical measures	Go more towards greening the infrastructure such as developing building's roofs and walls and cover them with more plants to increase the amount of shade and refresh the environment and generate a cooling effect on the environment Develop green areas in the city by planting trees and setting fountains to help reduce the heat island effect
Economy	Strategic actions	Elaboration of drought, water and ground water management Plan
	Alert and communication	Educate tourists and citizens on personnel on ways to conserve natural resources, especially during extreme weather events
	Technical measures	Utilization of drip irrigation practices Promote the use of renewable energy technologies

Biodiversity	Strategic measures	Establish a fire management plan Elaborate an integrated coastal management plan
	Technical measures	Improve or develop beach nourishment or replenishment ⁽⁹⁶⁾

⁽⁹⁶⁾ It is the artificial placement of sand on an eroded shore to maintain the amount of sand present in the foundation of the coast, and this way to compensate for natural erosion and to a greater or lesser extent protect the area against storm surge (nourishment may also use gravel and small pebbles, in particular for the shores' face). Beach nourishment also often aims at maintaining beaches (beach width for tourism and recreational purposes).

5.4 Elaboration of the plan: Access to energy actions

Almost 30 Sub-Saharan African countries are in the process of completing their Action Agendas, describing a nationally tailored approach to deliver SEforALL objectives (World Bank, 2017). Most of these action agendas in Sub-Saharan Africa include the definition of national targets for energy access for 2030: Angola has set 100% access to electricity and clean cooking, Nigeria 95% and 80%; Tanzania above 75% for both, and Uganda above 98% for both.

However, according to the African Progress Panel, on current trends, Africa won't achieve universal access to electricity until 2080. Universal access to clean cooking facilities would occur around 100 years later, sometime after the middle of the 22nd century (Africa Progress Panel, 2015).

Energy is a key input for meeting basic needs and for achieving socio-economic development goals: access to energy, fuel for cooking, heating and lighting in households, power for industry, agriculture, and petroleum products for transportation.

Energy access is linked to other basic services such as water and sanitation. The use of energy, the types of energy used and the lack of access to sufficient energy have far reaching implications for a city's economic development, its environmental health and for the poor. Access to energy is one of the factors that bring together human development, economic growth and sustainability. Living without energy has impacts on a wide range of development indicators, including health, education, food security, gender equality, livelihoods, and poverty reduction.

Thus if Sub-Saharan Africa is to achieve a reduction in energy poverty and sustainable access to renewable energy sources for all, resources as well as policy and regulatory frameworks to support energy service delivery need to be urgently reviewed.

5.4.1 Energy challenges faced by cities

African municipalities need to be prepared to deal with several energy challenges:

- how to meet increasing demand for energy services caused by high population growth and rapid urbanisation, while addressing inadequate supply and system inefficiencies;
- how to increase access to clean, affordable, and reliable energy; in a model of development that slows the growth of carbon emissions and that is not fossil fuel dependant.

The growing urban population will need access to energy. The challenge for municipal authorities is to make sure that this energy use is as sustainable as possible. Because defining a local strategy to address energy poverty and provide modern energy services coherent with sustainable development, will not only promote local economic development and enhance resiliency (Batchelor et al., 2017) but it will also save money for cities, business and households. And not just that, it would:

- Reduce global warming emissions.
- Improve energy security, by increasing the share of domestically available alternative or renewable energy sources.
- Stimulate household welfare: poor households often have limited access to modern, safe, clean energy sources such as electricity, or cannot afford them even when they are available. This leads to continued dependence on polluting and unsafe fuels such as paraffin, coal or wood.
- Promote equity: the poor often are burdened with inadequate, unsafe and inconvenient energy sources while wealthier, particularly urban people consume high levels of energy and are inefficient in their use of energy.

- Local environment /local air quality: In addition to local (indoor/outdoor) air quality, the use of traditional biomass impacts the local environment. High demand from urban centres coupled with unregulated charcoal industries result in deforestation lowers the resilience of communities to cope with natural disasters such as flooding.
- Improve financial efficiency: Current inefficient energy use patterns mean that countries, cities and people have to spend more money than necessary for the energy service required (e.g. cooking, lighting, water heating etc.). Many more efficient and cost-effective appliances and practices are available, including modern energy cookstoves, efficient lighting, using solar water heaters and constructing buildings in a way that reduce the use of energy for cooling and lighting.

5.4.1.1 The energy-poor

Energy-poor households suffer from a wide range of impacts, from increased risk of premature death due to indoor pollution to forgone productivity gains and lower quality of life. On top of these impacts, energy-poor households must spend a greater proportion of their income to meet their basic energy needs. They also spend more time engaging in energy-intensive tasks than do wealthier households who have access to modern energy sources (Morrissey, 2017).

Energy poverty poses at least three requirements of the actors, institutions and processes of energy governance: access, affordability, and quality (Bazilian et al., 2014).

a) Access: First, governance arrangements must ensure access in a physical sense for poor people (who may have limited consumption needs, and live in relatively remote areas) that meet their needs for cooking, lighting, entertainment or use of information technology, and potentially other services. Different technologies or fuels may be needed to deliver each of these services. Access involves much more than physical availability: for example, despite an abundance of energy resources, countries in Western Africa have some of the lowest rates of access to modern energy services, exemplifying the issue of governance

b) Second, access to energy means little if people cannot afford it. Affordability may be ensured through institutions that assess the ability of poor consumers to pay for energy services and tailor pricing to their circumstances in the context of ensuring the viability of the system as a whole, or by enabling access to finance to enable people to invest in energy service technologies (for example finance for solar water heaters through bill repayments, lease and use access to renewable energy systems).

c) Third, these arrangements should ensure acceptable quality of service, including adequacy, reliability, and safety. A final cross cutting consideration is environmental sustainability, for example air quality. A recent analysis of the institutional complexes that govern climate, energy and development found that “decisions affecting the nexus have often been made in an uncoordinated manner within each of the domains”.

5.4.2 Role of local authorities

5.4.2.1 Local authorities key players

Energy in the city is essential for almost every activity and function in urban areas: cooking, cooling, heating water, industry, offices, lighting, communication and entertainment, transportation, construction, housing (SEA, 2017). Local authorities have a big influence within their boundaries over current and future energy use patterns through building regulations, urban layout, transport planning, bylaws, standards & codes, air quality control measures and electrification.

Cities will be instrumental in achieving national energy targets. Local authorities can serve as a vehicle to implement top-down policies from national governments, deliver

meaningful results, and ensure national mandates are carried out. They can design solutions to climate change that are adapted to the needs of local constituents and are consistent with local policy priorities. Most countries have published some form of national energy plan, and most have introduced some kinds of renewable energy policy, but they do not include binding targets. A number of governments have introduced various policy and finance mechanisms to help reach targets, such as tax reductions. However, support is not yet available at a local government level (Batchelor et al., 2017).

It is the responsibility of leaders in all spheres of government, commerce, industry and civil society to promote action towards more efficient and renewable energy use.

5.4.2.2 Integrating energy and physical planning:

LAs are not in charge of the energy distribution networks management. For electricity, this is the responsibility of the national agencies and companies under the supervision of a National Ministry. However, LAs have a significant role to play with national authorities to integrate and articulate physical and energy planning. Indeed, for example, every new constructed area will generate an additional need for energy with two potential solutions: connection to the grid or renewable based off-grid. To be efficient in the decision making process, it is important to work hand in hand to integrate energy and physical planning. An Energy Master Plan at the City level would be an opportunity to conceive a general energy supply and demand Strategy (KCCA, 2015).

5.4.2.3 Institutions, policies, and regulatory frameworks

In the context of the energy sector, “energy governance” refers to the actors, institutions and processes that shape how decisions are made about how to provide energy services. It involves the actors connected to energy such as governments, NGOs, civil society groups, corporations, citizens, and public-private partnerships (PPPs), as well as the institutions or rules according to which decisions are made and the processes of agenda-setting, negotiation, implementation, monitoring and enforcement of rules related to energy (Sovacool and Florini, 2012).

Politics influence heavily the process of electrification; and so, in the context of Sub-Saharan Africa we find contrasting examples such as Kenya, which provides the political support for private enterprise, and Ethiopia, which sets policies with a clear preference for government control (Morrissey, 2017). The political context, not just national but also local, will be a decisive factor when deciding on aid policy.

The energy field is a particularly complex issue when compared with other sectors not allowing for simple governance, cooperation or regulation. Problems and externalities which transcend the jurisdiction of national government, limit their ability to address these issues unilaterally (Sovacool and Florini, 2012). Cascading down these administrative powers to local governments might create situations and challenges difficult to be addressed solely by municipal authorities.

Cities have an important role to play in the shift to a more sustainable energy picture in Africa.

Recommended approaches in the urban challenges are shown in **Table 48**.

Table 48. Recommended approaches to the urban challenges

	Accelerate shift to cleaner cooking	Scale up renewable energy	Increase energy efficiency of buildings and appliances
Benefits to the under-served	Health: Modern fuels result in dramatic reductions in particulate matter and associated mortality Economic: Significant cost and time savings, productivity improvements for enterprises in the informal sector	Access: Addresses the urgent need to provide electricity access, particularly in informal settlements Reliability: More reliable supply of electricity Economic: Costs of solar PV are declining rapidly; higher cost savings compared to diesel, productivity improvements, potential revenue source if owners can sell back to the grid (as "prosumers")	Economic: Significant cost savings from reduction in household energy consumption, increased productivity Health, Safety, and Comfort: Safer, more comfortable, and higher quality spaces to live and work with lower respiratory and heat-related illnesses
Benefits to the overall economy and environment of the city	Cleaner cooking cuts outdoor air pollution from solid fuels Reduced GHG emissions Cost savings where kerosene subsidies are high	Avoided costs of new transmission infrastructure Reduced electricity demand Reduced GHG emissions Energy security and climate resilience Local business development	Increased energy productivity Reduced need for new installed capacity Significant energy cost savings Air pollution benefits where cities rely on "dirty" electricity grids Greatest potential for cities to reduce GHG emissions and build climate resilience

Source: (Westphal et al., 2017)

5.4.3 Actions

Departmentalization within local government often means that cities do not have a complete understanding of energy use, energy issues and energy initiatives within its boundaries. This is best gathered and understood in order to inform longer term energy planning (Batchelor et al., 2017).

- *Develop a State of Energy Report.* This summarises current energy use, energy supply and key energy issues in a city. This can be used for discussion among colleagues, to help them understand the role of energy in the municipality.
- *Develop a Sustainable Energy Strategy.* This will coordinate energy planning with an overarching city energy vision and set realistic renewable and energy efficiency targets based on current data.
- *Develop an Action Plan.* This maps out how the targets are going to be achieved and explores the technical opportunities for addressing energy poverty, as well as the policy challenges involved in promoting and deploying these technologies.

Box 39. Recommendations for substantial shift in improved household energy access

- Align and coordinate government plans and policies
- Strengthen city level information and data systems
- Review and rethink how policies are implemented
- Engage communities and civil society

5.4.3.1 Access to electricity

In the policy environment surrounding energy access, a major focus has been put on providing access to electricity, and recent changes in the price of renewable energy technologies have sparked debate about the best way to do so. Different approaches include the following technologies (Morrissey, 2017):

Large-scale grids: Expanding the central electrical grid is the most established approach to provide access to electricity. In Sub-Saharan Africa, where regulation is often weak, utilities have performed notoriously poorly.

Mini-grids: Mini-grids are still capable of supplying electricity in quantities that can match the services supplied by the grid. However, the current cost of renewable components and battery storage might negatively impact the cost of electricity when compared to the grid. In addition, although the up-front costs of mini-grids are lower than grid expansion, they are still high compared with the incomes of local entrepreneurs - who might be expected to finance and run such grids.

Solar home systems (SHSs): SHSs can supply electricity to isolated households that are too dispersed to be connected through mini grids. However, SHSs suffer from limited capacity, which is sufficient only for lighting, information and communication technologies (ICTs), entertainment, and cooling. In addition, electricity from SHSs is more expensive than electricity from both the grid and mini-grids. Although SHSs can provide households with basic quantities of electricity, they can also suffer from regulatory issues and be compromised in conditions where thefts of solar panels are a problem and where demand on the system grows rapidly. Due to high irradiation potential, the falling cost of solar photovoltaic, the speed of roll-out, and the limited capital investment required (compared to grid connections), solar home systems may be attractive solutions in sparsely populated rural areas of SSA. Even low levels of electrification, especially solar lamps, can bring substantial economic and noneconomic benefits.

Solar appliances: Solar appliances provide electrification on an even smaller scale than SHSs and therefore result in the lowest up-front cost, but also the highest cost of electricity of all the technologies mentioned here. Nonetheless, given the high value placed on electrical energy for lighting, electronics, and cooling, solar appliances have been observed to generate rapid transitions in household energy economies. It's worth mentioning that few countries have set standards for off-grid solar products: Ethiopia, Kenya, and Tanzania—along with the 15 member countries of the Economic Community of West African States have or are in the process of adopting national standards for off-grid solar products (CLASP, 2018).

Table 49 summarizes the relative strengths and challenges associated with electricity technologies.

Box 40. Bringing Electricity to Kenya's Slums

Giving electricity access to the poorest seems a daunting challenge. But there are examples of how new approaches can help overcome difficulties. One recent example is how the Kenya Power and Lighting Company (KPLC), with support from the World Bank, is working to increase legal connections in poor areas, including the Kibera slum. While the program struggled to take off in the initial period, with only 5,000 connections in 2014, they counted 150,000 a year later. KPLC changed its business process: instead of taking down illegal connections, it listened to community leaders and marketed the benefits of legal connections. It collaborated with the Kenya Informal Settlements Improvement Project (supported by the World Bank). The World Bank provided funding to KPLC for each legal connection – reducing the cost of electricity, using the 'last mile' approach and ensuring electricity was available to households. Consequently, using power legally became less expensive for consumers than the illegal lines (World Bank 2015). In mid-2016, KPLC reported that 60 percent of Kibera was connected. The ability to increase electrification is not only dependent on financial and resource availability. Implementing innovative policies and a strategic framework can speed up this process.

Factors for the success: Using a community-based approach, Kenya Power has gone from 5,000 households connected under its informal settlements program, to over 150,000, in just one year. First of all, Kenya Power changed the way it was doing business, adopting a community-based approach in slum communities. This meant no longer taking down illegal connections. Instead, it focused on listening to community members and leaders, and marketing the benefits of the legal connections – safety, reliability, and affordability. The utility also stepped up collaboration with the Kenya Informal Settlements Improvement Project (KISIP), a World Bank-supported government program with widespread networks and a strong reputation in the slums. This collaboration helped Kenya Power 'segment' the country's slum areas and target areas where the new approach was most likely to take hold.

Source: World Bank 2015.

<http://www.worldbank.org/en/news/feature/2015/08/17/bringing-electricity-to-kenyas-slums-hard-lessons-lead-to-great-gains>

Box 41. Off-grid rural electrification with solar energy in Mozambique

The off-grid rural electrification market in Mozambique is dominated by Fundo de Energia (FUNAE), a government agency, which controls the complete value chain (design, implementation, funding and often also operation in cooperation with local authorities) and which is 100 % government / donor funded. In most cases FUNAE implements and operates the projects itself, together with local communities / municipalities, and simply sources equipment from suppliers.

While the work of FUNAE is to be commended in having brought power to thousands in rural and poor populations, this activity doesn't facilitate private sector entry (except as equipment supplier) in those areas which could otherwise be open to enterprise and innovation (e.g. mini-grids operating on hybrid systems – solar, mini-hydro, wind and diesel generators as back-up; containerized utility solutions; productive use of power).

Source: (Vaz et al., 2011)

Table 49. Electricity technologies, strengths and challenges.

	Key features	Strengths	Challenges
Expanding the grid	Success in providing electricity to population around the world. Advantage of economies of scale. Large role for the state.	Can sell electricity at low cost. Can provide large quantities of electricity. Essential for increasing overall penetration of renewables.	Very expensive to build State bureaucracy and unresponsiveness. Currently heavily reliant on fossil fuels.
Mini-grid	Very limited economies of scale. Future reductions in price of storage.	Very large scope for renewables. Can provide large quantities of electricity. Lower capital costs. Quick to deploy. Some role for the private sector.	Possible lack of supply chains and relevant skilled personnel. Challenges to new technology.
SHSs	No economies of scale.	Large role for private sector 100% renewable. Established technology.	Expensive electricity Limited quantities of electricity. Adaptation to new technologies, from social and cultural point of view.
Solar appliances	No economies of scale.	100% renewable. Large role for the private sector. Potential to drive rapid changes in household fuel use.	Very limited quantities of electricity. Electricity very expensive. Difficult to exercise quality control over different appliances.

Source: (Morrissey, 2017)

Box 42. SHS potential and limitations

Anna Aevarsdottir and colleagues discuss the potential and limitations of off-grid solar. The authors argue that due to high irradiation potential, the falling cost of solar photovoltaic, the speed of roll-out, and the limited capital investment required (compared to grid connections), solar home systems may be attractive solutions in sparsely populated rural areas of SSA. Even low levels of electrification, especially solar lamps, can bring substantial economic and noneconomic benefits. The authors cite a study in Tanzania that showed that the benefits of solar lamps include lower payments for lighting, kerosene, and mobile phone charging, along with increased income and even happiness. However, limited willingness and ability to pay will need to be addressed through broader financing mechanisms, flexible payment schemes, and possibly short-term targeted subsidies. Furthermore, available off-grid solutions are unlikely to provide the electricity needed for larger-scale productive uses; these activities will require mini-grid or on-grid solutions.

Source: Aevarsdottir, A. in (Morrissey, 2017)

5.4.3.2 Renewable energies

Cities must target specific renewable energy resource that best suits their conditions. For example, solar PV systems suit cities in lower-latitude, high sunshine regions; geothermal power suits cities located near the tectonic plates; and bioenergy is most common in areas with a forest industry nearby. Cities with such a prime resource often try and develop, or attract, business ventures and investments relating directly to it.

These commonly include waste-to-energy combined heat and power (CHP) plants, geothermal heat systems, solar thermal collectors on roofs and building integrated solar

PV systems. Other forms of renewable energy carriers such as wind power, hydro power, concentrating solar power, solid biomass and liquid biofuels, usually need to be purchased from outside of the city and brought in by transmission lines, pipelines, road, rail or boats.

For a detailed description of solar water heating, solar photovoltaics, concentrated solar power and wind technology, please consult (SEA, 2017).

Given the key role of PV technology in future energy systems strategies are needed for dealing with large future volumes of end-of-life PV panels. Reuse and recycling technology is available today although the short term lack of waste volume means that economies of scale often can't be realized. Likewise, the end-of-life management of batteries in the off-grid solar sector creates new related challenges (Annex 9 and Annex 11).

5.4.3.2.1 Policy recommendations for local governments for improving access to electricity and scale up renewable energies (IEA, 2009):

- *Consumer centred policies:* too often, energy access planning is addressed exclusively from techno-economic perspectives, without seriously questioning the ways in which those services are perceived, used, and paid for by consumers. But, to serve these populations well, it requires an understanding of ability to pay, willingness to pay, the value of unserved energy, and how consumers value different attributes of energy service. In short, successful energy access measures require consumer-centred policies and business models (Morrissey, 2017).
- *Planning should focus on the energy services provided:* requires a shift from top-down to bottom-up planning of the electricity system.
- *Governance should involve stakeholders from multiple sectors,* not just energy, as well as local authorities. An integrated framework for electricity access relies on a strong enabling environment, a solid supply of products and services, and a robust demand for these products and services.
- Regardless of size, a city should undertake policy development to support *renewable energy deployment in association with other policies*, including national policies linked to sustainability goals and climate change, and local policies relating to energy security, energy access, health, employment, equity and reducing energy demands. Policies that are not directly energy-related, but could influence renewable energy uptake, can have direct or indirect impacts.
- *Enabling environment with the right policies, institutions, strategic planning, regulations, and incentives is imperative for achieving universal access.* When addressing energy issues, municipalities can be either constrained or empowered in what they can achieve by national policy instruments. For example, if a building act has building codes that specify energy efficiency standards, then authorities can use that as a means to improve the energy performance of new building stock. For example, a review of energy related policy instruments in 46 Sub-Saharan African countries showed that 63% had some kind of national energy policy in place, and 48% even had some kind of instrument specifically relating to renewable energy (sometimes these were technology specific e.g. solar, biogas) (Batchelor et al., 2017).
- *An assessment of available energy resources,* together with analyses of future energy demands and costs of alternative supplies to meet heating, cooling, electricity and transport demands, should be undertaken prior to promoting the use of renewable energy. The assessment should include the potential for renewable energy projects based around water supply, wastes, and land managed by the local authority.
- *The evolution of decentralised energy systems* will vary with the location, existing energy infrastructure, renewable energy resources available, and energy business

ownership status. Local governments could take a lead role by developing policies that will help support the transition of the conventional energy sector to a less centralised system.

- *Setting priorities:* based on prior assessment and knowledge of the local circumstances, considering that resources are limited, LA would define their own priorities, targets and actions. Energy services for healthcare, for schools or clean water access; discover where services are falling short will highlight where priorities should focus.
- *Development of renewable energy deployment policies should be undertaken in association with energy efficiency measures.* In most countries, leading cities have attempted to reduce their energy demand through improved efficiency and energy management incentives, and this has been recognised as a key policy priority. Putting parallel policies in place to support the use of renewable energy by the local community usually makes good sense.

5.4.3.3 Clean cooking fuels and technologies

80% of people in Sub-Saharan Africa rely on biomass for cooking (OECD / IEA, 2017a). Although the proportion of people accessing modern cooking fuels is expected to increase, high population growth rates in Africa means the absolute number of people relying on biomass is still expected to increase in coming years, placing increasing strain on biomass reserves. In previous decades, the motivation to improve the efficiency of cooking was driven by environmental concerns – deforestation and global warming. More recently, the impact of cooking on health, especially women and children has begun to be understood. 4.3 million people die worldwide from illnesses linked to cooking with solid fuels (most biomass) (OECD / IEA, 2017a).

Evidence from the most recent World Health Organization (WHO) survey on the global burden of disease shows that nearly 600,000 Africans die annually and millions more suffer from chronic illnesses caused by air pollution from inefficient and dangerous traditional cooking fuels and stoves (Kammila et al., 2014). Diseases include stroke, heart disease, chronic obstructive pulmonary disease (COPD), pneumonia, and lung cancer. Another hazard associated with cooking includes fires and burns; burn deaths are estimated at 300,000 a year globally.

Densely populated slum areas are particularly vulnerable to fires caused by spilt fuels, because construction materials are not fire resistant, and because they lack access routes for fire engines. Women and girls, who have primary responsibility for cooking, spend hours each week collecting fuelwood. This translates into lost opportunities for increasing income, gaining education, and makes them subject to safety and security hazards. Extensive use of biomass in urban areas results in deforestation of neighbouring areas. Then suppliers have to travel further to source charcoal, and prices increase.

Burning biomass, especially on open fires and inefficient stoves, produces greenhouse gases that contribute to climate change at a global level (Batchelor et al., 2017).

The traditional African way of cooking is on a three stone wood fire. This is not an ideal practice in urban areas where wood is not readily available, so charcoal tends to be the fuel of choice. Although urban residents tend to have greater access to modern fuels for cooking, such as LPG and electricity, the majority still rely on biomass (Batchelor et al., 2017). Even in households that use modern fuels as their main cooking fuels, they will also use a variety of other fuels either at certain times (e.g. when an LPG cylinder is empty, or when cash is limited), on certain occasions (e.g. cooking for family gatherings), or for certain purposes (e.g. frying, boiling water for tea, stewing etc.) – this is known as *fuel stacking*.

The “business-as-usual” scenario for the clean and improved cooking sector’s growth is encouraging but falls far short of potential and need. Existing market dynamics will ensure that tens of millions of new Sub-Saharan African households will gain access to at

least minimally improved cooking solutions by the end of the decade without any further interventions. But by 2020, the business-as-usual scenario would still leave 80% of Africa's population without clean cooking solutions and more than 60% without access to even minimally improved cooking solutions (Kammila et al., 2014). Furthermore, in the absence of significant public- and private-sector investment, the spread of clean cooking solutions Sub-Saharan Africa will be highly uneven—with successes in countries, such as Ghana, Kenya, Senegal, and South Africa (where the combined penetration of ICS and clean fuels is already above 50%) serving as exceptions amidst the overwhelming majority of SSA countries still mired in traditional solid-fuel cooking.

Figure 21. Overview of improved and clean cooking solutions

	"Improved" solutions		"Clean" solutions		
	Legacy and basic ICS	Intermediate ICS	Advanced ICS	Modern fuel	Renewable fuel
					
Key features	Small functional improvements in fuel efficiency over baseline technologies; typically artisanally produced	Rocket-style designs with focus on highly improved fuel efficiency; includes both portable and built-in models	Fan or natural-draft gasifiers with high fuel and combustion efficiency; often designed for pellet/briquette fuels	Stoves that rely on fossil fuels or electricity; have high fuel efficiency and low emissions	Derive energy from renewable non-woodfuel energy; often used as supplementary stoves
Technologies	- Legacy biomass and coal chimney stoves¹ - Basic efficient charcoal - Basic efficient wood	- Portable rocket stoves - Fixed rocket chimney - Highly improved (low CO₂) charcoal stoves	- Natural-draft gasifier (top-loading updraft (TLUD) or side-loading) - Fan gasifier/fan jet - Combination TLUD and charcoal stoves	- LPG - Electric (including induction) - Natural gas stoves - Kerosene stoves²	- Biogas - Ethanol - Solar - Retained heat cookers
Efficiency	Tier 0–2	Tier 2–3	Tier 3–4	Tier 4	Tier 3–4
Emissions ³	Tier 0–1	Tier 1–2	Tier 2–3	Tier 3–4	Tier 3–4
Overall benefits	Moderate				High

Source: (Kammila et al., 2014)

Box 43. Awareness campaigns 'Fumbalive' & "Good Stove Better Cooking" brand

The Uganda Ministry of Energy and Mineral Development, together with the Global Alliance for Clean Cookstoves and Uganda National Alliance of Clean Cook stoves (UNACC) launched in 2016 a campaign dubbed 'Fumbalive' aimed at encouraging consumers to adopt the use of the improved cookstoves as a way of promoting energy saving cooking practices. The locally made improved cookstoves have also been clearly marked with the Good Stove-Better cooking quality mark as the standard sign for genuine stoves. The first-ever certification program for improved cookstoves in Uganda. Market transformation policies – such as standards and labelling – can help accelerate the transition to cleaner and more efficient cookstoves that burn less fuel. In the case of Uganda, "Good stove better cooking" brands, Serves as a quality seal for buyers to identify quality stoves. All stoves promoted under the brand are tested to: Save at least 40% in (specific) consumption of fuel and Show measurable and significant reductions in emissions.

Source: <http://www.cleancooking2015.org> and <http://cleancookstoves.org/about/news/04-06-2016-alliance-launches-fumbalive-cookstoves-campaign-in-uganda.html>

Table 50. Clean cooking fuels and technologies.

Clean Fuel Intervention	Description	Potential scope
Liquefied Petroleum Gas (LPG)	A bottled gas containing mainly propane and butane, among the most effective and available large-scale alternatives to solid fuels. Requires an LPG stove connected to a LPG cylinder (different sizes available) through a hose and a regulator. A distribution infrastructure should be in place to ensure fuel supply.	LPG is already a fuel largely used in urban middle-income households of most LMICs for all or most cooking tasks and increasingly represents a likely alternative for less advantaged households in a number of areas with emergent supply and infrastructure.
Biogas	A combustible gas (mainly methane) produced by anaerobic digestion of organic materials such as animal wastes and, to a lesser extent, agricultural residues and human excrement. Biogas is not a universal fuel, as its potential is largely restricted to rural households owning a sufficient number of livestock and being located within a certain temperature and altitude range to ensure adequate gas production.	Construction and installation of biogas plants is usually expensive, and requires some form of financial support even among high and middle-income rural households. Proper operation and maintenance of the plant is crucial for ensuring biogas production.
Solar cooking	Emission free solar stoves convert solar radiation into energy used for cooking.	Although the actual energy source is free, the use of solar energy for cooking is restricted to countries and settings with high levels of solar radiation, and needs to allow for day-to-day and seasonal variation. These considerations, and the need to plan for use around the middle part of the day, limit the opportunities for widespread promotion.
Alcohol fuels	Ethanol (bio-ethanol) is a high-viscosity liquid produced by sugar fermentation from a variety of feedstocks including sugar-, starch- and cellulose-containing materials. Ethanol is a renewable fuel. Methanol is a fossil fuel produced by natural gas or oil products at a production cost usually lower than for ethanol. Methanol is toxic to humans and should be handled carefully. Its use in the cooking sector is limited to feasibility studies.	Ethanol: The low cost and availability of raw material for ethanol production make it a competitive fuel in a number of countries, although land competition with agricultural production may present a challenge, as well as taxation related to the use of alcohol for beverages. Methanol: Potential for methanol for the domestic cooking market may be greater in countries with natural gas supplies.

Source: (Puzzolo et al., 2016)

Box 44. Cookstoves performance label in Ghana

Over 70% of Ghanaian households cook their meals using biomass fuel – primarily wood in rural areas and charcoal in urban areas. Ghanaians also face more than 13,000 smoke-related deaths each year from cooking with biomass fuel. Because of their consistent proximity to cookstove emissions, children under the age of five are the most vulnerable.

