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DEFINING CARBON NEUTRALITY FOR CITIES & MANAGING RESIDUAL EMISSIONS

CITIES' PERSPECTIVE & GUIDANCE

C40 CITIES Climate Action Planning | NYC Mayor's Office of Sustainability

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United Nations Framework Convention on Climate Change (UNFCCC)

LIST OF ACRONYMS

AFOLU	Agriculture, forestry, and other land use
BAU	Business-as-usual
BECCS	Bioenergy with carbon capture and sequestration
CAP	Climate action plan(ning)
CFCs	Chlorofluorocarbons
CDM	Clean Development Mechanism
CDR	Carbon dioxide removal
COF	Carbon Offset Fund
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DACS	Direct air capture of CO_2
ETS	EU Emissions Trading System
GHG	Greenhouse gas
GGR	Greenhouse gas removal
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial process and product use
LPAs	London's Planning Authorities
Mwh	Megawatt hour
$mtCO_2e$	Metric tonnes carbon dioxide equivalent
NDCs	Nationally Determined Contributions
NET	Negative emissions technology
OA	Ocean acidification
REC	Renewable energy credit
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RGGI	Regional Greenhouse Gas Initiative
SCS	Soil carbon sequestration
SR15	IPCC Special Report on Global Warming of 1.5°C
SRM	Solar radiation management
UNFCCC	United Nations Framework Convention on Climate Change
WCI	Western Climate Initiative

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Background

In 2016, 175 Parties ratified the Paris Agreement. In doing so, they committed to keep global average temperature rise to well below 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C. The Paris Agreement was also a promise to increase nations' resilience to the impacts of climate change.

The Preamble to the Paris Agreement recognised the significant role of local governments in tackling climate change. To be consistent with the objectives of the Agreement, cities need to ramp up their collective ambition, driving rapid and systemic change on the ground. Cities urgently need to position themselves on an ambitious emissions reduction (or peaking) trajectory to achieve carbon neutrality and climate resilience by 2050, at the latest[1].

In October 2018 the Intergovernmental Panel on Climate Change (IPCC) released the *Special Report on Global Warming of 1.5°C (SR15)*. This confirmed that current national government commitments are inadequate; projecting a warming between 2.9 and 3.4°C by 2100. This scenario has devastating implications for humanity and the planet, including to food and water security, living standards and human health, and loss of ecosystem services.

Limiting warming to below 1.5°C imposes difficult challenges for current and future generations; according to the SR15 reports if net zero is achieved by 2048[2] there is only a fifty percent chance that warming will stay below 1.5°C. Achieving net zero by 2038 improves this chance to two thirds, but global emissions must fall by up to seventy five percent (relative to 2017 levels) by 2030[3]. Further, for every year of failed action the window to reach net zero is reduced by two years.

These figures highlight that for citizens, businesses and society to thrive, aggressive strategies are needed to significantly mitigate GHG emissions, while towns, cities and regions need to prepare for the impacts of a changing climate, including a worst case scenario of 2.9 - 3.4°C or more.

Critically, the SR15 report finds that staying within the 1.5°C limit is technically possible but will require rapid behavioural and technological transformation at all levels - countries, cities, private sector and individuals – to enable major emissions cuts ahead of 2030 and to achieve global net zero emissions by 2050 or sooner.

If cities are to drive the rapid and systemic change The Paris Agreement prescribes, then it is crucial there is a clear guidance for cities on what citywide carbon neutrality looks like and how to implement and realise both interim milestones and carbon neutrality.

[1] https://www.c40knowledgehub.org/s/article/Deadline-2020-How-cities-will-get-the-job-done?language=en_US

[2] Summary for Urban Policymakers, https://www.ipcc.ch/site/assets/uploads/sites/2/2018/12/SPM-for-cities.pdf

[3] https://www.ipcc.ch/sr15/chapter/chapter-2/

Existing greenhouse gas (GHG) accounting and target-setting protocols make reference to terms such as "carbon neutrality" and "net zero," but to date[4] they do not clearly and consistently define these terms. Nor do they provide the detailed guidance that cities need to develop citywide carbon neutrality implementation strategies. While leading cities agree that carbon neutrality should be achieved at the citywide scale[5], there is ongoing debate regarding how residual emissions[6] should be defined (e.g. scopes, boundaries, sectors), cancelled out (e