SUMP Guidelines: <http://www.eltis.org/guidelines/sump-guidelines>

5.4.3.3.1 Policy recommendations for local governments for improving access to clean cooking (Kammila et al., 2014):

- *Increase support for clean cooking solutions*, while maintaining momentum for intermediate and basic ICS technologies where cleaner alternatives are not feasible in the near term.
- Design interventions to drive *consumer behavior change*; simply distributing cleaner cooking solutions and fuels will not lead to optimal health and environmental outcomes. The challenge of achieving the benefits of universal clean cooking in SSA is not simply one of technology and economics. Like water and sanitation programs and other public health initiatives, clean cooking solution promotion efforts can achieve health impact objectives only when accompanied by large-scale behavior change in the target end-user population.
- *Prioritize market-based approaches*, but also deploy direct subsidies linked to health and climate impacts. Market-led models should be emphasized wherever feasible to ensure sustainability. However, maximizing climate and health benefits might also require targeted subsidies delivered through carbon markets and focused “pull” mechanisms (e.g., results-based credits for health benefits).
- *Support sustainable production of clean-biomass and renewable fuel alternatives* alongside efforts to improve stove efficiency and reduce emissions. Given rapidly rising demand, more efficient cooking solutions alone will not be enough if the sustainability issues in African wood fuel value chains remain unaddressed.
- *Focus on providing critical public goods* to accelerate the development of the clean cooking sector. Policy makers should emphasize consumer education, access to finance, funding for R&D, the expansion of standards and testing, and enabling fiscal and trade reforms (e.g., tax, tariff, and subsidy reform).

5.4.3.4 Energy efficient lighting and appliances

According to the IEA, in 2013 lighting was responsible for 20% of global electricity consumption. The use of energy efficient lighting is one of the simplest and most cost effective ways of reducing energy consumption.

Lighting includes energy consumed for interior or exterior lighting of dwellings today mainly powered by electricity. Incandescent lamps, which have been around for more than a century, are slowly being replaced by more efficient fixtures, e.g. fluorescent tubes, compact fluorescent lamps and LEDs (light emitting diodes). More and more countries are passing regulations to phase out the use of incandescent bulbs. Households that do not have any access to electricity still rely on traditional forms of lighting such as kerosene and LPG lamps, and sometimes even candles and flashlights. Moreover, off-grid solar applications for lighting may become more prominent in the future.

Over 108 TWh of electricity – nearly 18% of Africa’s total consumption in 2014 – would be saved in 2030 if markets transitioned just to more efficient lighting, refrigerators, air conditioners and motors (CLASP, 2018).

Energy efficient lighting can be implemented by (SEA, 2017):

- replacing traditional incandescent bulbs with compact fluorescents light bulbs (CFLs);
- replacing old fluorescent tubes with efficient fluorescent tubes;
- replacing old magnetic ballasts with electronic ballast in fluorescent tube systems;
- Installing lighting control systems (motion and lux level sensors);

- Using light-emitting diode (LED) technology whenever possible. This technology is developing fast and is getting steadily cheaper;
- Making streetlights more efficient (e.g. by replacing mercury vapour lights with high-pressure sodium lights or LEDs that operate on around a third of the power.

Box 45. Energy Efficiency Strategy (EES) in South Africa

The Energy Efficiency Strategy (ESS) is the first review of the National Energy Efficiency Strategy of 2008. It provides sector-by-sector guidelines for the implementation of efficient practices within the South African economy. There are 8 goals, grouped in terms of social, environmental and economic sustainability, and which includes affordable energy for all. Energy Conservation Target: Energy efficiency improvement of 12% by 2015, set in 2003, by the Department of Minerals and Energy. It takes its mandate from the White Paper on Energy Policy, published in 1998.

Source: Policies and Measures Database, IEA

Trade and energy efficiency policies often influence each other. EE policies affect the products that can be sold on the market, and thus can restrict trade of inefficient products (eg. Minimum Energy Performance Standards, MEPS and Energy labeling), while trade policies (like taxes: local content requirements, and tariffs: product bans) can complement or hinder energy efficiency policies designed to increase the uptake of efficiency technologies (CLASP, 2018).

Ghana implemented minimum energy performance standards and bans the importation of incandescent light bulbs and used appliances. It has been reported that Ghanaian refrigerator imports jumped from 6% new products to only new, more efficient products. Seizing and destroying inefficient used refrigerators from this policy alone has saved around 400 GWh of electricity.

High-quality, energy-efficient appliances are essential to the growth of off-grid energy markets (CLASP, 2018).

In 2017, 2.8 million air conditioners (ACs) were sold in Africa, following 8.3% market growth over just the two years prior. The market grew 8.3% in 2016 compared to 2015. To date, only ten African countries have implemented energy efficiency policies for appliances such as room air conditioners, leaving many countries at risk of being saddled with inefficient, environmentally harmful, and poor quality appliances. But as demand for ACs grows, many policymakers are looking to energy efficiency policies as a key component of building sustainable cooling markets (CLASP, 2018).

Implementing standard and labelling policies will drive African AC markets towards high-efficiency ACs to increase the uptake of affordable, low-impact, high quality appliances and cut the catastrophic climate impacts of air conditioning.

Box 46. Standards for appliances

Kenya is in the process of implementing its first minimum energy performance standards for appliances, including refrigerators and room air conditioners. In collaboration with the Kigali Cooling Efficiency Program, CLASP has partnered with the Kenyan Energy Regulatory Commission to support their recently approved energy performance standards for ACs and on labeling and policy compliance. By reducing the projected cooling demand through energy efficiency policies and programs, Kenya can reduce utility bills for households and businesses, decrease the need for additional power supply, cut greenhouse gas emissions, and increase national energy access rates.

Source: <https://clasp.ngo/programs/africa>

Regarding refrigerants, while most African countries have instituted regulations to assist the phase out of HCFCs, few have regulations to control the importation of ACs that use HCFCs. Only South Africa has implemented HCFC regulations that cover AC units.

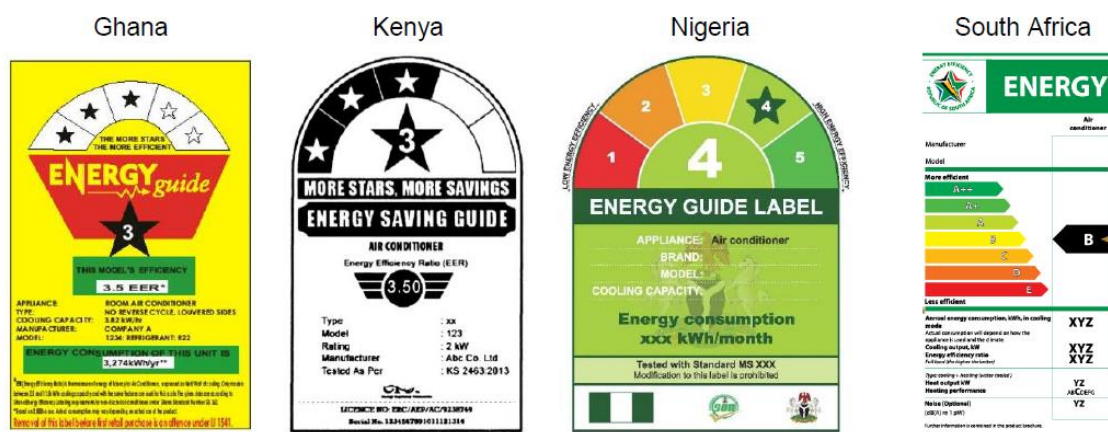
Minimum performance standards have been set for refrigerators, non-ducted air-conditioners and CFLs. Import duty and VAT were waived on the importation of CFLs in 2002 and on light emitting diode (LED) lamps in 2010. However, there are currently no energy standards or labelling for LED lighting in Ghana. Energy compliant Products list (<http://www.energycom.gov.gh/efficiency/energy-compliant-products>)

Table 51. Current status of minimum energy performance standards in six African countries

Minimum Energy Performance Standards (MEPS)	
Ghana	2,8 W/W
Kenya	2,8 W/W
Mauritius	No MEPS but Acs with efficiencies below Class D (<2,6 W/W) of the former EU efficiency classes attract a 25% customs levy
Nigeria	2,8 W/W (proposed) Information on the officially adopted MEPS not available
South Africa	3,00 W/W Class B of the repealed Directive 2010/30/EU (status as at 2014; under revision)
Tunisia	3,00 W/W Class B of the former EU efficiency classes (status as at 2016)

Source: (CLASP, 2018)

Figure 22. Comparative energy labels for Ghana, Kenya, Nigeria and South Africa



Source: (CLASP, 2018)

Box 47. The Ghana Electrical Appliance Labelling and Standards Programme

The Government of Ghana is already an energy efficiency leader in Africa. In 2007 the country implemented a programme to replace 6 million incandescent lamps with CFLs, which resulted in peak savings of 124MW and CO₂ savings of 112,320 tonnes per annum.

Ghana already operates a successful mandatory standards and labelling program for domestic refrigerators, air conditioners, and compact fluorescent lamps (<http://www.energycom.gov.gh/efficiency/standards-and-labelling>). Ghana is operating a Mandatory Appliance Standards and Labelling regime under which importers and retailers of Room Air Conditioners and Compact Fluorescent Lamps (CFL) are required to import and sell ONLY products that meet minimum efficiency and performance standards approved by the Ghana Standards Board.

It is an offence under LI1815 to import, display for sale or sell Air Conditioners and Compact Fluorescent Lamps in Ghana unless they meet the minimum performance standards and are properly labelled. The minimum energy efficiency standard for air conditioners to be acceptable in Ghana is an Energy Efficiency Ratio (EER) of 2.8 watts of cooling per watt of electricity input. This is equivalent to 9.55BTU/Watt.

In April 2003 the Government of Ghana removed import duties and VAT on Compact Fluorescent Lamps, commonly called Energy Saving Lamps to make them affordable to the general public as a measure to save energy and reduce electricity cost paid by consumers. CFLs should have a minimum service life of 6,000 hours. The lamps should also have a minimum efficacy of 33 lumens per watt.

The Ghana Electrical Appliance Labelling and Standards Programme requires that every products sold in the country must meet a minimum energy performance standard and be marked with a Ghana Energy Label. Ghana is well positioned to support the development of S&L activities for cookstoves and fuels (<https://clasp.ngo/updates/2017/ghana-cookstoves-label>)

Source: Dramani and Tewari, 2013

5.4.3.5 Energy efficient buildings

Municipalities have a more direct control over the building environment. It is generally the law that new buildings must comply with local planning and building regulations. This becomes a part of the authorities' resources to guarantee the right to sustainable cities and safeguard a healthy and comfortable urban environment. For more information on buildings, refer to section 5.2.

5.4.3.6 Partnership and awareness campaigns**Box 48. Actions included in Kampala Climate Change Action plan.**

Eco-stoves for the Wandegaya Market Kitchen: Kampala Capital City Authority (KCCA) has decided to support the development of Eco-Stoves in the city. 220 burners have been installed in the Market. Instead of firewood or charcoal, they use volcanic stones that can be re-used during 2 years.

They can be coupled with a solar photovoltaic panel to maintain longer the heat inside the stove and bring electricity for other use (lighting the kitchen, battery charger). This technology has social, economic and environmental benefits for the user, the guests and the local economy.

Solar energy for street lighting: KCCA has decided to develop the street lighting across the City to improve the conditions of mobility and security and to cut on the electricity monthly bill of Ugx200m. Decision has been taken that each new street light point will be supplied by solar energy. In October 2015, 170 photovoltaic solar panels have been installed (250 W to produce 90 MWh each year). KCCA has decided to add 700 solar street lighting points before the end of the year for a global amount of 3 million dollars on its own budget.

KCCA has embarked on a quick decommissioning exercise of old street lights and replacing them with solar powered lights in some sections of the city.

This action presents different benefits: the use of a free energy source, the continuous lighting during potential national electricity grid network breakdown, the promotion of these technologies for the private sector and an encouragement to the local economic fabric to invest in green growth potentials.

Biogas recovery at school: KCCA has implemented a bio-digester in Kansanga School which recovers biogas from the fecal waste of the pit latrines. This biogas is used to produce energy for cooking. The estimated amount of biogas produced is 36 m³ per month, which corresponds to about 2.6 MWh produced annually. This action presents different benefits: it turns a waste into resource, it is available on site and reduces the external energy supply, as well as reduces the particles emissions from firewood or charcoal used for cooking, it improves the management of operating costs

Kampala Climate Change Action: <http://www.kcca.go.ug/>

Support from citizens and local businesses for the greater deployment of renewable energy technologies and promoting energy access is essential, based on a good understanding of the issues. The personal benefits that would result for individuals and businesses need to be identified and disseminated. Leaders can motivate residents, offer them enhanced pride in their community as a result of being an early adaptor, as well as provide them with greater energy independence, energy security, employment and social cohesion. Strong leadership based on clear objectives is essential (See also chapter 5.2).

Table 52. Communication: what can I do to contribute? Raise awareness example from the Climate Action Plan of the city of Kampala

Who?	What?
Individual	Ride bicycle instead of motorized vehicle; Reduce, Reuse, Recycle; Take the bus; Plant a tree; Use train service.
Household	Use solar energy; Switch off power when not in use; Make compost from food/ organic waste; Harvest rainwater; Plant trees; Plant greens around the home; Recycle and reuse waste.
Institutions (schools, hospitals, government, donors)	Grow green for students meals; Segregate and reuse waste; Use energy efficient cookstoves or briquettes instead of firework; Harvest rainwater; Conduct energy audit; Develop biogas system to reduce energy costs; Allocate funds to climate smart projects; Promote shared transport systems for staff; Train staff in sustainable daily practices; Support public awareness campaigns; Set up climate smart policies.
Corporates (big and small business)	Promote staff awareness; Develop climate smart policies; Use energy efficient cookstoves or briquettes instead of firewood; Use energy efficient equipment; Take your waste to others who can reuse it; Conduct energy audit; Support the green economy.
Groups (Communities, religious cultural leaders, associations)	Hold dialogues to answer questions and solutions; Raise awareness; Advise people on why they need to take action now; Collect data on climate smart actions in your area; Do recycling projects, get your friends to join in! Support local actions eg: cleaning; Harvest rainwater; Support local actions eg: planting trees; Compost organic waste to set up community garden.

Source: (KCCA, 2016)

6 Implementation

The implementation phase takes the longest time, the most efforts and the largest portion of financial resources. It requires the involvement of all stakeholders, including national authorities, industry and citizens. Whether a thoughtful, effective SEACAP is successfully implemented largely depends on the human factor. Staff involved in SEACAP implementation needs to be empowered with clear responsibilities, sufficient resources and good communications. Shortcomings and mistakes should be considered as chances to learn, improve and expedite results. Local authorities should consider pilot and/or demonstration projects to test innovative ideas on a small scale.

Furthermore, during the implementation phase, it will be essential to ensure good internal and external communication between the different departments of the local authority, the associated public authorities and all the persons involved as well as with citizens and stakeholders. This will contribute to awareness-raising, increase the knowledge about the issues, induce changes in behaviour, and ensure wide support for the whole process of SEACAP implementation.

Monitoring and communicating progress on energy and CO₂ emissions reductions as well as climate vulnerability/risk reduction and increasing access to energy should always be integral components of SEACAP implementation. The local authority should decide on key indicators on mitigation, adaptation and access to energy for monitoring progress (see section 7) (such as percentage of compliance with deadlines, percentage of budget deviations, and percentage of emissions reduction with the actions already implemented and decisions already taken regarding adaptation and resilience).

Moreover, frequently informing the municipal council (or equivalent body) and other stakeholders is a good way to involve them in the success of the project. Similarly, networking with other signatories developing or implementing a SEACAP, will provide additional value towards meeting the targets by exchanging experience and best practices, and establishing synergies.

Box 49. Tips for putting the SEACAP into practice

- Adopt a Project Management approach: deadline control, financial control, planning, deviations analysis and risk management. Use a quality management procedure;
- Divide the project into different parts and select persons responsible;
- Strengthen horizontal cooperation between different policy-areas and mainstream climate actions into existing strategies;
- Prepare specific procedures and processes aimed at implementing each part of the project;
- Plan the follow-up with the stakeholders establishing a calendar of meetings in order to inform them;
- Anticipate future events and take into account negotiation and administrative steps to be followed by the Public Administration;
- Propose, approve and put into operation a training programme at least for those persons directly involved in the implementation;
- Motivate and offer training and support to the involved team.

7 Monitoring and reporting

Monitor the evolution and impacts of the actions included in the SEACAP and update it regularly allows to ensure continuous improvement in the process. CoM SSA signatories must submit a Progress Report every second year following the submission of the SEACAP for evaluation, monitoring and verification.

Box 50. Monitoring and reporting

It is mandatory:

- Submit monitoring reports every two years after submitting the action plan(s);
- Provide information about the implementation status of each action/action area/sector contained in the action plan;
- Update and resubmit the action plan(s) when there are significant changes to the existing plan(s).

It is recommended:

- Report the implementation cost for each action

The reporting requirements include timelines for different elements of reporting. The following table (**Table 53**) shows the overall reporting time for CoM SSA, coherent with GCoM recommendations (see all the Recommendations of the GCoM Framework in Annex 3). Year 0 corresponds with the year in which the local authority commits formally to join the initiative by signing the Political Commitment Document. Starting from then, they will be asked to submit the first group of documents the latest two years after; while in year 3 they must submit the SEACAP. Three reporting platforms are accepted in the GCoM framework: My Covenant- the European one-, CDP and the Carbon Climate Registry (cCR).

Table 53. Reporting elements and corresponding timelines for all CoM regional chapters.

Reporting element	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Baseline Emissions Inventory			X			
Risk and vulnerability assessment			X			
Targets and goals (mitigation and adaptation)			X			
Access to Energy assessment			X			
Climate action plan(s) (mitigation and adaptation, or integrated plan)				X		
Progress report						X*

* Every two years after submitting the SEACAP. Source: JRC own elaboration.

Progress reports should include an updated CO₂ emission inventory called a *Monitoring Emission Inventory* (MEI) developed according to the same methods and data sources of the BEI to ensure comparability. Ideally, local authorities compile CO₂ emissions inventories on an annual basis. If that frequency over-burdens human or financial resources, local authorities may carry out inventories after longer intervals and/or with simpler methodologies. Through the reporting a deeper understanding of the results delivered by the SEACAP is provided and corrective and preventive measures when this is required can be defined.

8 Financing Sustainable Energy and Climate Action Plans

8.1.1 Initial considerations

SEACAP(s) elaboration and implementation require tailored dedicated financing. The achievement of the sustainable targets often implies big investments at local and national level. To deliver such investments, local authorities face the challenge of accessing to finance. Moreover, LAs should take this challenge with holistic approaches in identifying both the kind of support required within the SEACAP process and available schemes and mechanisms. The need of financing support may arise for different stages of the SEACAP process: capacity buildings and trainings, technical and legal studies, feasibility assessments, assistance with financial studies for actions and their implementation. The C40 report (2018) (Moro et al., 2018) shows how the type of assistance needed by cities to advance in the implementation of climate related projects not only focused on financing modelling and development of bankable projects. On the contrary, it ranges from capacity development activities (such as capacity building, best practices, finance training) to implementation (such as organisational structuring, risk management, operational study), from technical studies (Impact assessment, socio-economic) to feasibility studies, from legal studies to financing studies and stakeholder engagement. These financing options are oriented at supporting capacity building of actors involved in the process, who will then be able to seek and apply for funding autonomously. Therefore, local authorities should at first identify at which stage of the process and for which activity they need financial support. Subsequently, available schemes, financial mechanisms and resources at the local, regional, national and international level should be defined. The role played by LAs is more important in the region due to the scarcity of resources, economic circumstances and high vulnerabilities faced in the territory. Therefore, efforts should be continuously made to find and to secure appropriate alternative sources of funding throughout elaboration and implementation.

Successful implementation also requires firm, long-term funding commitments. Local authorities should identify the required economic resources to finance the actions planned in their SEACAP and the relative timeframes. Different and specific short-term, medium-term and long-term funding options are available for implementing the variety of actions planned. Scarcity of financial resource increases the possibility of opting for energy-efficiency projects with short paybacks, but with low reductions in energy consumption and CO₂ emissions or quick adaptation effect. This approach will not capture the real potential savings available through the implementation of the actions. As a consequence, the choice of the appropriate funding options in terms of both the timeframe and the required kind of support is of utmost importance for the successful implementation of the plan and for the achievement of the mitigation and adaptation targets. Moreover, when considering the costs of SEACAP actions, local authorities should keep in mind the co-benefits to health, quality of life, employment, attractiveness of the city, reduction of vulnerabilities etc. which have an associated financial value.

Sub-Saharan Africa is extremely vulnerable to climate change impacts in multiple sectors, therefore, adaptation should be considered as a funding priority as well as mitigation. In literature, adaptation studies found that the costs of adaptation in Africa range between US\$20 –US\$30 billion per annum by 2030. However, those figures are far to be met (Bella-Corbin, 2011). The adaptation priority in the region is the improvement of its current adaptive capacity, which is linked to the increase of general development. This is considered as a pre-requisite for strengthening a country or region's ability to deal with climate change, and, therefore, adaptation investments are best implemented when a base level of development has been achieved ⁽⁹⁷⁾. In general, the financial policies

⁽⁹⁷⁾ The African Development Bank Group. The Cost of Adaptation to Climate Change in Africa. Available at: <https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Cost%20of%20Adaptation%20in%20Africa.pdf>

developed at national, regional, local levels have the role of enabling local authorities to initiate actions that will minimize the costs of climate impacts in the future.

Multiple funding sources are needed to fund climate change responses in cities since available resources may not be sufficient. Local authorities' budget is only one component of the financing structure. Due to the great involvement of stakeholders, SEACAP implementation will also require a strong institutional coordination to ensuring coherent and effective budgeting. In this context, local authorities may have to take into consideration the role of private actors in developing climate related projects. SEACAP actions could be partially co-financed by the private sector and part of the projects may receive grants support.

Box 51. Key definitions

Funding: refers to how a project is paid for over time.

Financing: refers to how debt or equity is raised to pay for immediate capital investment.

This section will attempt to describe the most common financing mechanisms and funding opportunities available to the CoM signatories in the SSA region. Links and examples are provided as a general guidance to local authorities and stakeholders. However, due to their intrinsic diversity and the dissimilar economic situation, some options will be more suitable to some countries than others.

8.1.2 Challenges for local authorities

Numerous barriers impede the development and implementation of sustainable actions in cities. Local authorities may face a number of challenges when considering the implementation of the actions planned in their SEACAP. Some common barriers faced by Local Authorities when dealing with financing mechanisms and funding opportunities are listed below.

- Local Authorities lack knowledge of all the options of financing schemes available. There are existing initiatives that try to tackle this problem by providing comprehensive information about the different financing options available.
- Local Authorities financial autonomy. Frequently LAs lack knowledge regarding the share of tax revenues transferred to the local authority. This also extends to a lack of mandate and systems in place to facilitate financial autonomy.
- Absence of capacity to present projects that can be financed. Local Authorities do not possess the proper manpower, professional training and experience to choose the most suitable instrument, to prepare application for the funding, to make the project eligible. The access to financing instruments, especially non-grant instruments, for climate action is often challenged by the difficulty in demonstrating the 'bankability' of the planned investments. Moreover, time constraints seriously challenge local authorities in developing documents for submission. There are funding opportunities oriented to increase the technical skills on this aspect and to support in the preparation of applications and documents.
- Local Authorities may face political constraints before accessing climate finance. Political instability may lead to delays in prioritisation of actions to be financed and in the application for funds.
- Climate investments are often small or scattered to attract investors. Moreover, these programs are hardly designed to be financially viable and replicable. Options to aggregate small projects should be explored.
- Lack of trust impeding private sector investment. Private sector involvement could be fostered by transparency and clearly defined risks. In parallel, LAs show low or no trust in private sector, which ends up with a scarce private involvement in action planning and implementation.

- Weak institutions and legal frameworks and underdeveloped capital markets harm the access of LAs to long-term finance. Financial intermediaries, including national, regional and international development banks, can play an important role in promoting urban finance, basing upon the experience of developed countries.

8.1.3 Financing mechanisms

Investment projects in the area of climate and energy for cities show many similarities in principles and models with other (more traditional) investment projects. Understanding these aspects would be an important step for local authorities who will have to decide the most effective approach to implement the actions contained in their SEACAP(s). More advanced tools are available, and depending on the local context these mechanisms may have significant potential to finance actions. Moreover, through the development of tailored market mechanisms the private sector is more involved and incentivised to invest in the climate action. However, due to the complexity of these instruments, special consideration should be given in the planning and implementation phases, to avoid potential pitfalls with adverse effects on the local population. The paragraphs below describe frequent mechanisms that can be used to support key actions in cities.

8.1.3.1 Local Authorities' own financial resources

Municipal budget is a short term funding option for local climate action. These resources may come from grants (national or external), local taxes (houses, business, income-producing sources), borrowing in terms of debt financing and loans. However, these last options are limited due to the lack of an adequate legal framework, difficulties for local authorities to be solvent and transparency issues. Green bonds and climate bonds are spreading among local authorities as a viable tool to sustain local climate projects. Municipal taxes can be used to support climate change action. Moreover, the big changes for African cities development call for the renewal of local taxation. Local authorities in most of African countries don't have the authority to determine characteristics of local taxes. These are, on the contrary, determined at national level. In most cases, the state services do not have contractual relations with the local communities for which they are supposed to work. As a consequence, it is central to raise awareness of the importance of strengthening the financial autonomy of local authorities through local taxation. Improving fiscal decentralization and local autonomy strengthen the administrative capacity to face the most alarming challenges in various contexts ⁽⁹⁸⁾.

⁽⁹⁸⁾ More information on this topic could be found at:
<http://localizingthesdgs.org/library/150/Renforcer-les-recettes-fiscales-locales-pour-financer-le-dveloppement-urbain-en-Afrique.pdf>
<https://www.uclg.org/fr/media/nouvelles/priorites-dactions-pour-renforcer-laces-aux-financements-climat-des-acteurs-non>

Box 52. Kampala Capital City Authority - KCCA

Uganda developed tax reforms and the collection of revenue over the years had improved. Tax education for future taxpayers was given priority, as well as enhanced training for existing ones who needed support. Uganda had embraced technology in the collection of revenue for tax and customs, while the training of staff helped on technical issues. The Kampala Capital City Authority (KCCA) is the governing body of the Capital City and administers Capital City on behalf of the central government. Created in 2011, this body aims at delivering quality services to the city. The mandate includes: the establishment of a clear link between the payment/collection of taxes and the provision of services for which they are meant to finance; and a campaign for taxpayer sensitizations, education and mobilization, policy review, decision making, and ultimately Revenue collection maximization. Revenue is a key factor for KCCA in achieving her mandate as provided for in Kampala Capital City Act 2010 (Section 50). The Act provides for the power to levy taxes giving KCCA the responsibility to levy, charge, collect and appropriate fees and taxes in accordance with the law as enacted by Parliament under article 152 of the Constitution. As a consequence, one of KCCA first priorities was to overhaul tax collection. Revenues have soared from Sh30 billion (\$9 million U.S.) in 2010/11 to Sh81 billion (\$24 million U.S.) 2015, a rise of 89 percent after inflation. KCCA is increasing its capacity to generate its own budget, which is the basis for the sustainability of the public services delivery. An electronic system, eCitie, allows citizens to make payment electronically, with a parallel increase of transparency. Moreover, beyond the financial benefits for KCCA, this system reduce the mileage that taxpayer should do to satisfy their obligations. It is also in line with the dematerialization policy followed by KCCA.

Kampala Climate Change Action – Energy and Climate Profile

<https://www.kcca.go.ug/revenue-collection#>

<https://www.un.org/press/en/2018/ecosoc6908.doc.htm>

8.1.3.2 Grant programs

Investment grants or interest rate subsidies are often provided by governments to support the upfront cost of energy efficiency projects that may entail too high investment costs and long amortisation periods. Investment subsidies increase the financial rate of return on investment, increasing investors' demand for investment. In addition, investment subsidies improve cash flow and thus increase investors' access to debt finance (Bertoldi et al., 2010).

Public grant programmes are used in order to support Energy Efficiency projects that contribute to energy and social policies and meet other public policy goals. The advantage of public grant programmes is that subsidies can be an important factor in raising the general awareness and trust in sustainable projects.

On the contrary, the great disadvantage is that in times of squeezed budgets, it is often difficult to put aside the necessary budget for subsidies to realise the policy goals. This often places subsidy programs in a stop-and-start operational mode, which may actually delay project implementation encouraging potential project proponents to wait for better grant conditions or for the next funding call (Bertoldi et al., 2010). However, through international funds aimed at climate change, grants dominate the financing of RE projects in Africa (Schwerhoff and Sy, 2017). Grants have the advantage of not requiring highly developed financial markets and are used for small scale projects, which have been identified as two of the main barriers for mitigation and adaptation actions implementation.

8.1.3.3 Soft loans

Soft loan schemes which offer below market rates and longer payback periods, and loan guarantees, which provides buffer by first losses of non-payment, are mechanisms whereby public funding facilitates/triggers investments in EPC. They give long-term financial coverage to help bridge the pre-commercialisation financing gap for EE projects

by direct subsidies on interest payments, by risk premiums (e.g. an IFI or a state can guarantee a certain amount of loans), or by capital gains to a revolving fund. They are commonly used for energy efficiency measures. Loan conditions include:

- extended payback periods,
- low or zero interest rates,
- short-term interest deferral periods, and/or
- inclusion of payback grace periods ⁽⁹⁹⁾.

8.1.3.4 Green Bonds

Bond markets can be a source of low-cost capital for cities and municipalities. Green bonds are bonds where revenues are allocated to "green" projects. In particular, these bonds have emerged as a financing tool for climate change mitigation and adaptation actions within cities ⁽¹⁰⁰⁾. Local authorities have begun to emerge as strategic issuers of green bonds in the United States, Europe, and South Africa, as they represent a low-cost and long-term source of capital to finance climate mitigation and adaptation infrastructure requirements. A green municipal bond is a fixed-income financial instrument for raising capital through the debt capital market. As with any other bond, the bond issuer raises a fixed amount of capital from investors over an established period of time (the "maturity"), repays the capital (the "principal") when the bond matures, and pays an agreed-upon amount of interest ("coupons") during that time.

Box 53. City of Cape Town's Green Bonds

The City of Cape Town issued a green bond whose proceeds are used to fund and refinance green projects in the city, including its emergency water-supply schemes. The City of Cape Town green bond is already listed on the JSE's bond market and was certified by the Climate Bonds Initiative. The JSE has aligned its JSE Green Bond listing requirements with international best practice but kept it in context of the South African economy to include specific rules pertaining to green bonds. The JSE requires transparency (green bond issuers to disclose the proceeds generated through issuing the bond as well as how these funds are applied throughout the lifetime of the bond) which gives investors comfort and trust regarding the application of the funds. The city was able to raise its targeted R1-billion from 8 allocated bidders, having received bids of almost R5-billion from 31 different bidders. Moreover, the City of Cape Town won the Environmental Finance Green Bond Awards 2018, being named 'Green Bond of the Year.

<https://propertywheel.co.za/2018/04/city-of-cape-towns-first-green-bond-wins-uk-award/>
<https://www.jse.co.za/articles/Pages/JSE-launches-Green-Bond-segment-to-fund-low-carbon-projects.aspx>

The key difference between a green bond and a regular bond is that the former is explicitly labelled as "green" by the issuer, and a commitment is made to use the proceeds of the green bond to exclusively finance or re-finance projects with an environmental benefit. Eligible projects include, but are not limited to, renewable energy, energy efficiency, sustainable waste management, sustainable land use, biodiversity conservation, clean transportation, clean water, and various climate adaptation projects (Saha and d'Almedia, 2017).

The African Development Bank Group's Green Bond program facilitates the achievement of the Bank's corporate priority of green growth through the financing of eligible climate change projects.

⁽⁹⁹⁾ Bertoldi, P. and Rezessy, S. (2010). Financing energy efficiency: forging the link between financing and project implementation. [online] Ispra: Joint Research Centre of the European Commission. Available at: http://www.konvencijazupanov.eu/IMG/pdf/Financing_energy_efficiency.pdf

⁽¹⁰⁰⁾ How to Issue a Green Muni Bond - Climate Bonds Initiative. Available at: <https://www.climatebonds.net/resources/publications/how-to-issue-a-green-muni-bond>

8.1.3.5 Public-private partnerships (PPPs)

Governments have difficulties in meeting the demand for services and implementing climate projects by acting alone. As a consequence, cooperation between the local authority, local investors, and local citizens are deemed to be vital factors of success for realizing ambitious projects in the adaptation and mitigation framework. The public-private partnership (PPP) is one of such collaboration, based on the awareness that both the public and private sectors can benefit by combining their financial resources, know-how and expertise. PPPs are a concession mechanism whereby the local authority acquires financing from the private sector, with certain obligations. Numerous stakeholder groups have a legitimate interest in sustainable actions development. The leadership of local authorities usually have a crucial role in forging partnerships and pooling resources across the public and private sectors. When identifying all the stakeholders that might contribute to the partnership, their level of participation and potential conflicts of interest must be taken into account.

Effective cooperation between local government, businesses and the community is always difficult to achieve because of the wide range of participants involved, the low level of trust that often exists between potential partners and the lack of predictability in the process. The transparency in the process is determinant for successful PPP⁽¹⁰¹⁾.

As an enabler, local authorities have the capacity to steer policies in support of niche innovations that are new to the market as well as technologies that offer multiple social benefits. For instance, public administration promotes the construction of a zero-emission swimming pool, or a district heating and cooling installation, by allowing a private company to run it revolving the profits on the initial investment.

A regulation and legal frameworks within which stakeholders play the role are key elements that may ensure the quality and the success of the partnership. Moreover, this kind of contract should be flexible to cater for the needs of the private company (for example to extend the contract in case of unexpected payback delays). A frequent due diligence is also recommended in order to follow up the evolution of incomes⁽¹⁰²⁾.

Box 54. Challenges for LAs in PPP

- Complex contractual and operational arrangements. African municipalities often lack the financial, legal skills as well as technical and project management expertise to sign advantageous PPPs
- PPPs often need to follow open and competitive bidding process which is time-consuming and constraining to implement for municipalities
- Government officials at all levels often view PPPs as complicated – Legal requirements are daunting for small municipalities in particular
- Potential vulnerability of PPPs agreements to political pressure and cycles

See also chapter 5.

Source:

https://repository.up.ac.za/bitstream/handle/2263/59872/Mbatha_Examination_2017.pdf?sequence=1

⁽¹⁰¹⁾ UNDP. Public Private Partnership for urban environment. http://pppue.undp.2margraf.com/en/01_2.htm

⁽¹⁰²⁾ Successful worldwide Public-Private Partnerships example can be found in the document "Public-Private Partnerships: Local Initiatives 2007" on www.theclimategroup.org/assets/resources/ppp_booklet.pdf

Box 55. iShack project in South Africa

The iShack project involves members of the Enkanini community, the Sustainability Institute of the University of Stellenbosch and the Department of Public Service & Administration (DPSA) collaborating on a pilot project, looking at ways to make informal housing/shacks more energy efficient and safe. The iShack Project is using solar electricity to demonstrate how green technologies can be used appropriately to incrementally upgrade informal settlements and slums and at the same time build local enterprising capacity and resilience within the community. The project is a viable and financially sustainable public-private business model for the provision of incremental energy services to under-served communities in South Africa. The iShack approach is mainly around the supply and installation of a solar PV panel, battery, the appropriate wiring, LEDS light bulbs and a TV. The off-grid utility provides household electricity to power lights, television and other small media appliances. The energy capacity of the service is somewhat higher than what is typically deployed in rural off-grid electricity projects elsewhere in the world.

Source: <https://www.ishackproject.co.za/>

Box 56. PPP toolkit

PPPUE is the global facility developed by UNDP that developing countries use to obtain support in their efforts to define, promote and implement Public Private Partnerships to reduce poverty by increasing the access of the urban poor to basic services. The programme offers a flexible portfolio of demand driven services built on the basis of a strong partner network and results at the country level.

The **Tools for Pro Poor PPP** at the local level are aimed at members of local level government, business and community organisations interested in an innovative approach to the problems of service delivery, especially to the poor. The toolkit has been developed as a working manual to be added to and modified as required by users to enhance its functionality. It has been prepared with the extensive involvement of people involved in PPPUE's projects and programmes around the world. These contributions have been invaluable and have served to ensure that the text presents a globally applicable entry point to PPPs while simultaneously remaining open to modification with locally appropriate contextual materials.

Source: <http://pppue.undp.2margraf.com/en/05.htm>

8.1.3.6 Revolving funds

Revolving funds are intended to establish sustainable financing for a set of investment projects. The fund may include loans or grants and have the ambition of becoming self-sustainable after its first capitalisation. The funds remain available to finance continuing operations, because they are replenished with the revenues earned. These funds are very important when liquidity is scarce. They can be established as a bank account of the owner or as a separate legal entity. The interest rate generally applied in the capitalisation of revolving funds is lower than the market one. Typically, several parties are involved and the owners can be public or private companies, organisations, institutions or authorities. The operator of the fund can either be its owner or an appointed authority. External donors and financiers provide contributions to the fund in the form of grants, subsidies, loans or other types of repayable contributions. The borrowers can either be the project owners or contractors. The advantage of revolving funds is that they are less dependent on external investors. If they are operated effectively, revolving fund can contribute to a permanent financing structure for energy efficiency investments, which is separate from political influence. A revolving fund can complement to an ESCO.

8.1.3.7 Crowdfunding

Crowdfunding distinguishes itself from more traditional mechanisms, in which a small number of investors provide large sums of money to finance sustainable development projects. In crowdfunding, the approach is subverted. It is based on individuals' efforts to support other's initiatives or projects by investing small sums of money. The main channel to gather money is internet: projects seeking funding are displayed in an online accessible portal. Once the project reaches the funding target, it can be commissioned to provide returns to investors. Crowdfunding is at an early stage, but it has potentials for supporting sustainable projects at the city level, since it is an easy to set-up mechanism and allows to overcome some of the most common finance-related barriers⁽¹⁰³⁾. In North America and Europe, crowdfunding has emerged as a promising alternative for entrepreneurial finance. Crowdfunding platforms are increasingly targeting the development and commercialization of clean technologies in developing countries. The Africa crowdfunding market is active and growing. However, there is still room to leverage the full range of options for this financing tool. To increase the potential of success of crowdfunding campaigns, the choice of the platform, the level of commitment in the project and the support from business incubators may be taken into account⁽¹⁰⁴⁾. Beyond monetary gains, crowdfunding help to increase the visibility and transparency of a company, which in turn increases its perceived trustworthiness with customers, investors and partners.

Box 57. Crowdfunding in Africa

The Kenya Climate Innovation Center (KCIC) — an initiative of the World Bank and its global entrepreneurship program *infoDev* —officially launched a support program for crowdfunding in East Africa in 2015. In its pilot phase, the program has helped six clean-tech ventures design, develop, and launch their online crowdfunding campaigns. Develatech (Kenya) is a company that produces and sells clean cookstoves and is an incubate of the KCIC. The incubator connected the company with a mentor to assist with preparation and launch of a 1% club campaign, which successfully raised €15,000. Then the mentor and the entrepreneur worked together to form a strategy to build on their success. As a result, Develatech is developing a camping cook stove which can be pre-sold to Western outdoor enthusiasts via an international crowdfunding site. In the future, in addition to sourcing mentors, business incubators could leverage an experienced crowdfunder like Develatech to provide peer-to-peer learning opportunities with other companies in the incubator.

Source: <https://www.kenyacic.org/>

Crowdfunding in Emerging Markets: Lessons from East African Startups." 2015. Washington, DC: The World Bank Group. License: Creative Commons Attribution CC BY 3.0

8.1.3.8 Third-party financing

The third-party financing is a mechanism that allows another party (as ESCOs) to provide the capital and take the financial risk. It is perhaps the easiest way for municipalities to undertake ambitious projects (such as comprehensive building energy retrofits). High financing costs may be expected to reflect the fact that the debt is registered on another entity's balance sheet. The interest rate is, however, only one factor among many that should be considered to determine the suitability of a third-party financing vehicle. In the region, almost all the countries have allowed for third party access (Bertoldi et al., 2010).

⁽¹⁰³⁾ Ferrer Nuñez J. (2013). Financing Models for smart cities-Smart Cities stakeholder platform.

⁽¹⁰⁴⁾ The World Bank (2016). Climate Technology Program - In Brief n°1. Available at: www.infodev.org

8.1.4 Energy services companies (ESCOs)

Energy Service Companies (ESCOs) are one of the most well-defined third-party financing mechanisms for energy-related initiatives. ESCOs provide the opportunity to reduce greenhouse gas emissions through increased energy efficiency in a variety of sectors. ESCO remuneration is based on the amount of energy saved through the project, thereby the ESCO usually finances the energy-saving projects without any up-front investment costs for the local authority. The energy savings achieved during the contract period recovers the investment costs and pays a profit. The contract guarantees the local authority a certain energy savings and saves the city investment in an unknown field. Once the contract has expired, the city owns the efficient project.

ESCOs often offer a performance "guarantee", which can take several forms. The guarantee can revolve around the actual flow of energy savings from a retrofit project. Alternatively, the guarantee can stipulate that the energy savings will be sufficient to repay monthly debt service costs. Measurements and verification of the energy savings are decisive for all the parts involved. Energy Performance Contracting (EPC) is a contractual arrangement between a beneficiary and an Energy Service Company about energy efficiency improvements or renewables installations. Normally an ESCO implements the measures and offers the know-how and monitoring during the whole term of the contract. Essentially the ESCO will not receive its payment unless the project delivers energy savings/production as expected (Bertoldi, Rezessy 2005).

Large number of programs and mechanisms has been established to facilitate the penetration of ESCOs in developing countries. However, ESCO market is still in its infancy in Sub-Saharan countries. Financial, technical or regulatory challenges and barriers have hindered the ESCO development. Some ESCO experiences in Cote d'Ivoire, Burkina Faso, Senegal, Mali, Togo are led by engineering companies, that integrated the ESCOs services to provide energy efficiency to the industrial and commercial sectors (Hansen et al., 2009). In Kenya, a GEF and UNDP project with Kenya Association of Manufacturers commenced in 2001 to remove barriers to energy efficiency in small- to medium-scale enterprises. The project involved capacity building, policy and institutional support and implementing energy-efficiency services through financing and ESCO development. As a result of the project, one ESCO was established in 2005 to deliver energy services (Ellis, 2010).

The first ESCOs in South Africa came into existence in the late 1990s when Eskom, the monopoly electricity utility, formally recognized the importance of Demand Side Management in its Integrated Electricity Planning. To become a registered supplier, an ESCO must be registered with Eskom. All companies applying for registration with Eskom have to undergo an intensive screening process. The ESCO Industry in South Africa has been active in four major sectors; namely the Residential and Municipalities, Mining and Industrial, Corporate and Commercial and Agriculture ⁽¹⁰⁵⁾.

ESCO associations can play a key role in promoting energy-efficiency investment in collaboration with governments, banks and utilities. ESCO associations engage in public outreach, the creation of new partnerships and training and capacity building for their members. The South African ESCO association is working on outreach to the public and business decision-makers, establishing standards and accreditation, working with the utility (their main source of project funding) to streamline project process and partnership building.

⁽¹⁰⁵⁾ Industrial Development Corporation. Developing a vibrant ESCO Market - Prospects for South Africa's energy efficiency future

8.1.5 Financing and funding opportunities

External funding is available and International Financing Institutions (IFIs) on sustainable projects are active in the region. Several multilateral funds are available in the region for both mitigation and adaptation projects (¹⁰⁶).

The African Development Bank (AfDB) has undertaken a number of initiatives to support African countries to strengthen climate resilience and enable a transition to low-carbon and green growth. The Climate Finance Team coordinates and leads the implementation of different facilities that provide multiple instruments (grants, concessional debt, equity, etc.) which ultimately enhance project bankability, build resilience to climate change and support transition to green growth in Africa. Among these initiatives, the Africa Climate Change Fund (ACCF) supports African countries in building resilience to the negative impacts of climate change and transitioning to sustainable low-carbon growth. In particular, the ACCF was established in 2014 to support countries in developing climate-resilient and low-carbon investment plans and projects, in Co-financing climate-resilient and low-carbon projects and programs; in developing capacity building of national and regional stakeholders for climate change, climate finance and green growth. ACCF grant recipients may include: African governments, non-governmental organisations (NGOs), funds, research institutions, and regional institutions (jointly referred to as "external recipients"). In addition, the AfDB operates as *Global Environment Facility* (GEF) implementing Agency. GEF funds are available to developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements (¹⁰⁷). The AfDB offers two risk guarantee products: the African Development Bank Partial Risk Guarantees (PRGs) and the African Development Fund (ADF) Partial Risk Guarantees in order to encourage the private sector to invest in renewable projects in Africa. AfDB is also an implementing partner in the Climate investment funds together with the World Bank.

The World Bank is an important actor in developing finance across SSA. It is supporting operations in Africa to increase access through grid extension and expansion of the transmission network, innovative off-grid electrification solutions, expansion of renewable generation capacity, and development of regional power pools and improvement of service efficiency. In addition, the Bank is supporting the development and adoption of new technologies such as solar storage solutions, smart meters, mobile utility payments, satellite mapping and imaging, high-voltage DC transmission, and solar home systems and mini-grids (The World Bank, 2018). Moreover, as climate change significantly impact Sub-Saharan Africa's development agenda, a new World Bank plan, the Africa Climate Business Plan, outlines actions required to increase climate resilience and low-carbon development in an effort to maintain current and protect future growth and poverty reduction goals. The Africa Climate Business Plan envisages mobilizing and deploying some \$19.3 billion of fast-track financing and \$21 billion in longer-term support (¹⁰⁸). The World Bank Group has adopted the Maximizing Finance for Development (MFD) approach which aims at systematically leveraging all sources of finance, expertise, and solutions to support developing countries' sustainable growth. The World Bank Group is piloting the MFD approach in nine countries where clients have requested private sector solutions to advance critical development projects: Cameroon, Cote d'Ivoire, Egypt, Indonesia, Iraq, Jordan, Kenya, Nepal, and Vietnam. The World Bank group works to help the client to find the suitable solution, to tap a variety of financing opportunities, incorporate global lessons and good practices, and address equity and affordability for consumers. The final aim is to equip countries to attract and manage private solutions. Working with partners, the World Bank Group can help low- and middle-income countries expand their range of options for financing efforts to sustainably grow their economies, reduce poverty, and

(¹⁰⁶) Further insight can be found in IFI, 2018. www.ifc.org

(¹⁰⁷) More information available at: <http://www.thegef.org/about/funding>

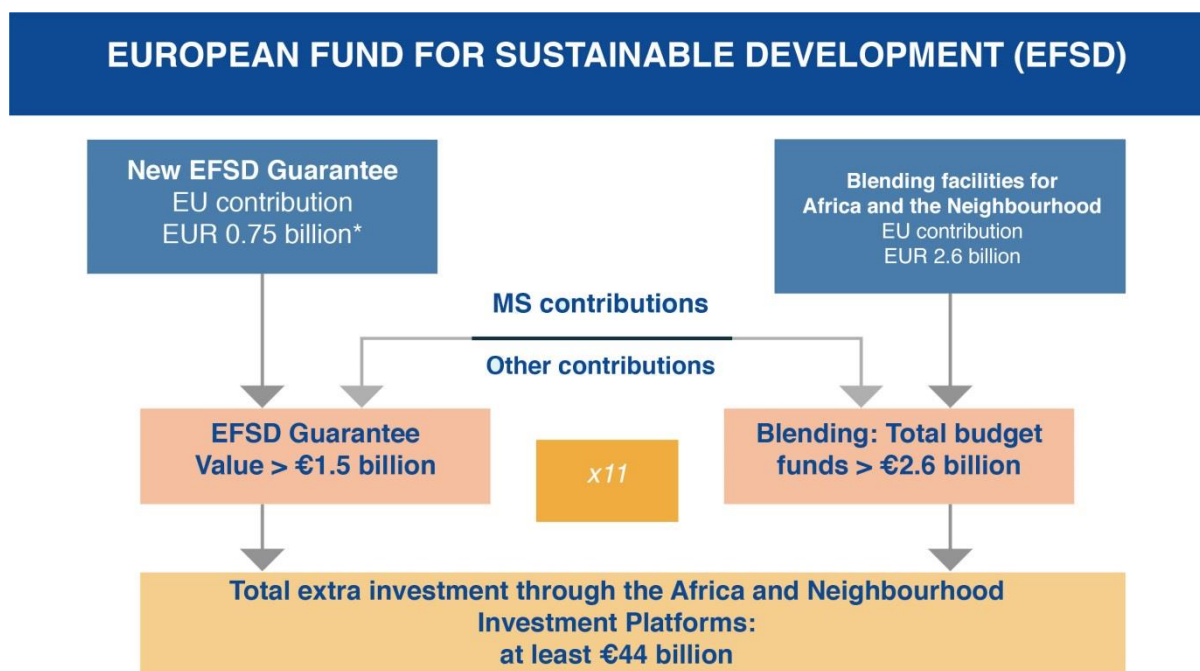
(¹⁰⁸) (<http://www.worldbank.org/en/programs/africa-climate-business-plan#1>)

expand opportunity. While every country has unique needs, it would necessary to find the right mix of public and private funding to meet their objectives ⁽¹⁰⁹⁾.

The European Union launched the External Investment Plan (EIP) in 2017 to attract more investment from business and private investors in EU-neighborhood countries and in Africa. The EIP is organised around three parts: *Financing*, through the European Fund for Sustainable Development (EFSD), *Expertise*, to provide technical assistance to both investors and governments, *Dialogue*, to improve the business environment through dialogue with stakeholders. The EIP is guided by the general objectives of the EU's external action. It contributes to the achievement of the SDGs of the United Nations (UN) 2030 Agenda for Sustainable Development. The External Investment Plan's financial pillar consists of two parts: Guarantee Fund and Blending Facilities.

The EIP is also open for contributions from other donors, including EU Member States, third countries as well as private philanthropic actors. The EFSD should contribute to the implementation of the Paris Agreement on Climate Change. The EFSD should also allow investors and private companies, in particular micro, small and medium-sized enterprises (MSMEs), to contribute more effectively to sustainable development in partner countries. Moreover, a guarantee accompanies the EFSD in order to attract financing for the initial stage of a project and provide liquidity to compensate, if necessary, losses covered under the guarantee agreement. The EFSD blended finance operations are composed of two regional investment platforms – the Africa Investment Platform (AIP, former AfIF) and the Neighbourhood Investment Platform (NIP, former NIF) (**Figure 23**).

Figure 23. European Fund for Sustainable Development (EFSD)



* Plus a EUR 0.75 billion contingent liability

Source: EC (https://ec.europa.eu/commission/eu-external-investment-plan/mobilising-finance-through-european-fund-sustainable-development_en)

The AfIF started operating in November 2015 in order to support investment in Africa. AfIF is funded mainly from different programmes under the European Development Fund (EDF) but also the EU's Development Cooperation Instrument. AfIF contributed over €295 million to 16 projects, leveraging a total investment of over €2.3 billion in its two-year window. Within the EIP, in 2017 the AfIF evolved into the AIP. The AIP supports:

⁽¹⁰⁹⁾ More information available at: <http://www.worldbank.org/en/about/partners/maximizing-finance-for-development#1>

- Infrastructure, including transport, energy interconnections and renewable energy, and information and communication technologies;
- Private sector development, including access to finance for households and MSMEs;
- The environment, including water supply and sanitation, and climate change adaptation and mitigation;
- Agriculture;
- Healthcare and education.

The final beneficiaries of the AIP are the EU's partners in Africa, their central, regional and local administrations, public and semi-public institutions. Many beneficiaries are households and micro or small businesses.

Box 58. Municipal pooled finances (MPF)

The municipal pooled financing is a cooperation between municipalities to jointly borrow money or access funding. This solution is increasingly exploited by African cities which develop joint proposals to access international funding.

Potential strengths of MPF – as an infrastructure funding too- are: increased power and flexibility in municipal general financial management, a higher capital market share on the demand side reached by jointed municipalities; improved their credit-worthiness. Potential weaknesses of MPF are in general: less transparency, costs for additional structure, Moral hazard between members, moral hazard between MPFM and lenders.

For further information, refer to:

<https://www.salga.org.za/dev/miif/Document/Municipal%20Innovation%20infrastructure%20BOOKLET.pdf>.

Box 59. Muzizi Hydro Power Project - Uganda

Energy demand in Uganda is rising due to a steady economic growth and expanding grid connections to private households, commercial and industrial consumers. Uganda is endowed with a significant potential for hydropower generation which can represent a cost-efficient and environmentally friendly alternative to thermal power both in Uganda and in Eastern Africa.

The project consists of the construction of a 45 MW Muzizi hydropower plant in western Uganda with the aim to improve the electricity supply to the growing economy and the households. Muzizi will be developed as a run-of-the-river plant with additional peaking capacity to provide electricity also during daily peak demand. The project includes construction, environmental and social mitigation measures, as well as expert services to support the implementation and monitoring of the project. The hydropower plant will produce 250 GWh per year from renewable sources. It will help to reduce CO₂ emissions and Uganda's reliance on fuel wood for energy, which leads to massive deforestation. Furthermore, the construction of the plant will create approximately 250-300 jobs.

The EU funding will contribute to a timely completion of works and help reduce pressure for increasing tariffs due to currency devaluation, and will therefore contribute affordability of energy for all consumers, in particular low income households.

Lead Financial Institution is KfW with €45m, other investors are AFD with €45m and Government of Uganda with €12.8m. EU contribution: €20.50m.

EU (2018). EFSD The European Fund for Sustainable Development. Promoting investment in the Neighbourhood and Africa. 2017 OPERATIONAL REPORT.

The Agence Française de Développement (AFD) is committed to projects in several sectors (energy, health, biodiversity, water) that improve the lives of people in developing and emerging countries. AFD also extended the range of products and services depending on changes in partners' needs and their priorities. The French Fund for the Global Environment (FFEM) is a specific instrument of bilateral funding dedicated

to the protection of the environment in developing countries, including their municipalities.

The FFEM is also responsible to promote partnerships with research organizations, the private sector, local authorities and NGOs in the context of funding pilot projects. AFD also provides funds for project preparation. These are used to finance feasibility studies and technical assistance in order to prepare future investment projects, mainly with climate co-benefits. These tools are increasingly common and are generally managed by AFD, but they are financed by other donors, mainly the European Union. CICLIA (Cities and Climate change in Sub-Saharan Africa Initiative) is a Regional Facilities addressing the missing link between planning & investment.

Box 60. Africa GreenCo

Among the first 12 Guarantee Tools proposed under the European Fund for Sustainable Development (EFSD) Guarantee, Africa GreenCo is supported by AFD. GreenCo is an independently managed power intermediary which will buy electricity from renewable electricity generation companies, and sell such electricity to both state-owned and private sector companies that buy electricity ('offtakers') mitigating the risk of payment defaults. The AFD and EFSD guarantees would be called if the national power utility failed to make payments when due and GreenCo's liquidity instruments were exhausted. This will enable GreenCo to provide capital protection to commercial lenders to renewable electricity generation companies. The innovative risk mitigation mechanism is expected to attract more investment in renewable energy projects. GreenCo's initial target project size is 5-50MW, in Zambia, Zimbabwe, Botswana, Namibia and other SAPP connected countries. EU delegations, AFD and GreenCo representatives have maintained a close policy dialogue with government representatives on energy related policy matters and intend to deepen this dialogue as part of the implementation of the programme. Local communities will enjoy better access to more reliable and cleaner electricity. Increased electricity access will also help create jobs and raise incomes. Smaller businesses will save money, with lower energy bills as they will no longer have to rely on expensive diesel-powered generators.

EFSD Guarantee: up to €28 m; Technical Assistance: up to €0.9 m; Total investments expected: over €450 m

The EU External Investment Plan Promoting investment in Africa and the European Neighbourhood. Summary of the first 12 Guarantee tools proposed under the European Fund for Sustainable Development (EFSD) Guarantee.

In December 2016, the European Union, Swiss State Secretariat for Economic Affairs (SECO) and AFD launched a 4-year program with EUR 10.5m for urban areas in Sub-Saharan Africa in order to assist them in the implementation of urban projects with climate co-benefits.

CICLIA aims to assist between 20 and 25 Sub-Saharan African cities, over a 4-year period, in the preparation of projects with climate co-benefits. The feasibility and vulnerability studies cover all the urban planning sectors (street lighting, waste management, water management, etc.).

CICLIA is based on three main components:

1. The financing of feasibility and vulnerability studies. These studies aim to generate an investment.
2. Support for existing projects and project implementation to maximize their impact.
3. Support for urban areas in the preparation of their climate strategies. Promoting city climate planning – in articulation with existing initiatives (in particular CoMSSA)

Among the local impacts of the facility there's the accompanying of local governments on the long-term in the definition of low-carbon and climate-resilient urban strategies and in the implementation of these strategies into concrete investments. Through CICLIA local

authorities' needs related to climate change issues are designed for each project, thus adapting their financial and physical size (¹¹⁰).

The C40 Cities Finance Facility (CFF) was launched at the C40 Forum during COP21 in Paris. It supports C40 cities in developing and emerging countries to prepare and deliver sustainable, low carbon and climate adaptation projects. The main aims of CFF include: project preparation of urban climate change projects for sustainable financing; capacity development of city administrations to mobilise and access a broad range of financing instruments; knowledge sharing beyond CFF partner cities via peer-to-peer learning and through other CFF stakeholders; partnerships between cities, investors/financiers and their representations. The CFF is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the United States Agency for International Development (USAID), with additional in-kind assistance from the Inter-American Development Bank (IADB). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and C40 together serve as implementing agencies (¹¹¹).

ICLEI has developed the Transformative Actions Programme which is an incubator/project preparation facility for municipalities. The initiative aims to catalyse and improve capital flows to cities, towns and regions and strengthen their capacity to access climate finance and attract investments (Box 61).

Box 61. Transformative Actions Programme

TAP was launched in 2015 with more than 120 projects submitted by 89 cities. TAP connects local and regional governments, technical experts and financial institutions. Local authorities can be supported to develop bankable projects ready for financing and implementation. These projects would require at least 9 billion US\$. By using the TAP, local and regional governments can benefit from its pipeline, project preparation facility services, platform and advocacy. In particular:

Pipeline:

Collection of TAPplications – demand by local and subnational governments
(Pre-) Project Preparation Facility, providing basic evaluation, feedback and quality check
Ready to go to Support Services

Services:

Project Support Services with TAP partners, including:
Capacity development
Technical support
Pre-feasibility check
Knowledge exchange
Relationship building

Platform:

Visibility and promotion of TAP Projects
Information structured for investors and funders
Promotion of TAP partners
Uniform display and searchable format (by country, by theme, etc.)

Advocacy:

Call for effective financing mechanisms (with CCFLA)
Global visibility for TAP Projects
Call for support to help achieve Paris Agreement and Nationally Determined Contributions (NDCs)

Source: <http://tap-potential.org/>

(¹¹⁰) <https://www.afd.fr/en/project-preparation-funds?prevId=56>

(¹¹¹) <https://www.c40.org/programmes/c40-cities-finance-facility>

WEST AFRICAN DEVELOPMENT BANK (BOAD) has developed an environmental and climate strategy for 2015-2019, with a vision to "making the environment a new growth area for the Bank". By implementing this strategy, BOAD adopted a pragmatic approach for increasing the resilience of vulnerable populations most affected by climate change, and make the environment the strong foundation of sustainable development in the region. The overall objective is to "make environment a new growth mechanism for the Bank. This 2015-2019 environmental and climate strategy outlines BOAD's commitment and the leading role it could play in the implementation of the agenda defined at RIO+20 (¹¹²)

There are various international funds aimed at climate change, some of them also funding RE. The funds in turn are financed by DFI, by multilateral donors or by bilateral donors.

The decision of establishing the Green Climate Fund (GCF) was taken during COP16 in Cancun in 2010 to set up a completely new financing institution governed by the principles of the UNFCCC. The GCF invests in adaptation and mitigation activities in developing countries, managing a project portfolio that is implemented by its partner organisations, known as Accredited Entities. These can be private or public, non-governmental, sub-national, national, regional or international. Accredited Entities carry out a range of activities that usually include the development of funding proposals and the management and monitoring of projects and programmes.

Box 62. Senegal Integrated Urban Flood Management Project

The Senegal Integrated Urban Flood Management project aims at protecting urban areas from flood risk by investing in drainage infrastructures and establishing a national disaster risk management policy.

More frequent intense rainfalls are among the identified hazards in the area, putting at risk of flooding areas and population, in particular in the cities where high shares of population live. Flood management is a major part of the Senegalese government's Disaster Risk Reduction framework, and building resistance to flooding is a top priority within the country's INDC submission.

Both soft and hard measures are to be undertaken. GCF financing will focus on soft measures. Flood risk mapping and assessments on how to increase the resilience of urban areas are carried out. Future risk will be reduced through hazard monitoring, and protocols developed for managing extreme rain events. These actions will be complemented by AFD financing towards hard investments in drainage and sanitation infrastructure in one of the most vulnerable areas of the capital city (Pikine Irrégulier Sud).

The project has an estimated lifespan of 5 years.

The ACCREDITED ENTITY is the Agence Française de Développement (AFD)

The Executing Entities are:

- Ministry of Urban Renewal, Housing and Living Environment (Ministère du Renouveau Urbain, de l'Habitat et du Cadre de Vie – MRUHCV) SENEGAL;
- Senegal National Office for Sanitation (Office National de l'Assainissement du Sénégal – ONAS) SENEGAL;
- National Agency for Civil Aviation and Meteorology (Agence Nationale de l'Aviation Civile et de la Météorologie – ANACIM) SENEGAL;
- Directorate for Water Resource Planning and Management (Direction de la Gestion et la Planification des Ressources en Eau – DGPRE) SENEGAL;
- Investment Promotion and Large Projects Agency (Agence de Promotion de l'Investissement et des Grands Travaux – APIX) SENEGAL.

Insights on this project and other projects and programmes are available at: <https://www.greenclimate.fund/home>

(¹¹²) <https://www.boad.org/portfolio-item/strategie-environnement-et-climat/>

Countries may access GCF resources through multiple entities simultaneously. The GCF overall aim is to reach a shift to low-emission and climate-resilient development, by taking into account the needs of nations that are particularly vulnerable to climate change impacts. The Fund allows the engagement of both the public and private sectors in transformational climate-sensitive investments. A guide on how to access the GCF (GCF 101) is available on the website (<https://www.greenclimate.fund/gcf101>).

An example for a DFI financed fund is the Climate Investment Funds (CIF). It is funded by the World Bank and the regional development banks, including the AfDB. The CIFs include a Clean Technology Fund (CTF) and a Strategic Climate Fund (SCF). The Clean Technology Fund promotes scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings.

Two examples of funds financed by multilateral donors are the Global Environment Facility Trust Fund (GEFTF) (<https://www.thegef.org/>) and the Global Energy Efficiency and Renewable Energy Fund (GEEREF) (<https://geeref.com/>). The GEFTF is one managed by the GEF aiming at helping emerging and developing countries to achieve the goals sets by the United Nations Framework Convention on Climate Change (UNFCCC) and supporting them in climate change mitigation and adaptation. The GEEREF is financed by the European Union, Germany and Norway. It works as a Public-Private Partnership (PPP) to support small and medium size enterprises (SMEs) that invest in energy efficiency and renewable energy.

The Adaptation Fund gives developing countries full ownership of adaptation projects, from planning through implementation, while ensuring monitoring and transparency at every step. The Fund was established under the Kyoto Protocol of the UN Framework Convention on Climate Change and is financed in part by government and private donors, and also from a two percent share of proceeds of Certified Emission Reductions (CERs) issued under the Protocol's Clean Development Mechanism projects. The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing countries that are particularly vulnerable to the adverse effects of climate change. The Adaptation Fund is supervised and managed by the Adaptation Fund Board (AFB). The Adaptation Fund Board Secretariat provides research, advisory, administrative, and an array of other services to the Board. The World Bank serves as trustee of the Adaptation Fund on an interim basis.

AF-funded projects are implemented around the world through accredited National Implementing Entities, Multilateral Implementing Entities and Regional Implementing Entities. The Fund also has a growing Readiness Programme that provides capacity-building workshops, small technical assistance grants and south-to-south cooperation to facilitate accreditation of new implementing entities and reach more vulnerable communities with urgently needed climate adaptation solutions. All funding applicants must submit project proposals through a National Implementing Entity, a Regional Implementing Entity, or a Multilateral Implementing Entity. Proposals also require endorsement by the Designated Authorities of the country in which the proposed activities would take place. More information available at: <https://www.adaptation-fund.org/about/>.

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List of abbreviations and definitions

AC	Air Conditioning
AU	African Union
AFOLU	Agriculture Forestry and Other Land Use
BEI	Baseline Emission Inventory
CCS	Carbon capture and storage
CH ₄	Methane
CHP	Combined heat and power
CO ₂	Carbon dioxide
CO ₂ CHPE	CO ₂ emissions from electricity production in a CHP plant
CO ₂ CHPH	CO ₂ emissions from heat production in a CHP plant
CO ₂ CHPT	total CO ₂ emissions of the CHP plant
CO ₂ EH	CO ₂ emissions related to heat that is exported outside of the territory of the LA
CO ₂ -eq	CO ₂ -equivalents
CO ₂ GEP	CO ₂ emissions due to the production of certified green electricity purchased by the LA
CO ₂ IH	CO ₂ emissions related to imported heat from outside the territory of the LA
CO ₂ LPE	CO ₂ emissions due to the local production of electricity
CO ₂ LPH	CO ₂ emissions due to the local production of heat
CoM SSA	Covenant of Mayors in Sub-Saharan Africa
CoM	Covenant of Mayors for Energy and Climate
COM-EF	CoM default Emission Factors data collection
CTC	Covenant Territorial Coordinators
DSO	Distribution system operator
EC	European Commission
EEA	European Environment Agency
EF	Emission Factor
EFDB	Emission Factor Database
EFE	Local emission factor for electricity
EFH	Emission factor for heat
ELCD	European Reference Life Cycle Database
EMEP	European Monitoring and Evaluation Programme
ENEL	Ente Nazionale per l'Energia Elettrica
EPLCA	European Platform on Life Cycle Assessment
ETS	European Union Greenhouse Gas Emission Trading System
EU	European Union
EU-28	European Union 28 Member States

EUROSTAT	Directorate-General of the EC providing statistical information to the institutions of the EU
GCoM	Global Covenant of Mayors
GEP	Green electricity purchases by the local authority
GHG	Greenhouse gas (only refers to N ₂ O, CH ₄ , CO ₂ in this report, if no explicit list)
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventory
GPG	Good practice guidance
GWP	Global Warming Potential
HDD	Heating Degree Days
HDDAVG	Heating Degree Days In An Average Year
ICLEI	Local Governments for Sustainability
IEA	International Energy Agency
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre of the European Commission
LA	Local Authority
LAU	Local administrative unit
LCA	Life Cycle Assessment
LDC	Least developed countries
LED	Light emitting diodes
LEP	local energy production
LHC	local heat consumption
LHC_TC	temperature corrected local heat consumption
LPE	Local Production Of Electricity
LULUCF	Land Use Land Use Change and Forestry
MEI	Monitoring Emission Inventory
MEI	Monitoring Emission Inventory
MESHARTILITY	Measure and share data with utilities for the Covenant of Mayors
N ₂ O	Nitrous Oxide
NACE	Statistical classification of economic activities in the European Community
NAPA	National Adaptation Programme of Action
NCG	National Coordination Group
NCV	Net calorific value
NDCs	Nationally Determined Contributions
NEEFE	National or European Emission Factor for Electricity consumption
NUTS	Nomenclature of territorial units for statistics
OECD	Organisation for Economic Co-operation and Development
PCD	Political Commitment Document

PKM	Passenger-kilometre
PV	Solar photovoltaic installation
RES	Renewable energy sources
RVA	Climate Change Risk and Vulnerability Assessment
SDG	Sustainable Development Goals
SEACAP	Sustainable Energy Access and Climate Action Plan
TCE	Total electricity consumption in the territory of the local authority
UNFCCC	United Nations Framework Convention on Climate Change
VKT	Vehicle-Kilometres Travelled

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Annexes

Annex 1. List of countries

Global Regional Coherence Technical Working Group (not Algeria, Egypt, Libya, Tunisia, Morocco, included in the CoM South; Western Sahara, Mayotte, French Southern Territories, British Indian Ocean Territory). Total of 49 countries.

Definition of regions varies. In the present document, we will refer to the four regions (Southern, East, West and Central) situated south of the Sahara desert, as defined by the African Union, with the exception of Mauritania (included in North Africa by the AU). 10 countries Southern, 14 East, 9 central and 16 West (15 plus Mauritania).

Name	Capital	Region
Burundi	Bujumbura	Central
Cameroon	Yaounde	Central
Central African Republic	Bangui	Central
Chad	N'Djamena	Central
Congo Republic	Brazzaville	Central
DR Congo	Kinshasa	Central
Equatorial Guinea	Malabo	Central
Gabon	Libreville	Central
São Tomé and Príncipe	São Tomé	Central
Comoros	Moroni	East
Djibouti	Djibouti	East
Eritrea	Asmara	East
Ethiopia	Addis Ababa	East
Kenya	Nairobi	East
Madagascar	Antananarivo	East
Mauritius	Port Louis	East
Rwanda	Kigali	East
Seychelles	Victoria	East
Somalia	Mogadishu	East
South Sudan	Juba	East
Sudan	Khartoum	East
Tanzania	Dodoma	East
Uganda	Kampala	East
Angola	Luanda	Southern
Botswana	Gaborone	Southern
Lesotho	Maseru	Southern
Malawi	Lilongwe	Southern
Mozambique	Maputo	Southern
Namibia	Windhoek	Southern
South Africa	Pretoria	Southern
Swaziland	Mbabane	Southern
Zambia	Lusaka	Southern
Zimbabwe	Harare	Southern
Benin	Porto-Novo	West
Burkina Faso	Ouagadougou	West
Cabo Verde	Praia	West
Côte d'Ivoire	Yamoussoukro	West
Gambia	Banjul	West
Ghana	Accra	West
Guinea	Conakry	West
Guinea-Bissau	Bissau	West
Liberia	Monrovia	West
Mali	Bamako	West
Niger	Niamey	West
Nigeria	Abuja	West
Senegal	Dakar	West
Sierra Leone	Freetown	West
Togo	Lomé	West
Mauritania	Nouakchott	West

Annex 2. Sub-Saharan countries' Nationally Determined Contributions (NDCs)

COUNTRY	MITIGATION	ADAPTATION
Angola	Angola plans to reduce GHG emissions up to 35% unconditionally by 2030 as compared to the Business As Usual (BAU) scenario (base year 2005). In addition, it is expected that through a conditional mitigation scenario the country could reduce an additional 15% below BAU emission levels by 2030. In achieving its unconditional and conditional targets Angola expects to reduce its emissions trajectory by nearly 50% below the BAU scenario by 2030 at overall cost of over 14.7billion USD.	Given to its extreme vulnerability to Climate Change impacts in some key economic sectors, Angola's INDC also includes priority Adaptation actions that will enable the strengthening of the resilience of the country towards the attainment of the Long Term Strategy for Development of Angola (2025). Angola prioritises the implementation of Adaptation measures in the following main sectors: agriculture, coastal Zone, Land-Use, Forests, Ecosystems and Biodiversity, Water resources and Health.
Benin	The implementation of the proposed measures is likely to help reduce greenhouse gas emissions by about 21.4% relative to a BAU scenario by 2030 (excluding LULUCF). The unconditional contribution corresponds to a 3.5% GHG emissions reduction relative to the BAU scenario by 2030. The conditional contribution would allow for an additional emissions reduction of 17.9%.	As part of its National Climate Change Management Program, Benin has developed levels of organization for the monitoring and assessment of climate change vulnerability and adaptation, aimed at giving the program a national piloting committee, a departmental and communal referral committee and intersectoral technical committees to provide general guidance and to monitor climate vulnerability and actions on adaptation / mitigation to climate change. The overall objective of Benin's INDC on adaptation is to increase efforts to reduce the vulnerability of human systems to the impacts of climate change and to increase the resilience of ecosystems in the context of global warming.
Botswana	Botswana intends to achieve an overall emissions reduction of 15% by 2030, taking 2010 as the base year.	As semi-arid country Botswana is vulnerable to the impacts of climate change and places high priority on adaptation to reducing vulnerability. Botswana is developing a National Adaptation Plan (NAP) and Action Plan that will highlight all the priority areas including Climate Smart Agriculture which include techniques such as low to zero tillage, multi-cropping to increase mulching which reduce evapotranspiration and soil erosion. The development of the NAP calls for a broader stakeholder consultation so that the products of this process represent the views and aspirations of all the stakeholders and respond to their needs. This will be informed by already exiting climate change information, socio-economic

and development indicators, local experiences as well as existing policies, plans and institutional frameworks. National Adaptation Plan development is coordinated by Ministry of Environment Wildlife and Tourism, with support from the National Committee on Climate Change.

Burkina Faso

The objective of the unconditional scenario is to reduce GHG emissions by 7,808 Gg per year in 2030, i.e. 6[.6]% when compared to BaU, for ongoing investments of US \$1.25 billion. A Hybrid Conditional scenario, which aims to reduce GHG emissions by 11.6%, which corresponds to 13,766 Gg per year in 2030, for investments of US \$756,032,667.

An unconditional pledge to reduce emissions by 6.6% below business-as-usual levels by 2030, with a further 11.6% reduction conditional upon international support. Includes interim pledges for 2020 and 2025. Includes section on adaptation, where actions proposed would reduce emissions by a further 36.95%, taking the total reductions up to a potential 55.15% below business-as-usual levels.

A third scenario, Adaptation, which aims, among other things, to restore and develop 5,055 million ha of degraded lands at the 2030 horizon, corresponding to 55% of the total current area of degraded lands in the country and making it possible to feed more than 6 million additional persons at the 2030 horizon. Moreover, these adaptation projects will contribute to a reduction in GHG emissions of 43,707 Gg of CO₂, i.e. 36.95% when compared to BaU, for an overall investment of US \$5,804,949,915.

The objectives, results and outputs expected from the Strategic Framework for Investment in Sustainable Land Management (SFI-SLM) broadly coincide with the themes classified as priority within the National Adaptation Plan (NAP). Because it has defined quantitative goals for the country at the 2025 horizon in the sectors of the sustainable management of natural resources (GDRN), as well as their costs, the SFISLM may be considered as an operational action plan for adaptation in the sectors of agriculture, animal husbandry, forests and land use, water management and biomass energy

Burundi

Unconditional contribution: Reduction of greenhouse gas emissions by 3% compared to the business-as-usual (BAU) scenario for 2030.

Conditional contribution: Reduction of GHG by 20%, beginning in 2016, compared to the business-as-usual scenario for 2030

Unconditional objective: Under the National Reforestation Programme, Burundi has undertaken to increase its carbon dioxide gas well through 4,000 hectares of annual

Studies conducted for the initial national communication on climate change and the evolution of climate parameters in Burundi through 2050, based on the general circulation model, show that the average annual temperature will increase by 1°C to 3°C. Rainfall will rise by roughly 10%, and the precipitation regime will be disrupted such that there will only be two seasons remaining, each lasting six months: a rainy season from November to April, followed by a dry season. These climate changes will engender a large number of risks associated with the following phenomena: (i) season creep; (ii) flooding of swamps and lowlands; (iii) land degradation and loss of soil fertility; (iv) shortage of groundwater resources; (v) extreme weather events (hail, violent showers, heavy winds, etc.); (vi) changes to the growing seasons of crops and forests; and (vii) unpredictable movements of pests.

	reforestation over the course of 15 years, beginning in 2016. Conditional objectives: a) Forestry: (i) reforestation of 8,000 ha/year during 15 years, beginning in 2016; (ii) replacement of 100% of traditional charcoal kilns and traditional home ovens by 2030; b) Agriculture: gradual replacement of 100% of mineral fertilizers with organic fertilizer by 2030	According to an integrated analysis of Burundi's vulnerability, conducted as part of the ACCES (Climate Change Adaptation for Soil and Water Resources Conservation) Project, it was found that the country's "hotspots of vulnerability" are located in the north and northwest. The slope of the ridge (and not the ridge itself) leading to the Imbo Plain to the west, the topographical structures to the north and the central plateau are the regions most vulnerable to erosion. The main causes are the highly variable relief and the pronounced sensitivity of those regions to climate variability"
Cabo Verde	Cabo Verde's mitigation contributions are expressed in the form of Renewable Energy (RE) and Energy Efficiency (EE) Targets and other Nationally Appropriate Mitigation Actions (NAMAs)	Key strategic axes: - Promoting integrated water resources management, guaranteeing stable and adequate water supply (for consumption, agriculture, ecosystems and tourism); - Increasing adaptive capacities of agro-silvo-pastoral production systems in order to ensure and improve national food production and promoting Cabo Verde's ocean-based ("blue") economy; - Protecting and preventing degradation of coastal zones and their habitat.
Cameroon	Reducing GHG emissions by 32% compared to a reference scenario for the target year (2035), and conditional on the support of the international community in the form of financing, capacity building, and technology transfers.	In June 2015 Cameroon approved a National Adaptation Plan for Climate Change (NAPCC), which includes, among others, an assessment of climatic changes in all five agro-ecological areas, a sensitivity, vulnerability and sectoral and geographical resilience assessment, a 2016-2025 intervention strategy, an evaluation of losses, risks and gaps, and a five-year action plan for 2016-2020 outlining 20 detailed projects. The vision of the PNACC is that in 2035: "climate change in the five agro-ecological zones of Cameroon will be fully integrated into the sustainable development of the country, reducing its vulnerability, and even transforming the problem of climate change into a solution / opportunity for development. Thus Cameroonians - particularly women, children and vulnerable people - and economic sectors of the country will gain greater resilience and a greater ability to adapt to the adverse impacts of climate change".

Central African Republic	The Central African Republic aspires to reduce its emissions by 5% and 25%, respectively, in the 2030 and 2050 horizons in comparison to its reference BaU emissions and to increase its sequestration potential. With international support, it will emit around 33,076.1 kt eq-CO₂ less in 2050 than the annual reference emissions.	Objectives: Agriculture and food security, health, basic infrastructure and sustainable management of natural resources, with the aim of maintaining an annual rate of growth of agricultural activities of 6% and stabilisation of the rate of food insecurity at 15%. Vulnerability profile: Extreme hazards (torrential rains, floods and drought), most vulnerable areas (south, north and northeast) and most vulnerable populations (women, children, indigenous peoples and the aged, i.e. around 75%). Sectors of priority activities: Agriculture and food security, forestry, energy, public health, water resources and land-use planning. Adaptation options: Adjustment of the policy framework, improved knowledge of resilience to climate change, sustainable management of the agricultural, forestry and animal husbandry systems, land-use planning, improvement and development of basic infrastructures, guarantee of energy security, improvement of public health systems, improvement of waste management and sustainable management of water resources.
Chad	Unconditional emissions reduction of 18.2% compared to the baseline in 2030, or about 41,700 GgCO₂e. Conditional emissions reduction of 71% in 2030, or a cumulative reduction of 162,000 GgCO₂e.	In order to reduce vulnerability and increase resilience, adaptation needs concern human capacity building, institutional, technical, financial support and technology transfer.
Comoros	The Union of the Comoros aims to reduce its greenhouse gas emissions by 84% by 2030 relative to reference scenario emission levels in the same year. This reduction includes sinks from the Land Use, Land-Use Change, and Forestry (LULUCF) sector	
Congo, Dem Rep	The DRC commits to reduce its emissions by 17% by 2030 compared to business-as-usual emissions (430 Mt CO₂e), or a reduction of slightly more than 70 Mt CO₂e avoided (Ministry of the Environment, 2009).	

Congo, Rep	In a conditional, low-carbon scenario, the contribution of the Republic of Congo should reduce GHG emissions by about 48% in 2025 (or 8 MtCO₂e) and by 54% in 2035 (or 19 MtCO₂e) compared to the baseline scenario and depending on the support of the international community. The vision of the Republic of Congo on climate change adaptation is based on the integration of this component into a coherent investment scheme and development strategy in the country, rather than aid or isolated grants unrelated to its strategy. This is the vision contained in Congo's National Development Program (NDP 2012-2016): "Accelerate the modernization of society and industrialization of the country." Our objective is to generate growing and shared prosperity as the foundation for Congo's emergence in the global economy.
Cote d'Ivoire	Reduction of 28% in GHG emissions compared to emissions in the target year (2030) in a baseline scenario (BAU or Business As Usual).
Djibouti	Through unconditional measures, the Republic of Djibouti commits to avoid 1.8 MtCO₂e of future emissions, reducing its emissions by 40% compared to the reference scenario. Implementing conditional measures would enable the reduction of an additional 0.9 MtCO₂e, or 20% of GHG emissions by 2030 compared to the reference scenario. The conditional mitigation scenario would therefore allow the Republic of Djibouti to maintain its level of emissions at the equivalent of 2010 levels. National priorities for adaptation have therefore been identified up until 2035 and are based on several strategies. Regarding adaption these are about: • Reducing vulnerability against droughts • Protecting against sea level rise • Improving access to water • Protecting biodiversity • Reinforcing the resilience of rural populations.
Equatorial Guinea	Equatorial Guinea's ambition is to reduce emissions by 20% by 2030, relative to 2010 levels, in order to achieve a 50% reduction by 2050.

Ethiopia	Ethiopia intends to limit its net greenhouse gas (GHG) emissions in 2030 to 145 Mt CO₂e or lower. This would constitute a 255 MtCO₂e reduction from the projected 'business-as-usual' (BAU) emissions in 2030 or a 64% reduction from the BAU scenario in 2030. In the long term, Ethiopia intends to achieve its vision of becoming carbon-neutral, with the mid-term goal of attaining middle-income status.	Ethiopia also intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment and economy to the adverse effects of climate change, based on its Climate Resilient Green Economy Strategy (CRGE).
Eritrea	The government of the State of Eritrea is committed to reduce the CO₂ emissions from fossil fuels by 23.1% in 2020, 30.2 % by 2025 and 39.2% by 2030 visa-vis to the reference year. If additional support is solicited, it can be further reduced by 36.4 % in 2020, 61.1% by 2015* and 80.6% by 2030. The BAU scenario for all GHG gases expected to increase to: 5 MtCO₂eq in 2020, 5.5 MtCO₂eq in 2025 and in 2030 6.3 MtCO₂eq. Therefore, Eritrea intends to limit its net greenhouse gas (GHGs) emissions in 2030 to less than 3.9 MtCO₂eq. This would constitute a 39% reduction from the projected 'business-as-usual' (BAU) emissions in 2030 or 80.6% reduction from the reducible BAU scenario in 2030. The BAU scenario for all fossil fuel CO₂ emission expected to increase 1.7 MtCO₂ in 2020, 2.2 MtCO₂ in 2025 and in 2030, 3 MtCO₂. Unconditional mitigation scenario: With internal resources Eritrea can implement its unconditional scenario reaching 1.3	Eritrea communicated information on adaptation contributions for the following categories: agricultural and forestry development, water resources development, land resource management, public health and marine resources development.

	MtCO₂ in 2020, 1.6 MtCO₂ in 2025 and 1.9 MtCO₂ in 2030 from fossil fuel CO₂. Conditional mitigation scenario: With external assistances Eritrea can implement its conditional scenario reaching 1.1 MtCO₂ In 2020, 0.9 MtCO₂ in 2025 and 0.6 MtCO₂ in 2030 from fossil fuel CO₂"
Gabon	Gabon commits to reduce GHG emissions by at least 50 % from baseline scenario emissions in 2025. The commitment could be extended to 2030 and 2050 based on additional studies that will be carried out by COP21. The commitment is to be achieved excluding carbon stocks from forests from the target. Gabon also submitted annexes describing land-use change, flaring from the oil industry, energy, other GHG emissions such as waste, adaptation, and financing. Gabon's vision for adaptation is based on integrating this component in a strategic investment plan based on the development strategy of the country, rather than on one-time aid or subsidies unrelated to the strategy. To this end, Gabon has a National Adaptation Strategy focused on coastal adaptation to climate change. The strategies focus on coastal management, such as establishing a legal framework, tools for data collection and training and information. Gabon's commitment to take action against climate change recognizes the need to take adaptation into account.
Gambia	Activity/Sector based commitment, including unconditional mitigation actions in afforestation and renewable energy, and conditional reductions in agriculture, energy, transport and waste sectors. With individual baselines developed for each sector, "excluding LULUCF and for Low Emissions Scenario, overall emissions will be reduced by about 44.4% in 2025 and 45.4% in 2030. Adaptation (national, sub-national and sectoral levels): In the short-term, for The Gambia to transition to a low-emissions and climate resilient development pathway, Government intends to adopt specific enabling conditions which must consist of national regulations, policies, subsidies and incentives, as well as international market and legal infrastructure, trade and technical cooperation. This will be achieved through intensive and extensive education, awareness raising and development and implementation of socio-economic research as it relates to climate change. Currently, enabling conditions are heavily weighted towards, and encourage, the prevailing brown economy, which depends excessively on fossil fuels, resource depletion and environmental degradation. In the medium- and long-term, the Government must continue the mainstreaming of climate change into national development frameworks as achieved for the medium-term strategy – the Programme for Accelerated Growth and Employment (PAGE) and some sectorial policies and strategies (the Agriculture and Natural Resources Policy, the Forest Policy and the Fisheries Strategic Action Plan) by adjusting all national and sectorial policies to take

		climate change into consideration. With appropriate changes in the policies, including fiscal policy, the fostering of public investments to green key sectors (agriculture, energy, water resources, waste management, etc.); employment of new market-based instruments; greening public procurement; improving environmental rules and regulations, as well as their enforcement; improving trade and aid flows; and fostering greater international cooperation can be easily achieved.
Ghana	Ghana's emission reduction goal is to unconditionally lower its GHG emissions by 15 percent relative to a business-as-usual (BAU) scenario emission of 73.95MtCO₂e by 2030. An additional 30 percent emission reduction is attainable on condition that external support is made available to Ghana to cover the full cost of implementing the mitigation action (finance, technology transfer, capacity building). With this external support, a total emission reduction of 45% below the BAU emission levels can be achieved by 2030.	The following priority adaptation policy actions will be implemented in order to achieve Ghana's INDC adaptation goal: • Agriculture resilience building climate vulnerable landscapes • Value addition-based utilization of forest resources • City-wide resilient infrastructure planning • Early warning and disaster prevention • Managing climate-induced health risk • Integrated water resources management • Resilience for gender and the vulnerable
Guinea	Estimated level of mitigation: -13% greenhouse gas (GHG) emissions in 2030 as compared to 1994 (Initial National Communication of the Republic of Guinea), excluding Land-Use Change and Forestry (LUCF)	Guinea finalized its National Adaptation Plan of Action (NAPA) in 2007, having identified the following vulnerable sectors: crop and livestock farming; water; and the coastal and forest zone. The NAPA also helped to identify the groups most vulnerable to climate change in different regions of the country, including in particular poor communities in rural areas such as farmers and small producers (men and women) and people whose livelihood mainly depends on the use of natural resources (hunters, fishermen, salt producers, etc.). Guinea has ratified the other two Rio conventions and put together national strategies to combat desertification and soil degradation, as well as conserve biodiversity. Implementation of these two strategies will also facilitate adaptation to climate change.

Guinea-Bissau	Guinea Bissau's mitigation contribution includes the implementation of policies and planned actions in forestry and energy sectors. I. Establish and schedule a new forestry policy; II. Conduct studies on the energy potential of the country and set the energy development incorporating the largest possible potential of renewable energies in the energy mix; III. Develop and establish a legal framework through a national strategy for long-term low-carbon development.	
Kenya	Kenya seeks to undertake an ambitious mitigation contribution towards the 2015 Agreement. Kenya therefore seeks to abate its GHG emissions by 30% by 2030 relative to the BAU scenario of 143 MtCO₂eq; and in line with its sustainable development agenda. This is also subject to international support in the form of finance, investment, technology development and transfer, and capacity building.	The priority adaptation actions are presented in the National Climate Change Action Plan NCCAP and further elaborated in the National Adaptation Plan NAP. The actions are based on risk and vulnerability assessments across the MTP sectors. Many of the actions have strong synergies with mitigation actions. Kenya's capacity to undertake strong mitigation actions is dependent upon support for the implementation of these adaptation actions. Kenya will ensure enhanced resilience to climate change towards the attainment of Vision 2030 by mainstreaming climate change adaptation into the Medium Term Plans (MTPs) and implementing adaptation actions. Any reasonable achievement of the adaptation goal will require financial, technology and capacity building support.
Lesotho	Lesotho is committed to reduce unconditionally 10% of its GHG emissions by 2030 compared to a Business-As-Usual (BAU) scenario. The conditional target is 35% by 2030.	Lesotho does not have an officially expressed medium to long term national adaptation plan to climate change. However, our aspirations are expressed explicitly or implicitly in all policy documents, and NSDP. The apparent national adaptation goal (s) towards 2030 embraces all tenets of the MDGs which seek to reduce and /or facilitate national resiliency against climate change shocks especially production decline leading to food insecurity; gender vulnerabilities to climate-change-related impacts especially natural resources e.g. declining quantity and quality of drinking water; environmental degradation; erosion of basic support systems for majority of livelihoods. These are implicit aspects of a long term national adaptation vision to be refined in the national adaptation plan in the pipeline

Liberia	Liberia's mitigation contribution is to reduce total GHG emissions by 15% below a Business-As-Usual trajectory by 2030, through the implementation of four mitigation actions.	Liberia's adaptation contribution is to implement actions in seven key sectors - agriculture, energy, health, forestry, coastal zone, fishery, and transport/infrastructure.
Madagascar	In 2030, Madagascar aims to reduce approximately 30 MtCO ₂ of its emissions of GHG, representing 14% of national emissions, compared to the BAU scenario, with projections based of GHG inventory from year 2000 to 2010. This reduction is additive to the absorptions increase of the LULUCF sector, which estimated at 61 MtCO ₂ in 2030. Total increase in GHG absorption is expected at 32%, compared to the BAU scenario.	The general approach adopted to identify adaptation measures was concentrated on the sectors or areas regarded as most vulnerable to climate change. Although sectorial, these actions and their impacts are of national scope. They deal particularly on the impacts of climatic hazards that mostly affect the country, i.e. cyclones, floods, drought, sea-level rise, whose intensities are exacerbated by climate warming observed both at national and global levels. Adaptation measures were frameworked by the Politique Nationale de Lutte contre le Changement Climatique that has been developed in 2010. This national policy has as first strategic target to "Strengthen adaptation to climate change, considering Madagascar's realistic needs.
Malawi	The Government of Malawi communicated mitigation and adaptation actions in its INDC, some of which will be implemented unconditionally using domestic sources; and some of which are conditional on external support in terms of capacity building, technology development and transfer, and financial resources.	
Mali	The GHG mitigation scenario's emission reduction levels, relative to the baseline scenario, are: 29% for agriculture, 31% for energy, and 21% for forests and land-use change.	To ensure sustainable development, adaptation to climate change is needed in all development sectors. It is in this context that Mali has developed several policies, strategies and action plans incorporating national guidelines on adaptation in reference to the Strategic Framework for Growth and Poverty Reduction. These programs are being reviewed to develop Mali's National Adaptation Plan (NAP) to climate change by 2030 to better guide and coordinate actions.

Mauritania	The Islamic Republic of Mauritania intends to contribute to the Paris Climate Agreement by reducing its greenhouse gas emissions by 22.3% in 2030 or by 4.2 million tons of carbon dioxide equivalent (MtCO₂e) compared to projected emissions for the same year in a business as usual scenario, which would increase from 6.6 MtCO₂e in 2010 to 18.84 MtCO₂e in 2030. Thus, for the period from 2020 to 2030 avoided accumulated emissions by the proposed mitigation measures are about 33.56 MtCO₂e. 12% of this contribution is unconditional and will be achieved with Mauritania's own means. 88% of the contribution is conditional on international support.	
Mauritius	The Republic of Mauritius imperatively needs international technical and financial support to enable it to abate its greenhouse gas emissions by 30%, by the year 2030, relative to the business as usual scenario of 7 million metric tonnes CO₂ equivalent.	
Mozambique	Mozambique communicated its mitigation contribution in the form of actions (policies/programmes) and also included an adaptation component in its INDC.	
Namibia	Namibia aims at a reduction of about 89% of its GHG emissions at the 2030 time horizon compared to the BAU scenario. The projected GHG emissions to be avoided in 2030 is of the order of 20000 Gg CO₂-eq inclusive of sequestration in the AFOLU sector and compared to the BAU scenario.	Namibia is still to prepare its NAP and as such has not yet developed an advanced adaptation strategy and plan. Yet, past experiences of disastrous climate change impacts have obliged government to incorporate climate change adaptation in the development agenda. While the near term vision is prevention and repair, the long term goals and targets are to instill resilience to impacts of climate change in the most vulnerable sectors of the economy. This is a necessity as climate change is a reality in the everyday life of all Namibians.

Niger	Unconditional reduction of 2.5% (BAU 2020) and of 3.5% (2030). Conditional Reduction of 25% (BAU 2020) and 34.6% (2030, or a reduction of 33,400 GgCO ₂ Eq).	National priorities related to the AFOLU sector focus on improving the resilience of the agriculture, livestock and forestry sub-sectors. Other priorities include water resources, fisheries, wildlife, health care, and the capacity building of stakeholders at all levels. Adapting to climate change is a challenge for the country. To achieve this, Niger's adaptation techniques will include sustainable land management (SLM CS-2014), and renewable energy and energy efficiency. Because of its relevance and its outcome, the CS-GDT is chosen as the reference document for the INDC.
Nigeria	Nigeria can make a significant additional contribution with international support, in the form of finance and investment, technology and capacity building. The combined policies and measures described below can deliver in a cost-effective manner direct development benefits to the country and reduce emissions 45 % below BAU.	Nigeria's response to climate change has focused on increasing resilience and managing the unavoidable impacts. The National Adaptation Strategy and Plan of Action for Climate Change Nigeria (NASPA-CCN) describes our adaptation priorities, bringing together existing initiatives and priorities for future action To this end, a set of thirteen sector-specific strategies, policies, programmes and measures have been prepared, which are included in the INDC. The objectives of these are to reduce the impacts of climate change through adaptation measures that can be undertaken by the Federal, State and Local Governments, civil society, private sector, communities and individuals.
Rwanda	Emission reductions from projected emissions resulting from the deviation of BAU emissions for the year 2030 based on policies /actions conditional on availability of international support for finance, technology and capacity building.	The priority adaptation actions have been identified in Rwanda's Green Growth and Climate Resilient Strategy (2011), are on-going and will be partially or fully achieved by 2050. Many of the actions specified under the sectors programmes have both mitigation and adaptation benefits.
Sao Tome and Principe	Lists a series of actions that it will take to reduce emissions below business as usual levels, conditional upon international support, though does not set a number of the level of reductions.	
Senegal	Under the unconditional scenario (INDC) emission reductions relative to baseline projections will be 3%, 4% and 5% in 2020, 2025 and 2030 respectively. Under the	All the sectors targeted for the revival of the Senegalese national economy, such as agriculture, livestock, fisheries, tourism, health care, nutrition, and access to water, which form the backbone of the PES, remain vulnerable to the impacts of

conditional scenario (INDC+), expected emission reductions will be 7%, 15% and 21% for the same years.

climate change.

Structuring options such as coastal protection works, retention basins, small dams, technologies that fight against land degradation, and drinking water systems have been put in place to mitigate their vulnerability and to reduce their negative impact on populations. However, in light of future climate projections and the inventory of biophysical, environmental and socio-economic systems, it is necessary to scale up appropriate practices.

To this end, the adaptation component, beyond the development of the INDC, is a national concern. Senegal aims to integrate adaptation to climate change in the formulation of development programs for other political priorities such as the fight against poverty, health care and National Programs for the Fight against HIV AIDS, malaria, tuberculosis, etc., to ensure a trajectory of growth.

Seychelles

The Republic of Seychelles will reduce its economy-wide absolute GHG emissions by 122.5 ktCO₂e (21.4%) in 2025 and estimated 188 ktCO₂e in 2030 (29 %) relative to baseline emissions. A 29% reduction in greenhouse gases by 2030, compared to 2010-12 levels, which is conditional on international climate finance.

As a Small Island Developing State (SIDS), the republic of Seychelles is vulnerable to the impacts of climate change and climate variability, and it gives priority concern for adaptation to climate change as communicated in this INDC. Given that the Republic of Seychelles is a net sink, its contributions to climate change mitigation to contribute towards the objectives of the UNFCCC will be the co-benefit of enhancing its energy security and reducing its energy bill.

Sierra Leone

It is against this backdrop, that this INDC intends to maintain the emission levels of Sierra Leone relatively Low (close to the world average of 7.58 MtCO₂e) by 2035 or neutral by 2050 by reducing her carbon footprint and by following green growth pathways in all economic sectors. Also presents an intensity based reduction target of 25% and 35%, to be achieved in 2020-2030 and 2030-2050 respectively, compared to 1990 levels.

Includes sections on adaptation and loss and damage.

Somalia	Somalia communicated nine "ready for implementation and planned adaptation and mitigation INDCs projects" in its INDC Outlines a number of projects relating to adaptation and mitigation, aimed at sustainable land management, water resource management, reducing risk from natural disasters, and sustainable charcoal production.	See Somalia's full INDC submission for additional information on "Climate, Ecology and the Status of the Environment", "Disasters in Somalia and the Needed Policies and Actions", "Importance of Livestock, Crop, Fisheries and Wildlife", "Environmental Challenges Resulting from Charcoal Production and Export", "Renewable Energy Potential Mitigation and Adaptation", "Solar Energy", "Hydroelectric", Wind", etc.
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South Africa	Takes a peak, plateau and decline ("PPD") approach to emissions. Aims to peak between 2020 and 2025, plateau for roughly a decade and then start to fall. Emissions during 2025-2030 will be in the range 398-614 million tonnes of CO₂ equivalent, including land and all sectors of the economy. Emissions were 461MtCO₂e in 2000.	The adaptation component of South Africa's INDC will address adaptation through six goals, underpinned by key elements of adaptation planning, costing of adaptation investment requirements, equity, and means of implementation. The six goals are: Goal 1: Develop a National Adaptation Plan, and begin operationalisation as part of implementing the NCCRP for the period from 2020 to 2025 and for the period 2025 to 2030 Goal 2: Take into account climate considerations in national development, sub-national and sector policy frameworks for the period 2020 to 2030 Goal 3: Build the necessary institutional capacity for climate change response planning and implementation for the period 2020 to 2030 Goal 4: Develop an early warning, vulnerability and adaptation monitoring system for key climate vulnerable sectors and geographic areas for the period 2020 to 2030, and reporting in terms of the National Adaptation Plan with rolling five year implementation periods Goal 5: Development of a vulnerability assessment and adaptation needs framework by 2020 to support a continuous presentation of adaptation needs Goal 6: Communication of past investments in adaptation for education and awareness as well as for international recognition
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South Sudan	Plans to increase use of clean and carbon-neutral energy, deploying them “whenever possible”. Also aims to plant 20 million trees. Is developing a national adaptation plan. Conditional on international support, with estimated needs of \$50bn to 2030.	The climate vulnerability of South Sudan’s abundant, unexploited natural resources makes it pertinent for the country’s INDC to comprise both Mitigation and Adaptation components, based on its national circumstances and in alignment with decisions 1/CP 19 and 1/CP20. South Sudan aims to undertake the policies and actions in following sectors: energy generation and use; Land Use and Land use Change; and Transport, to address its future emissions that are likely to result from growth strategies. These efforts are contingent on availability of technical assistance to develop the necessary regulations, policies, and standards as well as financial support for investing in low carbon options.
Sudan	Sudan intends to pursue implementing low carbon development interventions in three sectors of energy, forestry and waste in line with Sudan’s national development priorities, objectives and circumstances. To reach 20% renewable share in the power mix by 2030. Includes detailed per-technology aims and targets for energy efficiency. Aims to raise forest area to 25% of Sudan by 2030.	
Swaziland	Aims to double the renewable share of its energy mix by 2030, compared to 2010 levels. Also pledges to develop a national emissions inventory, baseline and business as usual projections, in order to draw up a national mitigation goal by 2020.	Aims to develop a national adaptation plan by 2020.
Tanzania	Tanzania will reduce greenhouse gas emissions economy wide between 10-20% by 2030 relative to the BAU scenario of 138 - 153 Million tons of carbon dioxide equivalent (MtCO ₂ e)- gross emissions, depending on	Tanzania will embark on a climate resilient development pathway. In doing so the adaptation contributions will reduce climate related disasters from 70% to 50%, and significantly reduce the impacts of spatial and temporal variability of declining rainfall, frequent droughts and floods which have long term implications to all productive sectors and ecosystems, particularly the agricultural sector.

	the baseline efficiency improvements, consistent with its sustainable development agenda. The emissions reduction is subject to review after the first Biennial Update Report (BUR).	Access to clean and safe water will be increased from 60% to 75% and, based on a conservative and a worst-case scenario of 50cm and 1m sea-level rise, the contributions will verifiably reduce the impacts of sea level rise to the island and coastal communities, infrastructure and ecosystems.
Togo	Unconditional target: an 11.14% reduction of GHG emissions relative to the baseline scenario. Conditional target level: a 31.14% reduction of GHG emissions relative to the baseline scenario.	Togo intends to contribute to the fight against climate change by strengthening the resilience of its production systems and means by embarking on a carbon-lean development path. This vision is in line with international commitments and national strategic orientations relating to the need for fair, inclusive growth that responds to the challenges of sustainability, creates decent jobs, helps to reduce poverty, and protects natural resources. These key points are also included in the National Adaptation Programme of Action (NAPA) for climate change, produced in December 2008 and whose objectives relate to: (i) the protection of human lives and livelihoods, resources, infrastructure and the environment; (ii) the identification of grassroots communities' urgent, immediate needs for adaptation to the harmful impacts of climate change and variability; and (iii) the incorporation of adaptation measures and objectives into sectoral policies and national planning.
Uganda	For mitigation, Uganda is to focus on implementation of a series of policies and measures in the energy supply, forestry and wetland sectors. In the business-as-usual (BAU) scenario the estimated emissions in 2030 will be 77.3 Million tons of carbon dioxide equivalent per year (MtCO₂eq/yr). The estimated potential cumulative impact of the policies and measures could result in approximately 22% reduction of national green house gas emissions in 2030 compared to business-as-usual. Uganda proposes to implement the identified policies and measures, and their impact may be higher or lower than these estimations illustrate.	The livelihood of the people of Uganda is highly dependent on the exploitation of her natural resources, including climate. In submitting this INDC, Uganda's priority is adaptation. The country will continue to work on reducing vulnerability and addressing adaptation in agriculture and livestock, forestry, infrastructure (with an emphasis on human settlements, social infrastructure and transport), water, energy, health and disaster risk management. Sustainable Land Management (SLM) and Climate Smart Agriculture (CSA) will be scaled up to increase resilience at the grassroots level.

Zambia	An unconditional 25% emissions cut in 2030, compared to business as usual, equivalent to holding emissions steady. A higher 47% reduction against business as usual emissions is conditional on international support.	Zambia's adaptation measures comprise 3 goals/programs and 11 priority actions. The adaptation measures are applicable to the following sectors: Agriculture; Water; Forestry; Energy; Wildlife; Infrastructure; and Health. These have been identified in the NAPA (2007) and subsequent assessments as the most vulnerable sectors to impacts of climate change especially droughts and floods
Zimbabwe	A 33% reduction in per capita emissions in 2030, compared to business as usual. This would see per capita emissions double compared to present levels, rather than tripling under business as usual. Pledge conditional on international support.	

Annex 3. Recommendations for a Global Covenant of Mayors Common Reporting Framework.



Global Covenant of Mayors Common Reporting Framework

Version 6.0

September 13th, 2018

1. Introduction

1.1. About the Global Covenant of Mayors

The Global Covenant of Mayors for Climate & Energy¹¹³ (GCoM) is the world's largest alliance of cities and local governments with a shared long-term vision of promoting and supporting voluntary action to combat climate change and move to a low emission, climate resilient future. This coalition gathers thousands of cities of all sizes across 6 continents and more than 120 countries, representing almost 10% of the world's population.

Through the GCoM, cities and local governments are voluntarily committing to fight climate change, mirroring the commitments their national governments have set to ensure the goals of the Paris Agreement are met. It is a commitment to not only take bold local action but to also work side-by-side with peers around the world to share innovative solutions that enable mayors to do more, faster. GCoM cities connect and exchange knowledge and ideas, supported by relevant regional stakeholders.

More information: www.globalcovenantofmayors.org.

1.2. About the Regional Covenants

Regional and National Covenants already exist or are being developed with the aim of supporting cities and local governments in different regions all around the world, operating under the shared vision of the GCoM and principles and methods that best suit each region.

A Regional/National Covenant consists of all relevant local, regional and national partners and city networks that support and contribute to the implementation of the mission and vision of the Global Covenant of Mayors for Climate and Energy in a given geographic area. Regional/National Covenants tailor the GCoM to regional realities, ensuring effective implementation that is in line with regional or national priorities.

1.3. About the GCoM common reporting framework

Local governments committed to GCoM pledge to implement policies and undertake measures to: (i) reduce/limit greenhouse gas emissions, (ii) prepare for the impacts of climate change, (iii) increase access to sustainable energy, and (iv) track progress toward these objectives.

In order to ensure solid climate action planning, implementation and monitoring phases, as well as streamline measurement and reporting procedures, a set of new global recommendations were developed with the intention to be flexible to meet specific local or regional circumstances while also allowing for global aggregation and comparison of data. Together, the GCoM movement will be able to showcase achievements and track progress transparently – and thus advocate with cities and city networks in the various regions and nations for better multilevel governance of climate and energy issues with decision makers at all levels of government, and for improved technical and financial support. A common reporting language of the Global Covenant of Mayors will unite local voices and raise the bar, also for other climate stakeholders.

¹¹³ GCoM formally brings together the European Covenant of Mayors and the Compact of Mayors, the world's two primary initiatives of cities and local governments, to advance their transition to a low emission and climate resilient economy.

The following recommendations have been developed by a team of multi-disciplinary experts from GCoM partners (see list in **Annex A**) with the aim of providing a harmonized definition of a common reporting framework. They have been designed considering local governments' needs and a step-wise approach on meeting GCoM commitments and are built upon already existing and broadly used frameworks for reporting on climate change: the Compact of Mayors and the European Covenant of Mayors (e.g. regional versions developed in Europe and Eastern Europe), merging common elements that can serve the efforts of GCoM-committed local governments around the globe in achieving their objectives, and considering national and regional contexts.

1.3. About the consultation process

After in-depth discussions among experts, a draft version was open for stakeholders' review and comments in the period 30 April – 21 June 2018. This period of consultation with cities and local stakeholders in all regions refined the proposed reporting framework in order to ensure it well embraces the vast variety of realities and effectively supports local efforts to take climate action.

The following sections present the reporting frameworks for the following topic areas: (i) greenhouse gas emissions inventory; (ii) target setting; (iii) risk and vulnerability assessment; and (iv) climate action and energy access planning.

1.4. Next steps

The present recommendations were refined based on the outcomes of the consultation process to ensure they best meet local governments' needs and finalized as the common global reporting framework. From this point, the framework can then be adapted to suit each regional context (if needed).

More information will follow on: (i) guidance and technical tools to support local governments and cities in planning and achieving their climate goals; (ii) technical assistance and capacity development for local governments; (iii) updates on reporting platforms for 2019 as well as (iv) procedures related to data collection, data management (and access), data validation, analysis and dissemination.

Further guidance and technical tools will be provided in the implementation phase.

2. Definitions

The terms “cities” and “local governments” are used throughout this document, understanding that the geo-political institutions of local governments may vary from country to country and terminology used may differ. In this document, a **city** refers to a geographical subnational jurisdiction (“territory”) such as a community, a town, or a city that is governed by a **local government** as the legal entity of public administration. The term “city boundary” refers to a local government’s administration boundary.

2.1. Proposed reporting levels

This reporting framework uses precise language to indicate which provisions are requirements and which are optional, as follows:

- The term “**shall**” is used to indicate what is **required** (indicated as “**mandatory**” in the annexes).
- The term “**should**” is used to indicate a **strongly advised recommendation**, so is not a requirement (indicated as “**recommended**” in the annexes”).
- The term “**may**” is used to indicate an **option** that is permissible or allowable that local governments may choose to follow (indicated as “**optional**” in the annexes).

Flexibility has been built into this reporting framework to accommodate limitations in data availability and differences in emission sources between local governments (see section 3.2. on **notation keys**).

2.2. General Principles

The **general principles** below are applicable to all topic areas presented in this document:

- The reporting framework allows **flexibility** to suit differentiated local circumstances and needs, such as: (i) the use of different methodologies under the IPCC framework, (ii) varied access to necessary and quality data, (iii) recognizing that local governments of smaller communities may have less capacity, and (iv) relevance to all geographical locations.
- The reporting framework allows for **consistency with national and/or sub-national requirements** for local governments within their own national contexts. It is also designed specifically to consider the UNFCCC’s framework for reporting under the Paris Agreement (work in progress on enhanced framework) and, as such, ensure overall consistency with the IPCC framework.
- Greenhouse gas (GHG) emissions inventories, risk and vulnerability assessments, target(s) and goal(s), identifying hazards, climate and energy access plans should be **relevant to the local and regional situation**, reflecting the specific activities, capacity and regulatory context of the local government.
- The proposed framework allows for the **continuation of the reporting requirements** by current European Covenant- and Compact-committed cities and local governments may develop **joint GHG inventories, targets, and/or action plans** with the neighbouring community(ies).

- Local governments **shall** report in a way that enables meaningful comparison and aggregation with other cities.

3. Greenhouse Gas Emissions Inventory

The following GHG reporting framework is built upon the Emission Inventory Guidance, used by the European Covenant of Mayors and the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), used by the Compact of Mayors. Both refer to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories¹¹⁴.

Local governments **shall** submit their greenhouse gas emissions inventory to GCoM¹¹⁵ within two years upon joining GCoM. Every subsequent two years, or as set by regional GCoM offices, a more recent greenhouse gas emissions inventory **shall** be submitted to GCoM. Greenhouse gas emissions inventories **shall** cover a consecutive period of 12 months.

3.1. GHG Accounting Principles

In addition to the general reporting principles mentioned in section 2.2 above, local governments **shall** follow the GHG accounting principles outlined below:

- The inventory shall be relevant to the local and regional (where relevant) situation: reflecting the specific activities and policy-making needs of the city; taking into account its capacity and regulatory context.
- Local governments **shall** consider all categories of emission sources and report all emissions that are significant. Exclusion of emission sources **shall** be disclosed and justified, using the notation keys¹¹⁶ in the reporting template.
- Local governments **shall** compile GHG inventories on a regular basis, to enable monitoring and tracking the impact of climate actions, also to ensure continuous improvement in data quality, resulting in a clearly defined inventory boundary, improved data sources and defined methodologies that **shall** be consistent through the years (e.g., clarify where there is an evolution, e.g. population growth), so that differences in the results between years reflect real differences in emissions and mitigation efforts by the local government and the city.
- Local governments **shall** ensure sufficient accuracy to give local decision makers and the public reasonable assurance of the integrity of emissions reported. Efforts **shall** be made to reduce uncertainties and make improvements over time.
- To the extent possible, all relevant activity data¹¹⁷, data sources, methodologies, assumptions, exclusions and deviations **shall** be documented and reported, to allow

¹¹⁴ Considering that the IPCC is busy revisiting the 2006 IPCC Guidelines, changes will also be studied and accommodated for the GCoM, as relevant.

¹¹⁵ Inventory should be submitted to the GCoM secretariat where a Regional or National Covenant does not exist.

¹¹⁶ Notation keys should be used when an emission source is not occurring, included elsewhere, not estimated, or confidential.

¹¹⁷ Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time (e.g., volume of gas used, kilometres driven, tons of solid waste sent to landfill, etc.).

for review, replication of good practice, and tackling challenges identified (e.g., lack of access to data in country X).

3.2. Notation Keys

Notation keys **may** be used to accommodate limitations in data availability and differences in emission sources between local governments. Where notation keys are used, an accompanying explanation **shall** be provided.

The following are the descriptions on how to use the notation keys:

- **"NO"** (not occurring): An activity or process does not occur or exist within the city. This notation key may also be used for insignificant sources.
- **"IE"** (included elsewhere): GHG emissions for this activity are estimated and presented in another category in the same inventory, stating where it is added. This notation key may be used where it is difficult to disaggregate data into multiple sub-sectors.
- **"NE"** (not estimated): GHG emissions occur but have not been estimated or reported, with a justification why.
- **"C"** (confidential): GHG emissions which could lead to the disclosure of confidential information, and as such are not reported publicly.

Further guidance on the use and application of notation keys will be provided in the implementation phase.

3.3. Emission Sources

Local governments **shall** report GHG emissions from at least three main sectors, namely stationary energy, transportation, and waste. The detailed reporting requirements are described in the following subsections.

Local governments **should** also report GHG emissions from Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU) sectors¹¹⁸ where these are significant.

Additionally, local governments **may** report GHG emissions from upstream activities, such as material extraction, or other out-of-boundary sources.

Further guidance on the reporting of emissions from IPPU, AFOLU and other sources will be provided in the implementation phase.

(1) Stationary energy

- All GHG emissions from fuel combustion and the consumption of grid-supplied energy, in stationary sources within the city boundary **shall** be reported.

¹¹⁸ Please refer to 2006 IPCC Guidelines for National Greenhouse Gas Inventories for more details on these sectors.

- The emissions data **shall** be disaggregated by residential buildings, commercial buildings and facilities, institutional buildings and facilities, industry¹¹⁹ and agriculture, forestry, and fisheries.
- GHG emissions from sources covered by a regional or national emissions trading scheme (ETS), or similar, **should** be identified.
- All fugitive emissions within the city boundary **shall** be reported.

(2) Transportation

- All GHG emissions from fuel combustion and use of grid-supplied energy for transportation within the city boundary **shall** be reported and disaggregated by mode: on-road, rail, waterborne navigation, aviation, and off-road.
- Waterborne navigation, aviation, and off-road are unlikely to occur or be significant in most cities. Where they are significant sources, GHG emissions **shall** be included, unless they occur as part of transboundary journeys, in which case the notation key "Included Elsewhere" (IE) may be used (see below for more details). Where these sources do not occur, the notation key "Not Occurring" (NO) **shall** be used; where they are not significant, the notation key "NO" **may** be used (see section 3.2. for more details on the notation keys).
- Local governments **should** further disaggregate road and rail travel by fleet type: municipal fleets, public, private and commercial transport.
- Local governments **may** use the fuel sales, geographic (territorial), resident activity and city-induced methodologies¹²⁰ to estimate activity. They **should** identify the methodology used. Depending on the methodology used, data availability, and where such activities occur, local governments **may** choose to report GHG emissions from the inboundary component of domestic and/or international waterborne navigation and aviation (such as the landing and take-off cycle for aviation), or assume these are all out of boundary emissions and use the notation key "Included Elsewhere" (IE, see section 3.2) instead.

Further guidance on the use and application of transport system data collection methodologies will be provided in the implementation phase.

(3) Waste

- All GHG emissions from disposal and treatment of waste and wastewater generated within the city boundary **shall** be reported and disaggregated by treatment type.
- Where waste is used for energy generation¹²¹, GHG emissions do not need to be reported. Instead, the notation key IE **should** be used (see **section 3.2.** for more

¹¹⁹ This includes all emissions from energy use in industrial facilities, construction activities, and energy industries, except emissions from the generation of energy for grid-distributed electricity, steam, heat and cooling.

¹²⁰ Please refer to the *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)* or the *European CoM Guidebook* for further details on these methodological approaches.

¹²¹ For example, household waste sent for incineration; or sludge from wastewater.

details on the notation keys). Instead, these GHG emissions will be captured in the inventory through the use of heat or electricity generated from the treatment of waste.

3.4. Energy generation

Additionally, local governments **shall** report GHG emissions from energy generation activities. To avoid double counting, these **shall** not form part of the GHG emissions inventory total, and will be reported under an “Energy Generation” sector, where:

- All GHG emissions from generation of grid-supplied energy within the city boundary, and all GHG emissions from generation of grid-supplied energy by facilities owned (full or partial) by the local government outside the city boundary **shall** be reported and disaggregated by electricity-only, combined heat and power (CHP), and heat/cold production plants.
- GHG emissions from sources covered by a regional or national emissions trading scheme (ETS), or similar, **should** be identified.
- In addition, local governments **should** report all activity data for distributed local renewable energy generation.

3.5. Activity Data and Emission Factors

In addition to GHG data, the reporting framework requires local governments to report activity data and emission factors as follow:

- Local governments **shall** report activity data (in MWh, PJ, etc.) and emission factors for all sources of emissions, disaggregated by activity/fuel type.
- Local governments **should** use activity-based emission factors (also referred to as IPCC emission factors), though **may** use Life-Cycle Analysis (LCA) based emission factors where this is required for GHG emissions reporting at the national level. Where local governments use LCA emission factors, they **shall** also consent to GCoM recalculating and reporting their inventory using standard activity-based emission factors to enable the comparability and aggregation of city inventories. Local governments **shall** specify whether the emission factor used to estimate GHG emissions from the consumption of grid-supplied electricity is locally estimated or covers a regional, national or supranational grid. In all cases, the emission factor used **shall** be fully referenced.
- Local governments **shall** account for emissions of the following gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)¹²².
- GHG emissions **shall** be reported in metric tonnes of CO₂ equivalent (CO₂e)¹²³. Where possible, local governments **should** report CO₂e emissions by individual GHG.

¹²² When reporting IPPU, it will include hydro fluoro carbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆), and nitrogen trifluoride (NF₃).

¹²³ CO₂ equivalent can be determined by multiplying each gas by its respective global warming potential (GWP). The IPCC Assessment Report used for the GWP factors should be clearly referenced (i.e. FAR; SAR; TAR; AR4; AR5).

- Emissions from biogenic carbon are not required to be reported. Where they are reported, this **shall** be categorized separately and will not be counted in emissions totals.

4. Target Setting

All local governments and cities are required to set and report city-wide emissions reduction targets. The GCoM defines eight categories of requirements for target setting, as explained below.

Local governments **shall** submit their greenhouse gas emissions reduction target(s) to GCoM within two years upon joining GCoM.

(1) Boundary (geographic coverage, sectors, and GHGs)

The target boundary¹²⁴ **shall** be consistent with all emissions sources included in the GHG emissions inventory, with the possibility to exclude sources that are not controlled by the local government. In case that the target boundary does not align with the inventory boundary, any additions or exclusions **shall** be specified and justified. All exclusions **shall** be indicated by the notation key "Included Elsewhere" (IE), along with clear justification.¹²⁵ Local governments are **recommended** to report any sector-level targets alongside their city-wide target(s).

(2) Target type

Local governments **shall** use one of the following four target types: base year emissions target, base year intensity target, baseline scenario target, or fixed level target¹²⁶. For a baseline scenario target, the modelling methodologies, and parameters **shall** be transparently described.

¹²⁴ Please note that the local government's administrative boundary may go beyond to the city's geographic boundary. According to the GCoM all the emission within the "city boundary", even beyond the geographic boundary, shall be reported to the GCoM.

¹²⁵ For example, some European cities' targets do not include emissions sources that are already included in the EU Emissions Trading Scheme.

¹²⁶ Please refer to the [Greenhouse Gas Protocol Mitigation Goal Standard](#) for more details on these target types.

Base year emissions target: Reduce, or control the increase of, emissions by a specified quantity relative to a base year. For example, a 25% reduction from 1990 levels by 2030.

Base year intensity target: Reduce emissions intensity (emissions per unit of another variable, typically GDP or capital Gross Domestic Product – GDP or per capita) by a specified quantity relative to a base year. For example, a 40% reduction from 1990 base year intensity by 2030.

Baseline scenario target: Reduce emissions by a specified quantity relative to a projected emissions baseline scenario. A Business as Usual (BaU) baseline scenario is a reference case that represents future events or conditions most likely to occur in the absence of activities taken to meet the mitigation target. For example, a 30% reduction from baseline scenario emissions in 2030.

Fixed-level target: Reduce, or control the increase of, emissions to an absolute emissions level in a target year. One type of fixed-level target is a carbon neutrality

(3) Target year

The target year **shall** be the same as, or later than, the target year adopted in the Nationally Determined Contribution (NDC¹²⁷) or as set by Regional/National Covenants. Cities that set a target year beyond 2030 **shall** also include an interim target between now and 2030.

If the NDC target is before 2030, cities **should** additionally set a target for 2030.

(4) Base year (only for base year emissions target and base year intensity target)

The base year should be the same as the base year used in the NDC or as set by Regional/National Covenants. Where the base year is different from the NDC (e.g. where a city has previously adopted another base year or due to a lack of data availability), this **shall** be explained.

(5) Ambition

At a minimum, the target **shall** be as ambitious as the unconditional components¹²⁸ of the NDC (see also footnote 127). Local governments **should** set targets that are more ambitious than the NDC. When a national government increases their NDC, local governments **shall** have a maximum of five years to ensure their target remains as ambitious as the unconditional components of the NDC.

Where target (and base/scenario) years are different between the local government and NDC, GCoM will apply linear interpolation to both targets to determine whether the above requirement is met.

¹²⁷ See e.g. [UNFCCC NDC List](#), [Climate Tracker](#), [CLIMATEWATCH](#)

¹²⁸ Many countries have submitted two sets of NDC targets: unconditional targets, to be implemented without any explicit external support; and conditional targets. The latter are more ambitious than unconditional targets and require external support for their fulfilment. This includes financial support, and policies or action in other countries which support or facilitate a given country's mitigation policy (e.g. adoption of carbon taxes in a particular country may be conditional on the widespread use of carbon taxes in other countries, to ensure that domestic industry is not unduly impacted).

(6) Units

Targets **shall** be reported as a percentage (%) reduction from the base year or scenario year (for base year emissions, base year intensity and baseline scenario targets). The absolute emissions in the target year(s) in metric tonnes CO₂e **shall** also be reported for all target types.

If possible, the same approach should be chosen as is the case for the NDC target.

(7) Use of transferable emissions

The use of transferable emissions units¹²⁹ is only permissible when a local government's target ambition exceeds the unconditional components of the NDC. Where this is the case, the local government **shall** report the target, with and without the transferable emissions units, as well as identify the source of the transferable emissions units. Further guidance on the use of transferable emissions will be provided in the implementation phase.

¹²⁹ These are emissions allowances and offset credits from market mechanisms outside the target boundary that are used toward meeting a target. Please refer to the Greenhouse Gas Protocol Mitigation Goal Standard for more details.

(8) Conditionality

The use of conditional components is only permissible when a local government's target ambition exceeds the unconditional components of the NDC. Any conditional components included in the target **shall** be identified and, where possible, the conditional components **should** also be quantified. Conditional components include where cities set a stretch target, or where actions are identified for other key stakeholders beyond that which they have committed to themselves (for example, where a local government assumes a more ambitious reduction in the carbon-intensity of the national electricity grid than that committed to in the NDC or official government policy).

5. Risk and Vulnerability Assessment

The following reporting framework for risk and vulnerability assessments is built upon the reporting guidance used by the Compact of Mayors and the European Covenant of Mayors. This section provides requirements for risk and vulnerability assessments that form part of the climate change adaptation (resilience) plans, also understanding hazards and the adaptive capacity of the local government and community. Please refer to **Annex D: Risk and Vulnerability Assessment Reporting Framework** for further details.

5.1. Climate Risk and Vulnerability Assessment

The local government **shall** prepare and submit climate risk and vulnerability assessment within two years after committing to the GCoM.

The assessment **shall** include the following information:

- Boundary of assessment (boundary of assessment **shall** be equal to or greater than the city boundary), including the local government(s) name(s)
- Year of approval from local government
- Data sources
- A glossary of key terms and definitions
- Leading/coordinating team in the city

Terminologies and definitions used in the reports **shall** be consistent with those used in the IPCC Fifth Assessment Report (AR5) or any update following the AR5 as well as with national frameworks/requirements.

5.2. Climate Hazards

For each identified climate hazard, the local government **shall** report the following information:

- Current risk level (probability x consequence) of the hazard
- Description of expected future impacts
- Expected intensity, frequency, and timescale of the hazard
- All relevant sectors, assets, or services that are expected to be most impacted by the hazard in future and the magnitude of the impact for each of them

Furthermore, the local government **should** provide information on vulnerable population groups (e.g. poor, elderly, youth, people with chronic disease, unemployed, etc.) that are expected to be most affected by future hazards; this information can help the local government in having a better understanding of the vulnerability dimension of risks and in prioritizing their adaptation actions.

See Annex D, Table 1 for further details.

5.3. Adaptive Capacity

The local government **shall** identify factors that will most greatly affect its own and the city's adaptive capacity and enhance climate resilience. For each factor, the local government **shall** report the following information:

- Description of the factor as it relates to (supporting or challenging) the adaptive capacity
- Degree to which the factor challenges (as opposed to supports) the adaptive capacity and obstructs enhanced climate resilience

See Annex D, Table 2 for further details.

5.4. Major Climate Hazards Occurred in the Past Years

Besides the assessment of future hazards, the local government **shall** report the following information about major hazards that occurred in the past years:

- Scale of the hazard, including loss of human lives, economic losses (direct and indirect, if possible), environmental and other impacts
- Current risk level of the hazards (probability X consequence)
- Intensity and frequency of the hazard
- All relevant sectors, assets, or services most impacted by the hazard and the magnitude of impact for each of them
- Vulnerable population groups most affected by the hazard (if available)

6. Climate Action and Energy Access Plan(s)

This section includes two elements, namely climate action plans and energy access plans. The climate action plan requirements outlined in this section are applicable to both mitigation and adaptation plans (or integrated plans). The energy access plan can be submitted in the same document as the climate action plan(s) or in a separate document.

6.1. Climate Action Plans

Local governments **shall** develop plans for both climate change mitigation and adaptation (climate resilience), which **may** be presented in separate plans or an integrated plan. The plans **should** be in an official language used by the local government. Local governments **shall** submit their climate action plans to GCoM within three years upon joining GCoM (see section 7).

All action plan(s) **shall** include the following information for both mitigation and adaptation actions:

- Description of the stakeholder engagement processes
- Mitigation target(s) and/or adaptation / climate resilience goal(s); including (if available) sectoral targets

- All actions of priority sectors (identified from GHG emissions inventories and risk/vulnerability assessments)
- Descriptions for each action
- The local government(s) which formally adopted the plan and the date of adoption
- Synergies, trade-offs, and co-benefits of mitigation and adaptation actions
- Lead author team/Action Plan responsible/coordination team in the local governments

The mitigation target(s) **shall** be in line with requirements outlined in section 4 above. For adaptation goals, local governments **shall** report the goal descriptions (**shall** be aligned with the risks identified in the risk and vulnerability assessment (see section 5)), delivery date, and baseline year. Local government **should** also report the metric (or key performance index) for tracking the progress and monitoring plans.

For each action/action area/sector, the action plans **shall** provide the following information:

- Brief description of the action/action area/sector
- Assessment of energy saving, renewable energy production, and GHG emissions reduction by action, action area or sector (only applicable to mitigation actions).

For each action/action area/sector, the action plans **should** provide the following information:

- Financial strategy for implementing the action/action area/sector¹³⁰
- Implementation status, cost and timeframe
- Implementing agency(ies)
- Stakeholders involved in planning and implementation

In additional, local governments **should** also provide the following information in the action plans:

- Prioritization of actions
- Policy instrument(s) to implement the actions

Local governments are encouraged to report actions in as much detail as possible.

6.2 Monitoring

¹³⁰ Cities require massive and targeted investment in order to deliver low carbon and resilient infrastructure for their populations. Through partnerships with the EIB, EBRD, World Bank and other IFIs, GCoM is helping to fill the existing urban financing gap by providing cities with new levels of access to investments, technical assistance and advice and new partnerships are under developments. Disclosure of projects contained in Climate Action Plans with the related financial information is critical to better evaluate what new levels of access to investments, advice and financing are critical and additional to existing efforts to realizing cities' ambitious climate commitments. Such disclosure and transparency increases investors' confidence on the city's ability to deliver with accountability and good governance. Further guidance on project development and financing will be provided alongside these recommendations.

The local government **shall** submit monitoring reports every two years after submitting the action plan(s). The monitoring reports **shall** provide information about the implementation status of each action/action area/sector contained in the action plan, helping to monitor progress made. The local government **shall** update and resubmit the action plan(s) when there are significant changes to the existing plan(s). The local government **should** also report the implementation cost for each action/action area/sector.

Further details on the reporting requirements and frequency can be found in section 7 and Annexes B-E.

6.3 Energy Access Plan

All local governments **shall** report their energy access plans. However, at this stage, the detailed reporting framework is still being defined by the GCoM. Further consultation will be carried out before local governments are required to submit their energy access plans (which may be already a component of their Climate Action Plans).

In general, energy access refers to “access to secure, sustainable and affordable energy”. It is in line with the Sustainable Development Goals (SDG), in particular SDG 7 “Access to affordable, reliable, sustainable and modern energy for all”, and the Sustainable Energy For All (SEforALL) Initiative, which aims to ensure universal access to modern energy services.

An energy access plan typically includes three components:

(1) Access to *secure* energy

- Reduce energy demand (i.e. energy efficiency and energy management).
- Diversify energy mix, including the biggest possible share of diverse renewable energy (also considering locally available RE sources).
- Lower dependence from imported energy and diversify sources of supply.

(2) Access to *sustainable* energy

- The aim of the GCoM is that all energy used should become sustainable¹³¹, so whenever there is no access to energy in a location, renewable energy sources should be considered first, using energy efficient technologies.
- For access to electricity, renewable energy plays a growing role in both grid-based electrification and the expansion of decentralized technologies that are essential for rural areas.¹³²

(3) Access to *affordable* energy

- Energy affordability depends on many factors that typically go beyond the local government’s purview. For example, energy prices are usually addressed at the national level. However, the affordability of energy can be influenced by factors under the control of the local government, such as local policies, energy management, the use of subsidies or other mechanisms like incentives to promote renewable energy systems or energy saving measures.

¹³¹ For GCoM, nuclear energy is not considered “sustainable”.

¹³² Energy Access Outlook 2017 “From Poverty to Prosperity”

7. Overall Reporting Timelines

The reporting framework includes timelines for different elements of reporting. The following table shows the overall reporting time after joining GCoM.

Reporting Elements	Com mit to join GCoM (Year 0)	Year 1	Year 2	Year 3	Year 4	Year 5
GHG emissions inventory	submit by year 2 at the latest				*	
Risk and vulnerability assessment	submit by year 2 at the latest					
Targets and goals (mitigation and adaptation)	submit by year 2 at the latest					
Climate action plan(s) (mitigation and adaptation, or integrated plan)	submit by year 3 at the latest					
Energy access plan	To be defined					
Progress report					*	

* Every two years after submitting the climate action plan

Local governments may apply for an extension of reporting deadlines along with a clear justification.

Annex A: Members of Data-TWG

Below are lists of the members of the Data-TWG main body, as well as the Emissions Inventory & Target Setting Subcommittee, the Risk and Vulnerability Assessment Subcommittee and the Climate Action and Energy Access Planning Subcommittee. An asterisk (*) indicates membership in the main working group body. Dagger (†) indicates membership in the subcommittee.

D-TWG

Co-Chairs	
*†Paolo Bertoldi	European Commission - DG Joint Research Centre
*†Michael Doust	C40
Members	
*†Albana Kona	European Commission - Joint Research Centre
*†Silvia Rivas - Calvete	European Commission - DG Joint Research Centre
*†Olav Berg	European Commission - DG ENER
*Joanna Ziecina	European Commission - DG ENER
*Eero Ailio	European Commission - DG ENER
*Alessandra Sgobbi	European Commission - DG CLIMA
*†Cesar Carreño	ICLEI World Secretariat
* Maryke van Staden	ICLEI World Secretariat
*†Miriam Badino	ICLEI World Secretariat
*†Miguel Morcillo	CoM-IUC office/Climate Alliance
*†Lucie Blondel	CoM-IUC office/Climate Alliance
*Mikaël Ange (new work assignment) – replaced by Alessandra Antonini	CoM-IUC office/Climate Alliance
*Frédéric Boyer	CoM-IUC office/Energy Cities
*†Claire Markgraf	C40
*†Fong Wee Kean	WRI
†Carina Borgström -Hansson	WWF
*†Shannon Mc Daniel	GCoM Secretariat

Emissions Inventory and Target Setting Subcommittee

Chair	
Michael Doust	C40
Members	
Claire Markgraf	C40
Alessandra Sgobbi	European Commission - DG

	CLIMA
Olav Berg	European Commission - DG ENER
Albana Kona	European Commission - DG JRC
Cesar Carreño	ICLEI World Secretariat
Carina Borgstrom – Hansom	WWF
Miguel Morcillo	CoM-IUC office/Climate Alliance
Wee Kean Fong	WRI
Shannon Mc Daniel	GCoM Secretariat

Risk and Vulnerability Assessment Subcommittee

Co-Chairs	
Paulo Barbosa	European Commission - DG Joint Research Centre
Laura Kavanaugh (<i>until 28 FEB 2018</i>)	ICLEI World Secretariat
Members	
Alessandra Sgobbi	European Commission - DG CLIMA
Alice de Palma	CDP
Sara Telahoun	CDP
Chantal Oudkerk Pool	C40
Aleksandra Kazmierczak	European Environment Agency
James Deweese	WRI
Lucie Blondel	CoM-IUC office/Climate Alliance
Shannon Mc Daniel	GCoM Secretariat

Climate Action and Energy Access Planning Subcommittee

Chair	
Silvia Rivas Calvete	EC - DG JRC
Members	
Wee Kean Fong	WRI
Lucie Blondel	CoM-IUC office/Climate Alliance
Miriam Badino	ICLEI World Secretariat
Michael Doust	C40
Julia Lipton	C40
Nicola Mander	C40
Robert Kehew	UN HABITAT
Shannon Mc Daniel	GCoM Secretariat

Annex B: GHG Inventories Reporting Framework

Outline of reporting framework under the GCOM, mandatory level. This is not a reporting template.

	Mandatory	Description	GCOM support
Local Government Information			
Official name of local government	✓		
Country	✓		
Region	✓		
Inventory year	✓		
Geographic boundary	✓	Description of boundary and accompanying map	
Resident population (in the inventory year)	✓		
GDP	Optional		
Heating degree days / cooling degree days	Optional		
GHGs	CO2 or CO2e (CO2, CH4, N2O)	CO2e at a minimum, state which gases are included and encouraged to disaggregate by individual GHG. Biogenic carbon is not required but may be reported separately	
Emissions factors	IPCC or LCA	IPCC recommended but may use LCA where required for national reporting. If LCA, will also need to consent to GCOM converting data to an 'IPCC' inventory	- Develop tool and capacity to convert LCA inventory to 'IPCC' inventory
GWP	✓	Local governments should disclose which GWP factors	

they are using (i.e. FAR; SAR; TAR; AR4; AR5)

Emission Sources (Activity data and Emission Factors by Fuel type / activity and GHG Emissions)

Building / Stationary Energy		Fossil fuels	Grid-supplied energy	All GHG emissions from fuel combustion in stationary sources within the city boundary, consumption of grid-supplied energy consumed within the city boundary and fugitive emissions within the city boundary. GHG emissions from sources covered by a regional or national emissions trading program should be identified. - Make ETS data available at local government level
Residential buildings		✓	✓	
Commercial building and facilities		✓	✓	
		✓	✓	
Institutional buildings and facilities		✓	✓	
		✓	✓	
Industry	Non-ETS (or similar)	✓	✓	
	ETS (or similar)	✓	✓	
Agriculture		✓	✓	
Fugitive emissions		✓		
Transportation / Mobile Energy		Fossil fuels	Grid-supplied energy	All GHG emissions from fuel combustion and use of grid-supplied energy for transportation within the city boundary. In case waterborne navigation, aviation and off-road are not occurring, the notation key NO shall be used, where they are not significant the notation key NO may be used. Where they are significant sources, emissions shall be included (see section 3.2 (2)). Road and air travel should additionally be disaggregated by municipal fleet, public transport and private and - Guidance on disaggregating road and rail data by fleet type - Guidance on using the four different boundary methodologies
On-road		✓	✓	
Rail		✓	✓	
Waterborne navigation		✓	✓	
Aviation		✓	✓	
Off-road		✓	✓	

comment transport.

Cities may use the Fuel sales, Geographic (Territorial), Resident activity and City-induced methodologies to estimate activity.

Waste (non-energy)		Waste generated	
Solid waste		✓	All GHG emissions from disposal and treatment of waste generated within the city boundary. Where waste is used for energy generation, emissions do not need to be reported here. Instead, the notation key IE should be used. These emissions will be captured through the use of heat or electricity generated from the treatment of waste. If a treatment type is not applicable, the notation key NO shall be used. - National-level waste composition and treatment data - Calculators using default and user data estimate emissions from waste by treatment type
Biological waste		✓	
Incinerated and burned waste		✓	
Wastewater		✓	

Energy Generation (Activity Data and Emission Factors by energy carrier and GHG Emissions)

	Within city boundary	Owned by city	
Electricity-only generation	✓	✓	All GHG emissions from generation of grid-supplied energy within the city boundary and all GHG emissions from generation of grid-supplied energy by facilities owned (full or partial) by the local government outside the city boundary disaggregated by electricity-only, CHP and heat/cold production plants. GHG emissions from sources covered by regional or national emissions trading program should be identified. In addition, local governments are recommended to report all GHG emissions associated with distributed renewable generation, if any. - Make ETS data available at local government level.
CHP generation	✓	✓	
Heat/cold generation	✓	✓	

Local renewable energy generation	Recommended		
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Allowable Notation Keys			
Notation keys may be used to accommodate limitations in data availability and differences in emission sources between local authorities. Where notation keys are used, local authorities should provide an accompanying explanation.	Not Occurring	NO	An activity or process does not occur or exist within the local government (e.g. waterborne navigation in a city with no coast or river)
	Included elsewhere	IE	GHG emissions for this activity are estimated and already presented in another category in the inventory (e.g. waste is used for energy generation)
	Not estimated	NE	GHG emissions occur but have not been estimated or reported. NE should be used sparingly and where used should be priority for future data collection
	Confidential	C	GHG emissions which could lead to the disclosure of confidential information

- Guidance and examples on using notation keys

Annex C: Targets Reporting Framework

	Minimum	Ambitious	Comments
Boundary (geographic, coverage, sectors and GHGs)	Consistent with minimum requirements of GHG inventory framework		Where target boundary does not align with inventory boundary, additions and exclusions shall be specified and justified. Exclusions shall be indicated using the notation key Included Elsewhere (IE)
Target type	Any target type (base year, base year intensity, baseline scenario, fixed level)		For baseline scenario target, modeling methodology and parameters shall be transparently described
Target year	Same as NDC, or as set by regional/national Covenants	2050	If beyond 2030, shall also include interim target. If the NDC target is before 2030, cities should additionally set a target for 2030.
Base year (base year and intensity targets only)	Should be the same as NDC, or as set by regional/national Covenants		If different to NDC, shall be justified
Ambition	Same as NDC, or as set by regional/national Covenants	More ambitious than NDC	Refers to unconditional components of NDC
Units	% reduction from base / scenario year, and absolute emissions for target year in tCO ₂ e		
Use of transferable emissions	Only permissible where target ambition exceeds the unconditional components of the NDC		The local government shall report the target, with and without the transferable emissions units, as well as identify the source of the transferable emissions units.
Conditionality	Permissible but conditional components shall be stated and identified	Conditional components of the target are identified and should be quantified where possible	Permissible only when LG's target ambition exceeds the unconditional components of the NDC

Annex D: Risk and Vulnerability Assessment Reporting Framework

(m)	= mandatory to report
(r)	= Recommended to report
(opt)	= Optional to report
<i>italics</i>	= Explanatory notes

Table 1. Section A - Current and future climate risks, exposure, impacts and vulnerability

Table 1. Please identify the most significant climate hazards faced by your jurisdiction (m) and complete the questions to the right for each one.		
HAZARDS ¹³³ (grouped under headers, can report on multiple across the table)	CURRENT hazard RISK level (dropdown for each hazard selected)	
	Probability of Hazard (m)	Consequence of hazard (m)
Extreme Precipitation		
Rain storm	☐ High ☐ Moderate ☐ Low ☐ Do not know	☐ High ☐ Moderate ☐ Low ☐ Do not know
Monsoon	[dropdown as above]	[dropdown as above]
Heavy snow	[dropdown as above]	[dropdown as above]
Fog	[dropdown as above]	[dropdown as above]
Hail	[dropdown as above]	[dropdown as above]
Storm and wind		
Severe wind	[dropdown as above]	[dropdown as above]
Tornado	[dropdown as above]	[dropdown as above]
Cyclone (Hurricane / Typhoon)	[dropdown as above]	[dropdown as above]
Extra tropical storm	[dropdown as above]	[dropdown as above]
Tropical storm	[dropdown as above]	[dropdown as above]
Storm surge	[dropdown as above]	[dropdown as above]
Lightning / thunderstorm	[dropdown as above]	[dropdown as above]
Extreme cold temperature		
Extreme winter conditions	[dropdown as above]	[dropdown as above]
Cold wave	[dropdown as above]	[dropdown as above]
Extreme cold days	[dropdown as above]	[dropdown as above]
Extreme hot temperature		
Heat wave	[dropdown as above]	[dropdown as above]
Extreme hot days	[dropdown as above]	[dropdown as above]
Water Scarcity		
Drought	[dropdown as above]	[dropdown as above]
Wild fire		
Forest fire	[dropdown as above]	[dropdown as above]
Land fire	[dropdown as above]	[dropdown as above]
Flood and sea level rise		
Flash / surface flood	[dropdown as above]	[dropdown as above]
River flood	[dropdown as above]	[dropdown as above]
Coastal flood	[dropdown as above]	[dropdown as above]
Groundwater flood	[dropdown as above]	[dropdown as above]
Permanent inundation	[dropdown as above]	[dropdown as above]
Chemical change		
Salt water intrusion	[dropdown as above]	[dropdown as above]
Ocean acidification	[dropdown as above]	[dropdown as above]
Atmospheric CO2 concentrations	[dropdown as above]	[dropdown as above]
Mass movement		
Landslide	[dropdown as above]	[dropdown as above]
Avalanche	[dropdown as above]	[dropdown as above]
Rock fall	[dropdown as above]	[dropdown as above]
Subsidence	[dropdown as above]	[dropdown as above]
Biological hazards		
Water-borne disease	[dropdown as above]	[dropdown as above]
Vector-borne disease	[dropdown as above]	[dropdown as above]
Air-borne disease	[dropdown as above]	[dropdown as above]
Insect infestation	[dropdown as above]	[dropdown as above]

¹³³ Hazards based on C40 Hazard Taxonomy. Full definitions will be made available in the GCOM guidance materials. Can report on 1 or more. If you identify a hazard that has not been listed here, please notify the GCoM/Regional Covenant Secretariat.

...Current and future climate risks, exposure, impacts, vulnerability (table 1 continued horizontally from hazards table, only top row shown, which is repeated down *the table*)

Please indicate how you expect climate change to affect the intensity and frequency of each hazard and when you FIRST expect to experience those changes ¹³⁴			Please describe the overall impact of FUTURE hazards in your jurisdiction and the sectors, assets, and/or services that will be most affected (at least 5). ¹³⁵			Please indicate which vulnerable population groups will be most impacted by FUTURE hazards. ¹³⁶	
Expected change in frequency (m)	Expected change in intensity (m)	Timescale ¹³⁷ (m)	Description of expected impact (r)	Impacted sectors, assets, and services (m) and the magnitude of those impacts (m) ¹³⁸		Impacted vulnerable groups (r) (<i>can specify multiple for each hazard</i>)	
- o Increase - o Decrease - o No change - o Not known	- o Increase - o Decrease - o No change - o Not known	- o Immediately - o Short-term - o Medium-term - o Long-term - o Not known	[open field]	- o Transport - o Energy - o ICT (Information and Communications technology) - o Water supply and sanitation - o Waste management - o Public Health - o Law & Order - o Emergency Services - o Land use planning - o Education - o Food & Agriculture - o Environment, Biodiversity, Forestry - o Commercial - o Industrial - o Tourism - o Residential - o Society/community & culture - o Other _____	Magnitude of expected impact - o High - o Moderate - o Low - o Do not know	Women and girls Children and Youth Elderly Indigenous population Marginalized groups Persons with disabilities Persons with chronic diseases Low-income households Unemployed persons Persons living in sub-standard housing Other	
[repeat as above, for all hazards]	[repeat as above, for all hazards]	[repeat as above, for all hazards]	[repeat as above, for all hazards]	[repeat as above, for all hazards]	[repeats, for all hazards and s/a/s]	[repeat as above, for all hazards]	

²² Allow entities to report multiple expected impacts across multiple time scales for the same hazard (e.g. allow cities to add multiple rows for the same hazards).

¹³⁵ Terminology: this and the following section address exposure and impacts (further guidance will be provided in the implementation phase).

²⁴ The guidance document that will be made available will elaborate on the concept of vulnerable population and provide examples and guidance helping local governments to identify the relevant groups.

¹³⁷ Short Term = by 2025 Medium term = 2026-2050 Long term = after 2050 (further guidance will be provided)

¹³⁸ For each hazard, select which sectors/assets/services will be most impacted. Then for each sector/asset/service selected, indicate the magnitude of the expected impact (creative formatting needed). **Law & Order** = police, security personnel and systems etc.; **Emergency services** = first responders, EMT, Firefighters etc.; **Society/Community & culture** = things like cultural assets, heritage, community in the sense of social cohesion etc. (which could be impacted if communities are relocated or heritage sites submerged, for example). Further guidance will be provided in the implementation phase.

Table 2. Section A (continued) – Adaptive Capacity

Table 2. Please identify and describe the factors that will most greatly affect your jurisdiction's adaptive capacity. (m)		
FACTOR (grouped under headers, can report on multiple across the table)	Description (m)	Degree to which this factor presents a challenge for your jurisdictions adaptive capacity (m)
Services		
Access to basic services	[open field]	☐ High ☐ Moderate ☐ Low ☐ No concern ¹³⁹ ☐ Do not know
Access to healthcare	[open field]	[dropdown as above]
Access to education	[open field]	[dropdown as above]
Public health	[open field]	[dropdown as above]
Socio-economic		
Cost of living	[open field]	[dropdown as above]
Housing	[open field]	[dropdown as above]
Poverty	[open field]	[dropdown as above]
Inequality	[open field]	[dropdown as above]
Unemployment	[open field]	[dropdown as above]
Migration	[open field]	[dropdown as above]
Economic health	[open field]	[dropdown as above]
Economic diversity	[open field]	[dropdown as above]
Governmental		
Political stability	[open field]	[dropdown as above]
Political engagement / transparency	[open field]	[dropdown as above]
Government capacity	[open field]	[dropdown as above]
Budgetary capacity	[open field]	[dropdown as above]
Safety and security	[open field]	[dropdown as above]
Land use planning	[open field]	[dropdown as above]
Access to quality / relevant data	[open field]	[dropdown as above]
Community engagement	[open field]	[dropdown as above]
Physical & Environmental		
Rapid urbanization	[open field]	[dropdown as above]
Resource availability	[open field]	[dropdown as above]
Environmental conditions	[open field]	[dropdown as above]
Infrastructure conditions / maintenance	[open field]	[dropdown as above]
Infrastructure capacity	[open field]	[dropdown as above]
Other		
Other _____	[open field]	[dropdown as above]

¹³⁹ Factors reported as “no concern” may have a neutral or a positive influence on adaptive capacity. To reduce reporting fields, preference is given here to factors that challenge adaptive capacity, though cities may also describe factors that have a positive influence as well (and GCOM partners may choose to independently collect more data on positive factors as an optional field).

Table 3. Section A (continued) - Climate risk and vulnerability assessment

Table 3. Please provide more information on your jurisdiction's climate risk or vulnerability assessment(s) (rows can be added so multiple assessments can be reported on) ¹⁴⁰						
Title (m)	Year (m)	Scope/Boundary ¹⁴¹ (m)	Primary author (m)	Update/revision process (opt)	Upload (m) ¹⁴²	file
[open field]	[dropdown of years]	○ Same, covers whole jurisdiction and nothing else ○ Smaller, covers part of the jurisdiction ○ Larger, covers the whole jurisdiction and adjoining areas ○ Partial, covers part of the jurisdiction and adjoining areas	○ Local government ○ Consultant ○ International organization ○ Community group ○ Regional / state / provincial government ○ National / central government ○ Other _____	○ Formal schedule for update ○ Yes ○ No ○ Do not know ○ If yes, what is the time period for update? (years): _____ ○ Status of current update ○ Currently Exists ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know		

¹⁴⁰ Combined with other questions, a full picture of where the city is in their planning and revision process is provided.

¹⁴¹ The boundary of the assessment shall be equal to or greater than the boundary of the whole jurisdiction. Jurisdiction definition = ICLEI Typology - State / Region; Province / County / District; Independent province; City / Municipality; Independent city; Special city / Federal district; Sub-municipal district; Sovereign city-state (guidance on where "metropolitan area" fits will be provided).

¹⁴² The mandatory fields in this table are required for compliance after 2 years.

Table 4. Section B – Climate adaptation plan

Table 4. If available, please provide more information on your jurisdiction's climate adaptation plan(s) ¹⁴³							
Title (m)	Short Description (m)	Year adopted (m) ¹⁴⁴	Nature of climate adaptation plan (m)	Scope/Boundary ¹⁴⁵ (m)	Primary author (m)	Update/revision process (opt)	Upload file (m) ¹⁴⁶
[open field]	[open field]	[dropdown of years] ☐ Not adopted	☐ Standalone climate adaptation plan ☐ Addressed in combined adaptation and mitigation climate action plan± ☐ Addressed in general city plan ☐ Addressed in city sector plan(s) ☐ Other _____	☐ Same, covers whole jurisdiction and nothing else ☐ Smaller, covers part of the jurisdiction ☐ Larger, covers the whole jurisdiction and adjoining areas ☐ Partial, covers part of the jurisdiction and adjoining areas	☐ Local government ☐ Consultant ☐ International organization ☐ Community group ☐ Regional / state / provincial government ☐ National / central government ☐ Other _____	☐ Formal schedule for update ☐ Yes ☐ No ☐ Do not know ☐ If yes, what is the time period for update? (years): _____ ☐ Status of current update ☐ Currently Exists; ☐ In Progress ☐ Does not exist but intending to undertake in the future; ☐ Do not know	

¹⁴³ Combined with other questions, a full picture of where the city is in its planning and revision process is provided.

¹⁴⁴ Refers to year officially adopted, not published, if the years are different.

¹⁴⁵ The boundary should be at least equal to the boundary of the whole jurisdiction. Jurisdiction definition = ICLEI Typology - State / Region; Province / County / District; Independent province; City / Municipality; Independent city; Special city / Federal district; Sub-municipal district; Sovereign city-state (guidance on where "metropolitan area" fits will be provided).

¹⁴⁶ The mandatory fields in this table are required for compliance after 3 years.

Table 5. Adaptation goals

Table 5. Please describe the main goals of your jurisdiction's adaptation efforts and the metrics/KPIs if applicable.					
Goal description (m)	Delivery date (m)	Baseline year (m)	Metric/KPI ¹⁴⁷ (r)	Progress (r)	Monitoring Plan (r)
[open field]	[year dropdown]	[year dropdown]	[open field]	○ 0-25% complete ○ 25-50% complete ○ 50-75% complete ○ 75-99% complete ○ 100% complete	[Upload/link]

¹⁴⁷E.g. Reduce by half the population exposed to heat waves.

Table 6. Section B (continued) Key Adaptation Table 6. Please describe a selection of key or representative actions contained in the adaptation plan												
Related Hazard ¹⁴⁸ (r)	Action	Short Description	Policy instrument (opt)	Financial cost and strategy (opt)	Implementation status ¹⁴⁹ (opt)	Timeframe (opt)	Responsible body (opt)	Stakeholders involved (can select multiple) (opt)	Identification of synergies, trade-offs and co-benefits of mitigation and adaptation (opt)	Target (r)	KPI (r)	
Key Hazard 1 (auto-populate) [Auto populate or dropdown]	[open field]	[open field]				[years dropdown]	[dropdown]	○ National government ○ Regional government ○ Local government ○ Academia ○ Business & Private sector ○ Trade union ○ NGO and associations ○ Citizens ○ Other _____				

Please describe how your jurisdiction has prioritized adaptation actions (opt)
[open field]

¹⁴⁸ Cities should report a key or representative action for the main hazards identified as high risk above.

¹⁴⁹ If possible, quantitative information should be provided.

Table 7. Section C – Adaptation Planning Process

Table 7.	Commit and mobilize resources (m) ¹⁵⁰	Risk and vulnerability assessment (m) ¹⁵¹	Develop and prioritize adaptation options (m) ¹⁵²	Develop adaptation plan (m) ¹⁵³	Implement adaptation plan (opt) ¹⁵⁴	Monitor and evaluate progress (m) ¹⁵⁵
Please describe your progress in the adaptation planning process (m)	○ Currently exists ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know	○ Currently exists ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know	○ Currently exists ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know Please select the factors considered when prioritizing adaptation options (can select multiple) (opt) ○ Financial costs ○ Risk level of each hazard ○ Impacted sectors, services, and assets ○ Vulnerable populations ○ Stakeholder consensus ○ Other _____	○ Complete ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know	○ Complete¹⁵⁶ ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know	○ Currently exists ○ In Progress ○ Does not exist but intending to undertake in the future ○ Do not know

¹⁵⁰ E.g. Initial adaptation policy commitment is defined. Human, technical, and financial resources are mobilized. Institutional structures are set up and appropriate coordination mechanisms are in place. Review of local policy and institutional context, previous plans, available resources, and data sources. Climate risk and vulnerability data collected.

¹⁵¹ E.g. Conduct Analysis of climate risks and vulnerabilities including potential impacts on residents and sectors.

¹⁵² E.g. Develop strategic vision and targets for developing and mainstreaming adaptation actions and policies. Compile, assess, and prioritize portfolio of potential adaptation options.

¹⁵³ E.g. Complete adaptation plan with detailed actions, programs, projects, and implementation strategies (including funding). This may be a standalone plan or may be integrated into a related sectoral plan or broader urban development strategy.

¹⁵⁴ E.g. Institutional arrangements as well as human, technical, and financial resources are in place to execute adaptation actions locally according to approved plans.

¹⁵⁵ E.g. Monitoring framework with key performance indicators is in place for adaptation actions. Progress is regularly monitored and reported to relevant decision makers and/or stakeholders locally, nationally, and globally as appropriate.

Table 8. Overall overview of the participatory process carried out in the adaptation planning process

Stakeholders	Drop down list: level of participation	Multiple choice: participatory technique
National government	High Medium Low None	Questionnaire/survey Online consultation In-depth interview Roundtable Focus group Workshop Citizen jury Other: indicate which one
Regional government	[drop down list as above]	[drop down list as above]
Local government	[drop down list as above]	[drop down list as above]
Academia	[drop down list as above]	[drop down list as above]
Business & private sector	[drop down list as above]	[drop down list as above]
Trade union	[drop down list as above]	[drop down list as above]
NGO and associations	[drop down list as above]	[drop down list as above]
Citizens	[drop down list as above]	[drop down list as above]
Other: indicate which one	[drop down list as above]	[drop down list as above]
Legend: Low → Information (meaning “low” level of participation): this is produced when the public are informed through a one-way flow of information, i.e. information passes from officials to the public, with no chance to provide feedback from the public to officials. There is no room for negotiation. The most frequent tools for informing are news, media, pamphlets, posters, and responses to inquiries. Medium → Consultation (“medium” level): the public is invited to give their opinion and provide feedback on analyses, alternatives and/or decisions; however, these opinions may have or may have not been taken into account. High → Partnership (“high” level): there have been negotiations between planners and the public in each aspect of the planning process. They have both agreed to share planning and decision-making responsibilities through joint policy boards, planning committees or other mechanisms for resolving impasses. The public have had some genuine bargaining influence over the outcome of the plan, including the development of adaptation options and the identification of the preferred solution.		

Annex E: Climate Action and Energy Access Reporting Framework

ACTION PLANNING	
1. Develop an action plan for mitigation and adaptation	Mandatory
2. Plan to include target(s) / goal(s) of plan	Mandatory
3. Joint / collective action plans amongst local governments	Optional for neighbouring governments
4. Description of stakeholder engagement process in development of plan	Mandatory
5. Timeline for submission of the action plan	Within 3 years upon joining GCOM
6. Possible extension of the submission deadline	Possible extension with justification
7. Language of the plan	Any official language
8. Name of the plan	Any - as long as the plan is compliant with the GCOM requirements.
9. Integrated climate action plan (mitigation and adaptation)	Optional
10. Description of prioritization process of actions	Recommended
11. Key sectors addressed by the plan	Key sectors in line with local governments' priorities and assessments (baseline emission inventory and risk and vulnerabilities assessment) outputs
12. Description of each action in the Climate Action Plan document	Mandatory
13. Policy instrument(s) foreseen for the action, when appropriate	Recommended
14. Financial strategy per action/action area/sector	Recommended
15. Implementation status and timeframe	Recommended
16. Responsible body for each action/action area/sector	Recommended
17. Stakeholders involved for each action/action area/sector	Recommended
18. Assessment of energy savings, renewable energy production and GHG emissions reduction per key mitigation action/action area/sector	Mandatory (recommend inclusion of figures)
19. Formal adoption of the plan	Mandatory
20. Identification of synergies, trade-offs and co-benefits of mitigation and adaptation	Mandatory

MONITORING	
22. Monitoring, tracking and reporting progress towards commitments in the climate action plan	Mandatory - performed by city and publicly disclosed
23. Status of the implementation of each action in the climate action plan	Mandatory
24. Monitoring the costs of each action	Recommended
25. Frequency for submitting monitoring report of the implementation of actions	Every 2 years but recommended yearly, following action plan submission

26. Provisions for updating the Action plan (both mitigation and adaptation) when needed

Mandatory to update and resubmit the action plan when there are significant changes

EVALUATION AND FEEDBACK

27. Evaluation on mitigation and adaptation by an independent body providing a feedback report to the city

By an independent body and to be decided regionally

Annex 4. How to account indirect emissions from the consumption of electricity

4.1. Definition of local production of electricity

The methodology specifically developed in the frame of the GCoM allows defining and assessing the “*Local production of electricity*” (in MWh). The amount of electricity to be reported in as local electricity production will have a direct influence on the value of the local emission factor for electricity and consequently on the emissions associated with the local consumption of electricity.

The following selection criteria and method have been developed in order to identify the plants or installations that should be included in the calculation of the total LPE.

These selection criteria are based on the geographical location, source/type/size and the ownership/operation of the local electricity generation facility.

Consequently, the information on the total amount of electricity produced in all plants/units that meet the selection criteria and the associated GHG emissions are accounted for in the calculation of the local emission factor for electricity (EFE).

a) Geographical location of the plant/installation

The location of the energy plant/installation in the local territory is the first criterion. However it is not mandatory: electricity produced by installations/plants (refer to as “unit” hereafter) located outside the local territory can also be optionally included, if they are under the direct control of the LA (see point c). If the signatory decides to include plants located outside its territory as defined hereafter (which can make reaching the mitigation target easier or more difficult), it has to include all of them, as is the case with the ones located in its territory.

b) Source, type and size of local electricity production plant/installation

In order to calculate the total amount of LPE and associated GHG emissions to be accounted for in the calculation of the indirect emissions from electricity consumption, the local authority is recommended to include all the individual electricity generation plants in the local territory, (as well as any plant outside the local territory that is owned and/or operated by itself in section c), that meet the following criteria:

- Local electricity production from renewable sources in particular: wind, solar (solar thermal and solar photovoltaic), geothermal energy, ambient heat, hydropower, etc.) and combustible renewables (biofuels, bioliquids, biogas, solid biofuels and combustible wastes of renewable origin). The amount of energy from renewable sources corresponding to guarantees of origin/green certificates transferred to a third party, outside the local administrative boundaries, shall be deducted from the local energy production from renewable sources .
- Local electricity production from non-renewable sources:
 - all combined heat and power plants/installations,
 - all electricity-only plants/installations

c) Case of plants or installations (co-)owned and/or operated by the local authority

All plants/installations under the direct control of the local authority (operated and/or at least partly owned by the municipality) can be accounted for in the calculation of the LPE. This refers to any plant running on renewable or non-renewable energy sources as defined above, some of which are of particular interest for the municipality, such as plants consuming the municipal wastes or cogeneration plants providing heat for the municipal district heating network. The information on the electricity production can be assessed according to the responsibility of the LA and to the share of ownership of all partners (municipalities or commercial partners),

following the approach detailed in Annex 5 which avoids double counting inside and outside the territory.

For renewables, the part of local production that is sold outside the local territory is excluded from the calculation of the local emission factor for electricity consumption.

In many cases, the information on local production ⁽¹⁵⁷⁾ is directly available or assessable from the local (private or public) electricity provider, costumer and/or unit operator. For the large plants (such as CHPs), the information on the (distributed or centralised) local electricity production can usually be obtained via direct contact with the plant manager (municipal power agency or private company) or with the operators of the distribution network.

In other cases, the data can either be obtained through questionnaires to the local producers/suppliers (e.g., Energy communities) and/or costumers or be derived from statistics (e.g., number of permits delivered, if required; number of subsidies granted) related to the amount of installations and power. Energy market operators may also have data about entities that provide electricity to the grid (e.g., from the certified green electricity).

This list of the selected plants together with corresponding energy inputs, generated electricity and CO₂ emissions have to be updated all along the implementation process so as to account for the changes in local production of electricity and to avoid double counting across signatories. In case a given installation falls into different categories (included/optional/excluded) during the SEACAP implementation process, the local authority might need to recalculate the BEI/MEI(s) accordingly. This would be the case for instance of a small combustion installation, which would have grown above the 20 MW threshold and been excluded meanwhile by the signatory

In case of Combined Heat and Power (CHP) plants, the energy input has to be split between electricity and heat/cold production. The selection of the plants to be reported as local electricity production will have a direct influence on the value of the local emission factor for electricity and consequently on the emissions associated with the local consumption of electricity. Therefore, when building the subsequent MEI(s), consistency in the selection of production units is required to ensure that the local emission factor reflects the real changes in local electricity production. For example, for the installations running on renewable energy sources, all the additional units reported in MEI(s) should be new installations, installed after the baseline year.

4.2. Indirect emissions from the consumption of electricity

In order to calculate the indirect CO₂ emissions to be attributed to the local production of electricity, EC JRC developed a specific methodology of estimating the local emission factor for electricity (EFE) taking into account the following components:

- a) National emission factor for electricity consumption (NEFE)
- b) Indirect emissions from local electricity production (LPE)
- c) Purchase and sale of Certified Electricity (CE)

a. National emission factors for electricity consumption

The National Emission Factor for Electricity (NEFE) shall be used as a starting point to determine the local emission factor for electricity. If no local, regional or country specific sources are available, local authorities should use IPCC default factors or data from Emission Factor database ⁽¹⁵⁸⁾ or other databases ⁽¹⁵⁹⁾.

b. Purchase and sale of certified electricity (CE)

⁽¹⁵⁷⁾ See also section 5.2 on data collection of energy consumed in the Building macro-sector.

⁽¹⁵⁸⁾ <https://www.ipcc-nggip.iges.or.jp/EFDB/main.php>

⁽¹⁵⁹⁾ <http://www.iea.org/statistics>

Local authorities should report in the emission inventory i) any certified electricity (CE) purchased from outside and in addition ii) the amount of certified electricity generated within the local territory and sold to third parties outside its administrative boundaries.

Certified electricity is the electricity that is produced from renewable energy sources (for example certified electricity that meets the criteria for (international) renewable energy certificates, guarantee of origin of electricity, green certificates or similar):

Instead of purchasing the “mixed” electricity from the grid, the local authority/other local actors can decide to purchase certified electricity. The LA will report the amount of purchased electricity ($\sum CE_{purchased}$).

$$\sum CE_{purchased} = \text{Certified electricity purchased [MWh]}$$

The amount of renewable energy produced by facilities that are located inside the local territory for which the guarantee of origin/green certificates of electricity produced from renewable sources is sold to third parties outside the administrative boundaries should not be accounted as local energy production ($\sum CE_{sold}$)

$$\sum CE_{sold} = \text{Electricity produced and certified by the guarantee of origin/green certificates which is sold to third parties [MWh]}$$

Therefore, the amount of certified electricity that can be accounted for in the calculation of the local emission factor for electricity consumption results as follows:

$\sum CE$: Certified electricity accounted in the inventory

$$\sum CE = \sum CE_{purchased} - \sum CE_{sold} \quad (2)$$

c. Calculation of local emission factor for electricity (EFE)

The local emission factor for electricity (EFE) to be reported as local emission factors should be calculated as follows:

In the case where the local authority would not be a net exporter of electricity ($TCE \geq LPE + GE$)⁽¹⁶⁰⁾

$$EFE = \frac{[(TCE - \sum LPE - \sum CE) * NEFE + \sum CO2_{LPE} + \sum CO2_{CE}]}{TCE} \quad (3)$$

In the case where the local authority would be a net exporter of electricity ($TCE < LPE + CE$)

$$EFE = \frac{\sum CO2_{LPE} + \sum CO2_{CE}}{\sum LPE + \sum CE} \quad (4)$$

Where:

EFE = local emission factor for electricity consumption [$\frac{tCO_2}{MWh}$]

TCE = Total electricity consumption [MWh] in the local territory

$\sum LPE$ = local electricity production from RES and non RES facilities [MWh]

⁽¹⁶⁰⁾ This formula neglects transport and distribution losses in and to the local territory, as well as auto-consumption of energy producers/transformers and tends to double count the local production already included in the NEFE. However, at the scale of the local authority, these approximations will have a minor effect on the local CO₂ balance and the formula may be considered as robust enough to be used in the context of the Covenant of Mayors.

ΣCE = Certified electricity

$NEFE$ = national emission factor for electricity consumption [t CO₂/MWh]

ΣCO_{2LPE} = CO₂ emissions due to local energy production [t CO₂]

ΣCO_{2CE} = CO₂ emissions [tCO₂] due the purchase/sold of CE certified electricity. In the case that the standard approach is used, the emission factor for certified electricity is zero. If the LCA approach is used, the local authority has to estimate the LCA CO_{2CE} either by requesting required information from the power provider or by using the CoM default factors provided for local renewable electricity generation if they are deemed suitable.

In the case of CHP plants, it is first required to distinguish between the energy input and emissions due to heat and electricity production.

4.3. How to allocate emissions in CHPs

Part or all of the heat used in the territory of the local authority may be generated in a combined heat and power (CHP) plant. It is essential to divide the emissions of a CHP plant between heat and electricity when filling the B online templates. The fuel use - and consequently, the associated emissions - can be allocated between heat and electricity generation by using the following methods proposed, based on the data availability:

I) The following method allocate the emissions based on the energy inputs required to produce separately (non in cogeneration) the same amount of outputs of heat and electricity (as in the CHP power plant output) as follows¹⁶¹:

$$CO_{2CHPH} = \frac{\frac{P_{CHPH}}{\eta_h}}{\frac{P_{CHPH}}{\eta_h} + \frac{P_{CHPE}}{\eta_e}} * CO_{2CHPT} \quad (a)$$

$$CO_{2CHPE} = CO_{2CHPT} - CO_{2CHPH} \quad (b)$$

where

CO_{2CHPT} : total amount of CO₂ emissions in the CHP power plant [tCO₂]

CO_{2CHPH} : amount of CO₂ emissions from heat production [tCO₂]

CO_{2CHPE} : amount of CO₂ emissions from electricity production [tCO₂]

P_{CHPE} : amount of electricity produced [MWh]

P_{CHPH} : amount of heat produced [MWh]

η_e typical efficiency of separate electricity production. The recommended value to be used is set in the national efficiency factor for electricity generation and/or the average of EU regularly published by Eurostat (46 %).

<http://ec.europa.eu/eurostat/web/energy/data/shares>

η_h : typical efficiency of separate heat production. The recommended value to be used is 90 %.

(¹⁶¹) See for instance Annex II of the European Energy Efficiency Directive (2012/27/EU)

Annex 5. Default Net calorific values (IPCC, 2006)

Fuel type	Net calorific value [TJ/Gg]	Net calorific value [MWh/t]
Crude Oil	42.3	11.8
Orimulsion	27.5	7.6
Natural Gas Liquids	44.2	12.3
Motor Gasoline	44.3	12.3
Aviation Gasoline	44.3	12.3
Jet Gasoline	44.3	12.3
Jet Kerosene	44.1	12.3
Other Kerosene	43.8	12.2
Shale Oil	38.1	10.6
Gas/Diesel Oil	43.0	11.9
Residual Fuel Oil	40.4	11.2
Liquefied Petroleum Gases	47.3	13.1
Ethane	46.4	12.9
Naphtha	44.5	12.4
Bitumen	40.2	11.2
Lubricants	40.2	11.2
Petroleum Coke	32.5	9.0
Refinery Feedstocks	43.0	11.9
Refinery Gas 2	49.5	13.8
Paraffin Waxes	40.2	11.2
White Spirit and SBP	40.2	11.2
Other Petroleum Products	40.2	11.2
Anthracite	26.7	7.4
Coking Coal	28.2	7.8
Other Bituminous Coal	25.8	7.2
Sub-Bituminous Coal	18.9	5.3
Lignite	11.9	3.3
Oil Shale and Tar Sands	8.9	2.5
Brown Coal Briquettes	20.7	5.8
Patent Fuel	20.7	5.8
Coke Oven Coke and Lignite Coke	28.2	7.8
Gas Coke	28.2	7.8
Coal Tar	28.0	7.8
Gas Works Gas	38.7	10.8
Coke Oven Gas	38.7	10.8
Blast Furnace Gas	2.47	0.7
Oxygen Steel Furnace Gas	7.06	2.0
Natural Gas	48.0	13.3
Municipal Wastes (non-biomass fraction)	10	2.8
Waste Oil	40.2	11.2
Peat*	9.76	2.7

These IPCC default Net calorific values (NCV) may be used for both stationary sources and road transport (see fuels in bold) when country-specific data are unavailable.

*Although peat is not strictly speaking a fossil fuel, its greenhouse gas emission characteristics have been shown in life cycle studies to be comparable to that of fossil fuels and CO₂ emissions from combustion are included in the national emissions as for fossil fuels.

Annex 6. CO₂ emission factors for fuels (IPCC, 2006)

Fuel type	CO ₂ emission factor [kg/TJ]	CO ₂ emission factor [t/MWh]
Crude Oil	73300	0.264
Orimulsion	77000	0.277
Natural Gas Liquids	64200	0.231
Motor Gasoline	69300	0.249
Aviation Gasoline	70000	0.252
Jet Gasoline	70000	0.252
Jet Kerosene	71500	0.257
Other Kerosene	71900	0.259
Shale Oil	73300	0.264
Gas oil / diesel	74100	0.267
Residual Fuel Oil	77400	0.279
Liquefied Petroleum Gases	63100	0.227
Ethane	61600	0.222
Naphtha	73300	0.264
Bitumen	80700	0.291
Lubricants	73300	0.264
Petroleum Coke	97500	0.351
Refinery Feedstocks	73300	0.264
Refinery Gas	57600	0.207
Paraffin Waxes	73300	0.264
White Spirit & SBP	73300	0.264
Other Petroleum Products	73300	0.264
Anthracite	98300	0.354
Coking Coal	94600	0.341
Other Bituminous Coal	94600	0.341
Sub-Bituminous Coal	96100	0.346
Lignite	101000	0.364
Oil Shale and Tar Sands	107000	0.385
Brown Coal Briquettes	97500	0.351
Patent Fuel	97500	0.351
Coke oven coke and lignite Coke	107000	0.385
Gas Coke	107000	0.385
Coal Tar	80700	0.291
Gas Works Gas	44400	0.160
Coke Oven Gas	44400	0.160
Blast Furnace Gas	260000	0.936
Oxygen Steel Furnace Gas	182000	0.655
Natural Gas	56100	0.202
Municipal Wastes (non-biomass fraction)	91700	0.330
Industrial Wastes	143000	0.515
Waste Oil	73300	0.264
Peat*	106000	0.382

These IPCC default CO₂ emission factors may be used for both stationary sources and road transport (see fuels in bold) when country-specific data are unavailable. It is recommended to ensure that default emission factors, if selected, are appropriate to local fuel quality and composition.

*Although peat is not strictly speaking a fossil fuel, its greenhouse gas emission characteristics have been shown in life cycle studies to be comparable to that of fossil fuels and CO₂ emissions from combustion are included in the national emissions as for fossil fuels.

Annex 7. Selected vulnerability indicators at community level identified within the CLUVA project.

CLUVA (CLimate change and Urban Vulnerability in Africa) was a 3 years project, funded by the European Commission, which started in 2010. It has the general objective to estimate the impacts of climate changes in the next 40 years at urban scale in Africa.

The mission of CLUVA is to develop methods and knowledge to assess risks cascading from climate-changes. It downscales IPCC climate projections to evaluate threats to selected African test cities; mainly floods, sea-level rise, droughts, heat waves and desertification. One of the deliverables within the project consisted in the identification, by literature review and participatory approach with partners and citizens from 5 cities (Addis Ababa, Dar es Salaam, Douala, Ouagadougou and St. Louis), of several vulnerability indicators to be applied in the mentioned cities.

GENERIC HAZARD TYPE			
THEME	ID	IDENTIFIED INDICATOR	DESCRIPTION
Hazard prone area	i1	Location of buildings in hazard prone area	Indicates the location of buildings or settlements identified in hazard prone areas. Determines the likelihood of damages an area by water flow, water stagnation and waste water floods
	i2	Type of hazards identified	Indicates potential damages by providing accounts of past climatic events having an impact in human and economic livelihood of the community

ASSET VULNERABILITY			
THEME	ID	IDENTIFIED INDICATOR	DESCRIPTION
Economic condition	i3	Source of income	Indicates the level of employment or type of economical asset in the community. An important consideration is evaluating whether the percentage of incomes reported are 'stable' regardless of local hazards. Also the percentage of 'vulnerable employment' can be addressed as well as the degree of dependency on local employment
	i4	Material asset	Indicates the existence of collective goods and material resources in the community
Education level	i5	Level of literacy	Refers to male and female literacy rate in the community. Years of school indicates the percentage of male and female with primary, secondary and tertiary education
	i6	Years of school	
Demographic structure	i7	Household size	Indicates the mean of household size and composition in the community that may be either affected or capable of coping with a disaster.
	i8	Household composition	Indicates the difference of co-residency characteristics in the community. Associated variables are age group and gender. Attention to gender is due to the fact that women along with children and elderly appear to be more vulnerable (Cutter et al., 2003; O'Brien and Mileti, 1992; Wisner et al., 2004). The percentage of ethnic, clan or group affiliations may provide clues related to the heritage, distinctive culture and common language in
	i9	Ethnic background	

			the community
Health	i10	Medical condition/problems	Indicates the percentage of diseases identified in the community. Proxies are average life expectancy, and or cause of deaths

ATTITUDINAL VULNERABILITY			
THEME	ID	IDENTIFIED INDICATOR	DESCRIPTION
Social capital	i11	Level of trust	Indicates the level of trust extended to other members of the community and local institutions. This indicator is based on the rationale that when individuals in communities trust each other and the institutions that operate among them, they can easier reach agreements concerning disaster prevention and warning. A proxy is the trust in official information
	i12	Degree of social inclusion	Indicates the degree of social isolation in the percentage of isolated households in the community
	i13	Level of social network	Indicates the existence of professional /social/ financial groups, religious and/or sport organizations active in the community. Also provides information on the degree to which there is cohesion of groups in the community
	i14	Degree of collective action	
	i15	Length of residence	Indicates how old is the community in other words its number of years of existence
Risk awareness	i16	Perceived communal risk	Indicates the recognized risk faced by the community
	i17	Hazard experience	Relates to any previous experiences or account of (death, damage, injuries and material losses) due to a disaster in the community. Also could be expressed as the number of human and/or material loss. The indicator provides an estimate of human and economic impact of a potential disaster in the community
	i18	Knowledge of protection measure	Indicates the level of awareness and knowledge about possible resources and measures to resist, cope and adapt to a possible disaster
	i19	Training of health and emergency human resources	Indicates the degree to which the community has access or has been involved with education and awareness raising programs

INSTITUTIONAL VULNERABILITY			
THEME	ID	IDENTIFIED INDICATOR	DESCRIPTION
Local governance structure	i20	Local government structure	Indicates the degree of representativeness of the community in higher local government bodies and its level of participation in decision-making processes.
	i21	Participatory decision making	Indicates the degree to which communal gatherings (i.e. community meetings) take place and may provide signals of self-mobilization which is linked to collective action
Local institutions and actors	i22	Existence of CBO and NGO and other local institutions	Indicates the numbers of active local organizations in the community and their level of contact with local residents and/or local leaders
	i23	Existence of an emergency plan	Indicates the awareness or knowledge of existence of an emergency plan for the community
PHYSICAL VULNERABILITY			
THEME	ID	IDENTIFIED INDICATOR	DESCRIPTION
Green areas	i24	Existence of trees	Measures the proportion of land area covered by trees in the community
	i25	Existence of green parcels or urban cropland area	Indicates the percentage of practices of farming for income earning or food producing purposes in the community. Can be linked to food security and food safety factors (UN, 2007)
Land use	i26	Density	Indicates the number of persons per residential unit or cultivable land
	i27	Land ownership and property titles	Indicates the percentage of house owned or the number of holding property titles. It provides an indication of dwelling usage rights and the level of decision making power in the community
	i28	Land use change	Provides information on changes in productive and protective uses of land to facilitate urban planning and policy development (UN, 2007). The change in land use may also indicate to what degree land degradation, soil cover loss and landscape changes occur in the community
Social infrastructure	i29	Existence of schools	Indicates the existence of mechanisms for social welfare in the community. Provision of schools and health facilities are crucial in the establishment of a community's wellbeing particularly when a disaster
	i30	Existence of churches and other worship	

	i31	Existence of sport facilities or areas for recreation	known to serve as community shelters in the event of severe weather
Technical infrastructure	i32	Access to energy supply	Provides information on accessibility and affordability of energy services, being essential components of basic technical infrastructure. Indicates the percentage of households with access to electricity using communal grid or using other energy supply options as primary fuel for cooking. A variable is the percentage of households using solid fuel as source of cooking also serves as a proxy for indoor pollution and can contribute to deforestation and land degradation when there is a high demand to meet households' needs (UN, 2007)
	i33	Access to water supply	
	i34	Level of sanitation	Indicates the percentage of households with sanitation facilities. Associated variables are connection to the municipal sewage system, existence of septic tanks and latrines
	i35	Solid waste generation and management	Indicates amount of solid waste generated collected and disposed of (in sanitary landfills or in dumpsites) per household. This indicator provides information on the pressure of waste practices on the urban environment and livelihood of communities as well as the economic pressure on their municipalities. Poor waste disposal have local impact such as the contamination of soils and ground water, waste water floods, spread of diseases
	i36	Access to communication technology	Provides a measure of internet, mobile phone, telephone (landlines), television access and use in the community. Telecommunication is critical to sustain the development of communities and is closely linked to social, economic and institutional factors (UN, 2007). A proxy is the number of mobile subscribers given the fact that mobile phone have overtaken fixed landlines in recent years
	i37	Existence of road network	Indicates the level to which the road network is reliable and its capacity to function in determined conditions. It may provide information on the existence and reliability of connections among several points and their level of exposure when face with a hazard. A common proxy is the level of accessibility which in transportation terms refers to the ease of reaching destinations such as places of employment, education and recreation
	i38	Transportation	
Housing	i39	Type of housing	Indicates the percentage of construction type predominant in the community

Annex 8. Energy potential of waste from urban areas in Africa.

All countries (Low income countries and High Income countries as well) produce large amounts of waste. Despite all efforts to reduce, recycle and reuse waste, there is a growing amount of waste that needs in some cases to be disposed in landfills. Waste generation is expected to rise with increased population, urbanisation and improved lifestyle; this would result in additional challenges to waste management systems and in an additional pressure on the environment. Waste management is usually one of the most complex and cost-intensive public services. In developing countries, waste management has the highest share in municipalities' budgets, spending from 20% to 50% of their available budget on solid waste management (World bank 2012, UNEP 2013, UN-HABITAT 2010). Many cities in Africa face significant difficulties related to waste management, collection and disposal of Municipal Solid Waste (MSW) linked to the lack of infrastructure (Achankeng 2003, Henry et al 2006, Simelane et al 2012). The poor waste management in Africa has important consequences for the disposal of uncollected waste in dumps and the associated severe environmental and health related problems. An integrated approach to solid waste management is thus required in order to enable local/ national authorities to reduce the overall amount of waste generated and to recover valuable materials for recycling and for the generation of energy. Energy recovery from waste can play a role in minimising the impact of Municipal Solid Waste (MSW) on the environment with the additional benefit of providing a local source of energy.

Energy supply in Africa

Energy is a critical issue for Africa, where many people do not have access to energy. Africa has consumed on average 685 ktoe per capita in 2010, which is only one third of the global average energy consumption per capita (1881 kgoe/capita), using a mix of hydropower, fossil fuels and biomass, mostly in traditional uses. Energy consumption in Sub-Saharan Africa was even smaller, only 632 kgoe/capita, while, if excluding South Africa, this figure drops down to 501 ktoe per capita in 2010 (IEA, 2012). African countries often have to rely on diesel power generation to meet their electricity needs, which costs some African economies between 1% and 5% of GDP annually. Africa, with 15% of the world population has produced 662 TWhe, representing only 3.1% of world electricity and only 647 kWe/capita. In Sub Saharan Africa, however, the electricity consumption per capita was even smaller, only 473 kWe/capita, compared to the world average of 2981 kWe/capita in 2010 (IEA, 2012, UN 2013).

Nearly 1.3 billion people globally, almost one-fifth of the Earth population, did not have access at all to electricity in 2010 with the majority from Africa (about 590 million people, representing 57% of the African population). The urban electrification rate has reached 72.1% in 2010 while the rural electrification rate was still only 23.6% in 2010. Regional differences are significant: while in North Africa only 1% of the population does not have access to electricity, the average electrification rate for Sub-Saharan Africa was only 31.8% in 2010. For Sub-Saharan Africa this share varies across countries between 50% and 85%. The average urban electrification rate was 64.2% in 2010 and the rural electrification rate was only 12.9% in Sub-Saharan Africa; a high share of people (around 57.8%) lived in rural areas in Africa (IEA 2012, IRENA, 2012).

Waste management and energy recovery options

Solid waste management (including collection and disposal) are key challenges that all cities in the world have to face, but that are particularly difficult in Africa where many towns and cities lack regular waste collection and disposal services. Poor financial resources, limited technical capacity and insufficient infrastructure are important challenges for the planning and management of solid waste. In addition, the increase in population puts more pressure on waste management. Additional issues are related to the economic development, technology access, lack or weak enforcement of environmental legislation, as well as a limited environmental awareness (Mwesigye et al 2012, Mohammed et al 2013, Trois and Jagath 2011).

Waste management services in Africa are provided mainly to large cities (Couth and Trois 2011). Nevertheless, a limited share of waste is generally recovered and reused. No waste management systems are generally available for rural areas where waste is traditionally deposited in uncontrolled areas or subject to some extent to reuse, recycling and composting (Trois and Jagath 2011). Most of the MSW in Africa is burned on site or deposited in open dumps or semi-controlled landfills with no groundwater protection, leachate recovery, or treatment systems and usually without soil cover. Waste dumps are located on the edges of urban areas, sometimes in ecologically sensitive areas with potentially negative impacts on water sources. Waste deposited in these areas contaminates the surface and ground water and poses major health hazards. If not properly controlled, waste disposal has important negative impacts on the local environment, e.g. soil, pollution and air pollution (odours, emissions), health risks (pathogens) and climate change (methane emissions) (Mwesigye et al 2012, UNEP 2013).

Several practices are possible for waste management, such as waste reduction, recycling, recovery, and energy recovery. Several technologies are commercially available for energy recovery from waste, such as incineration, biochemical conversion (e.g. anaerobic digestion). These options can bring other additional benefits (e.g. fertiliser from anaerobic digestion) and Land Fill Gas (LFG) collection.

Waste generation and collection

Solid waste generation rates and composition vary across Africa in relation to local economy, industrial development, local conditions and cultural traditions. They are estimated to range from 33 kg/capita/year to 1095 kg/capita/year. Several studies showed that waste production is linked to the income: the higher the GDP, the greater the waste production (Mwesigye et al 2012, USAID 2009). The data available show that the average waste production from Sub Saharan African countries is around 237 kg/capita/year, well below the waste production of 803 kg/capita/year in OECD countries, as shown in Table 1.

Since a large share of the African population lacks access to waste management, waste collection rates are well below the generation rates. The waste collection rates vary significantly by national income and by region. Higher income countries have higher collection rates, averaging 98% in high-income countries and 40% in low-income countries. There are large differences between collection rates in Sub-Saharan region, ranging between 18% and 48%, with the exception of South Africa (Table 2). These collection rates are much lower than in other developing countries, especially in comparison with Northern Africa (World Bank 2012, UNEP 2013). Moreover, large differences between cities and between rural and urban areas are also known to exist. In general, only major cities in Africa have waste management systems collecting waste; data on waste generation and collection are generally available at country level and several studies provided some data for large cities, such as Yaounde or Kampala (World Bank 2012, Mwesigye et al 2012, Mohammed yet al 2013), while data for smaller cities appears to be very limited. Some cities face faster increases in waste generation rates compared to collection rates, as it was the case for Yaounde (Parrot et al 2009).

Table 1. Present waste generation rates by region (Source: World Bank 2012)

Region	Range (kg/capita/year)	Average (kg/capita/year)
Sub-Saharan Africa	33-1095	237
North Africa	296-533	442
OECD	400-1351	803
Latin America	40-1945	402
East Asia and Pacific	160-1570	347
South Asia	44-1862	164

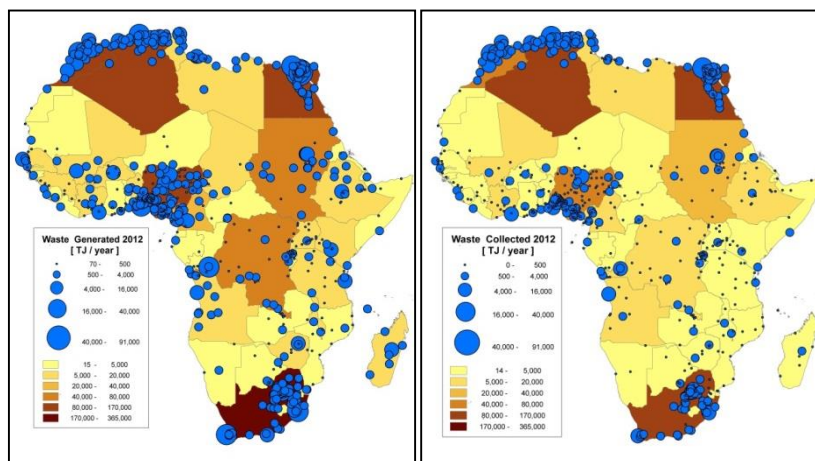
Table 2. Waste collection in several African countries in the present (Source: World Bank 2012)

Country	Income	Collection (%)	Country	Income	Collection (%)
Algeria	LMI	92	Morocco	LMI	86
Benin	LI	23	Senegal	LI	21
Cameroon	LMI	43	Seychelles	UMI	95
Chad	LI	20	Sierra Leone	LI	44
Comoros	LI	20	South Africa	UMI	50
Egypt	LMI	63	Tanzania	LI	48
Ghana	LI	85	Togo	LI	42
Madagascar	LI	18	Tunisia	LMI	95
Mali	LI	40	Uganda	LI	39
Mauritania	LI	30	Zambia	LI	20

Energy recovery from waste

A JRC study was carried out to assess, at the African level, the role which waste could play in providing energy to citizens and provides an estimate of the total potential of energy from waste incineration and from LandFill Gas (LFG) for 2012 and 2025. The estimations consider waste production and collection in urban areas only, since no waste management systems are generally available for rural areas in Africa. Data on waste generation and composition for 2012 were made available by World Bank, which also provided predictions depending on urbanisation and perspectives for economic development, based on the current solid waste management practices. Considering the limited data availability on waste management in Africa, the average data at country level was taken into account for the purpose of assessing the energy potential, although there are large variations from city to city in terms of waste generation and collection.

This study also provides an estimate of the potential energy recovery from waste generation through incineration (as a theoretical potential) or from landfill gas recovery in managed landfills. The energy potential of waste was estimated at 1,125 PJ for the whole of Africa in 2012 and can reach 2,198 PJ in 2025, if all the waste generated is supposed to be collected. Only waste generated in urban areas was considered, where waste management is generally available or could realistically be established in the near future. Considering the actual collection rates for 2012 and projected for 2025, the energy potential of waste was estimated at 613 PJ for the whole of Africa in 2012 with a possible increase to 1,508 PJ in 2025. In comparison, the primary energy supply in Africa was about 29,308 PJ in 2010. Thus, the share of energy from waste is relatively reduced, due to the low amount of waste generated, but especially due to the low rate of waste collected per capita.



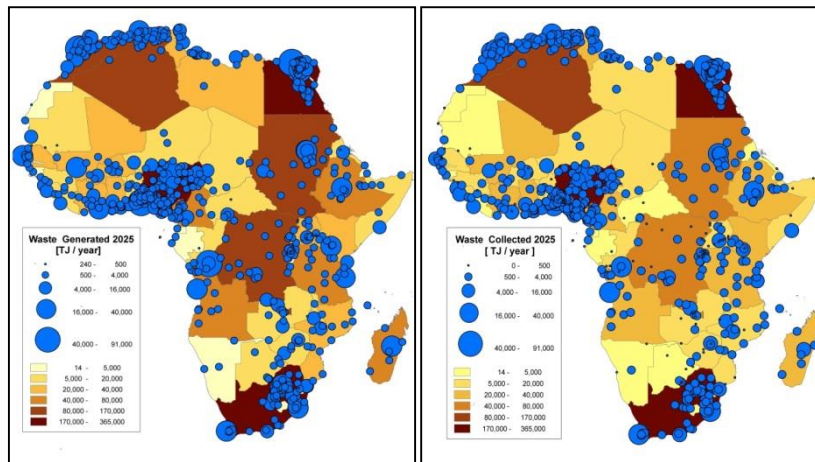


Figure 1. Energy potential from waste generated and collected in Africa in 2012 and 2025

LFG can be captured and used for energy generation or flared on-site to reduce GHG emissions. The LFG collection is technically feasible starting from some years after landfill opening and can continue after landfill closing (typically 25 years). The large majority of landfills in Africa do not have any system for gas collection installed. A study conducted in Uganda to explore the viability of electricity generation from landfill gas in Kampala assessed the electricity potential of the landfill at 31,000 MWh in 2009 and 26,600 MWh in 2011 (Mwesigye et al 2012). South Africa is currently considering the option of generating electricity from landfill gas collected from landfill sites. The study conducting an economic assessment of electricity generation at the landfill site in Cape Town proved that grid-connected or stand-alone systems using turbines appear to be economically viable (Dowling et al 2012).

The JRC study shows that methane potentially recoverable from managed landfills in Africa would reach 7.7 billion Nm^3 in 2012 and 14.8 billion Nm^3 in 2025, if all waste generated would be collected. In real conditions, however, with much lower collection rates, the potential recovered methane from managed landfills could have reached only 4.3 billion Nm^3 in 2012 and 10.1 billion Nm^3 in 2025. Compared to the total energy potential of waste of 1,125 PJ in 2012, about 283 PJ could be recovered from the LFG from landfills in the whole African continent, if all waste from urban areas is collected. From the total 2,198 PJ of waste expected to be generated in 2025, around 530 PJ can be recovered from the LFG from landfills, also assuming a complete collection of generated waste. Considering the total energy potential of waste actually collected of 613 PJ in 2012, only about 155 PJ could be recovered from the LFG from landfills and from the overall 1508 PJ of waste generated in 2025, 363 PJ could be recovered from the LFG.

The energy potential of waste and the methane potential have been quantified for African major cities considering cities' location and population (FAO 2008). The potential locations of the landfill sites were supposed to be chosen in the vicinity of the urban areas, where they are actually typically placed. The amount of the waste deposited in each location was estimated on the basis of the waste generated or collected in that specific urban area. Figure 3 shows the exemplification for Burkina Faso and Côte d'Ivoire of the spatial distribution of energy potential of waste. Several major cities were considered in this analysis (8 cities for Burkina Faso and 11 cities for Côte d'Ivoire) where the waste could be collected and its energetic potential could be used. This figure gives a closer view of the potential at country level for the year 2008 and the projections for 2025.

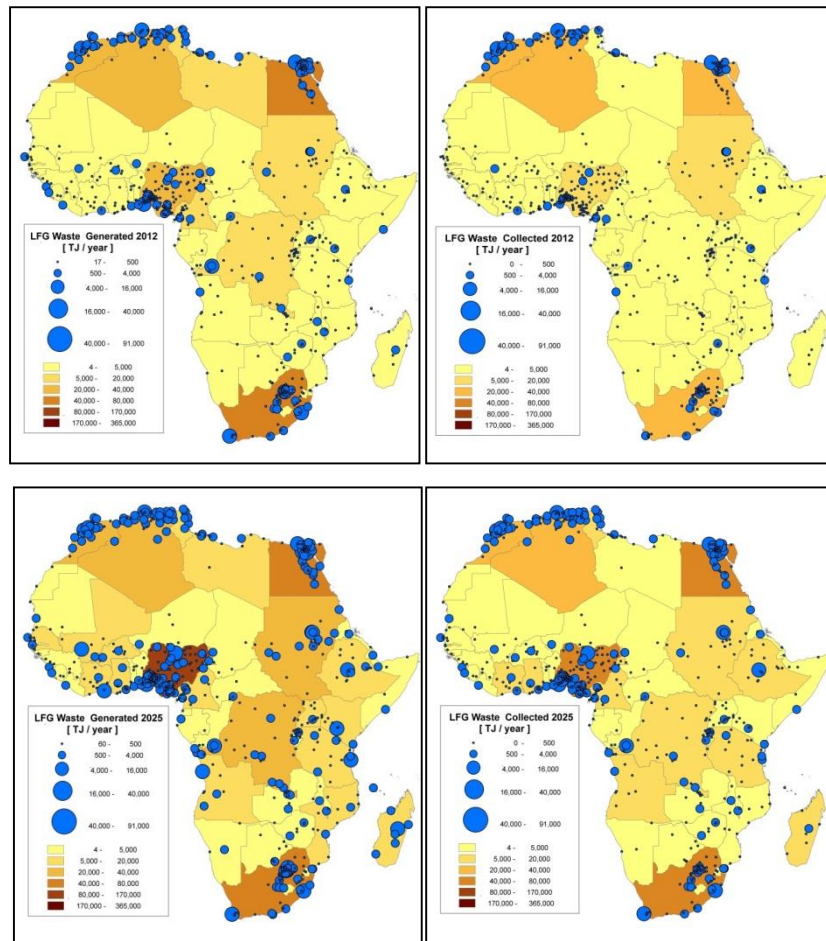


Figure 2. Energy potential of LFG from waste generated and collected in Africa in 2012 and 2025



Figure 3. Spatial distribution of energy potential of waste - exemplification for Burkina Faso and Côte d'Ivoire

As a conclusion, waste management is an important component of urban sustainability and the CoM SSA signatories can assess the present situation in the field, plan future activities and implement measures aiming to reduce, recycle, re-use or convert to energy.

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Annex 9. End-of-life Management of Solar Photovoltaic Panels

Photovoltaics are set to play a key role in meeting the global need for clean and sustainable energy and in particular can help address the fast growing demand for energy in low income countries. The basic element of PV systems is the PV panel or module, comprising mostly glass, the PV active material, organic encapsulants, connectors and in some cases an edge frame. This package typically has useful operational life of 25 to 30 years.

Although the global market is still relatively young, its dynamic growth has led to the realisation that strategies are needed for dealing with large future volumes of end-of-life PV panels. There are two main considerations:

- a) sustainable use of resources through reuse and recycling (in particular of precious and scarce metals such as silver, gallium, indium, and germanium, as well as of conventional material such as aluminium, glass and silicon), and
- b) environmental concerns for incorrect disposal, in particular leaching of hazardous substances (e.g., lead for crystalline silicon photovoltaics and cadmium for some thin film products).

The 2016 IRENA-IEA-PVPS report [1] on end-of-life management provides a holistic view of the state of the art regarding decommissioning, repair, reuse, recycling and disposal from both a technical and regulatory perspectives. If you want to know more about what is being done at international level, the International Energy Agency Task 12 focuses among other activities on recycling of manufacturing waste and spent modules. Some good quality documents and reports are found on its website (<http://www.iea-pvps.org/index.php?id=56>).

Recycling

Up to now relatively few countries have addressed the issue of PV waste and recycling in regulations. The EU is forerunner in the respect and since 2012 includes PV panels under its Waste Electrical and Electronic Equipment (WEEE) directive, which requires an 85% recovery rate of waste PV modules by mass. Regional schemes for collecting solar panels are in place. Although solar panel recycling presents technical challenges to separate multiple, extremely different materials, the technology has developed accordingly and the European solar panel recycling association PV Cycle boasts processes for recovering over 95 percent of a panel's materials.

Recycling technologies can be classified into bulk recycling (recovery of high mass fraction materials such as glass, aluminium and copper) or high-value recycling (recovery of both semi-conductor and trace metals). End-of-life crystalline silicon panels¹⁶², which currently make up well over 90% of the global market, are crushed or shredded and then glass and metals are separated. Pyrolysis at about 500°C is needed for the recovery of the silicon wafers from the modules and a chemical etching for the removal of metal coatings, antireflective coatings, and diffusion layers. For thin-film¹⁶³ CIGS and CdTe modules, both bulk and high-value recycling is also possible. For example First Solar, the main producer of CdTe modules, claims that up to 90% of the semiconductor material can be reused in new modules and 90% of the glass can be reused in new glass products.

At present recycling faces significant economic challenges [1]. One factor is the lack of volume needed to achieve economies of scale. A more serious long term issue is that

⁽¹⁶²⁾ A "crystalline silicon" solar panel or module typically has an area of about 1.5 m² and is composed of approximately 60 interconnected silicon wafers, a backsheet, polymer encapsulation, front glass and a conjunction box. There may also be a aluminium or plastic edge frame. By weight, glass contributes approximately 80%. Other elements include: 5% silicon, 1% copper and less than 0.1% of silver, tin and lead

⁽¹⁶³⁾ Thin film refers for modules that are fabricated by deposition of active layers of a few micron thickness on a large area substrate, almost always glass. The glass makes up well over 90% of the mass. Cadmium telluride (CdTe) and Copper Indium Gallium Diselenide (CIGS) are the two main commercial products

crystalline silicon the panels contain relatively few valuable materials, so the recycling cost is generally higher than the landfilling one. Thin-film module may offer more commercial scope given the presence of more valuable materials.

Disposal

Where recycling is not performed for reasons of cost-economics or lack of facilities, various materials from end-of-life PV panels or from the recycling process may need to be disposed of in appropriately design and manged landfills, subject to regulation and classification of hazardous content. PV panels are generally seen as inert waste, but given the presence of various trace metals in PV modules, there have been concerns about potential environmental impacts if module material were to be disposed of in unlined landfills. Studies have focussed in particular on leaching of lead from crystalline silicon module material and of cadmium from cadmium telluride thin film module material, exploring factors such as the acidity of the landfill environment, size of the module fragments etc. [3,4].

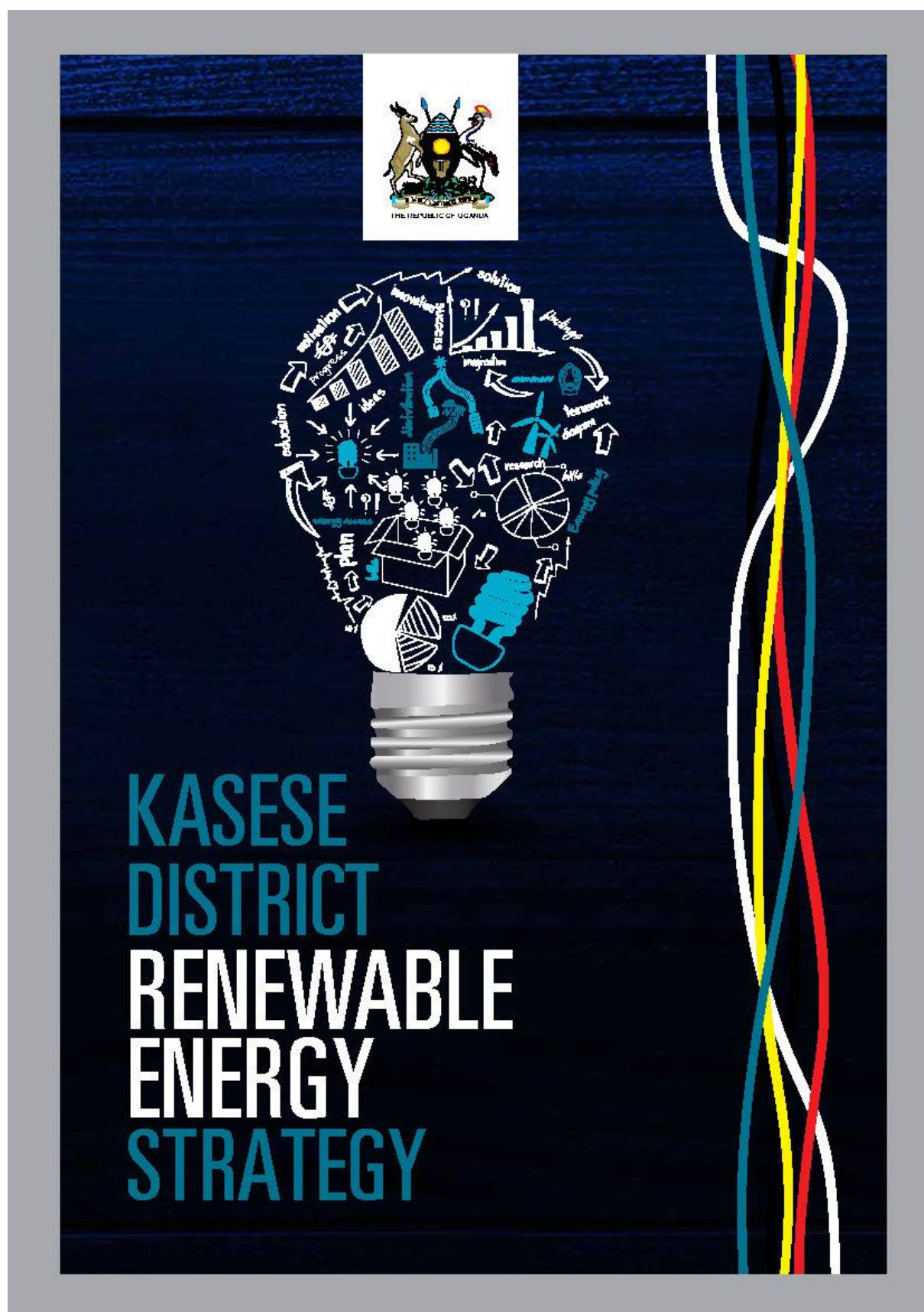
Summary points

- Given the key role of PV technology in future energy systems, all jurisdictions should PV end-of-life management aspects in regulatory schemes; experiences in Europe and other countries can provide useful examples. Collection schemes are an important part of such strategies given the distributed nature of PV deployment, especially in the urban environment.
- Reuse and recycling technology is available today although the short term lack of waste volume means that economies of scale often can't be realised.
- Disposal of materials from end-of-life PV panels or those remaining from the recycling process should be appropriately design and manged landfills, subject to regulation and classification of hazardous content.
- The PV sector should be encouraged to develop a sustainable product life cycle and industrial value chain, including repair, reuse, recycling and safe disposal of PV panels.

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Annex 10. Kasese district renewable energy strategy



Kasese District has developed a Renewable energy strategy to guide its initiatives of promotion and distribution of clean, renewable and efficient energy technologies through its Public Private Partnership (PPP) to replace the unsustainable harvesting of our natural vegetation in the name of energy supply.

The energy sector in Kasese district includes energy sources that are either locally produced or imported. The overall objective of the Renewable Energy Strategy is to diversify the energy supply sources and technologies in the district and aim to achieve 100% access to renewable energy by the year 2020. It sets out the district's vision, strategic goals, principles, objectives and targets for promoting and implementing renewable energy investments in Kasese.

For more information the document is available at:
https://d2ouvy59p0dg6k.cloudfront.net/downloads/kasese_district_renewable_energy_strategy.pdf

Annex 11. End-of-Life Management of Batteries in the Off-Grid Solar Sector

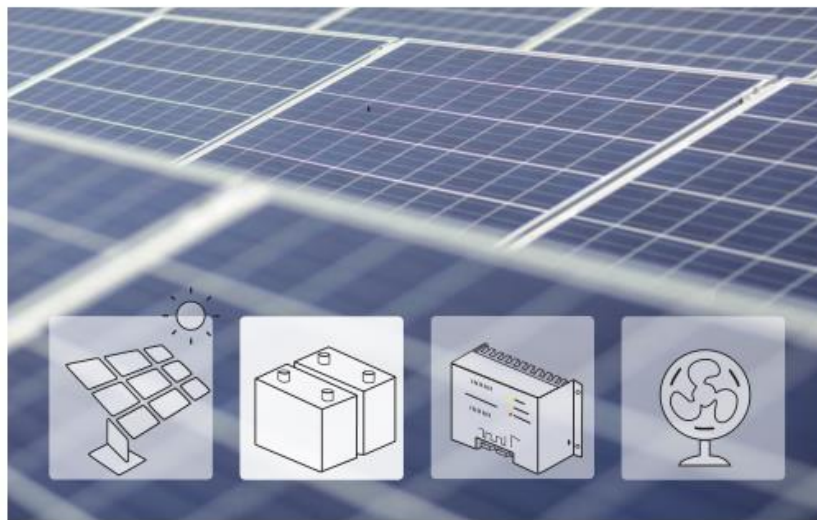
E-waste and battery waste are already known to be a challenge in many developing countries and emerging economies with serious hot spots in many urban areas where collection and recycling is often conducted by informal sectors with little regard to emission control and impacts on human and environmental health. If these challenges are not taken into account by energy-access projects, related problems might soon expand to rural communities. But this negative scenario should not be used as a reason to slow down energy access efforts.

The document "END-OF-LIFE MANAGEMENT OF BATTERIES IN THE OFF-GRID SOLAR SECTOR - How to deal with hazardous battery waste from solar power projects in developing countries?" introduces the realities of managing e-waste and battery waste in the context of developing countries, with a specific focus on energy access projects.

The document, published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, authored by Andreas Manhart, Öko-Institut e.V. Inga Hilbert, Öko-Institut e.V. Federico Magalini, Sofies and edited by: Daniel Hinchliffe, Ellen Gunsilius (GIZ Sector Project), Caspar Priesemann (Energising Development (EnDev)) is available at: <https://www.giz.de/de/downloads/giz2018-en-waste-solar-guide.pdf>

END-OF-LIFE MANAGEMENT OF BATTERIES IN THE OFF-GRID SOLAR SECTOR

How to deal with hazardous battery waste from solar power projects in developing countries?



Andreas Manhart, Inga Hilbert – Öko-Institut e.V.
Federico Magalini – Sofies

Developed in cooperation with GIZ sector project "Concepts for Sustainable Solid Waste Management" on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), and in cooperation with the multi-donor programme Energising Development (EnDev).

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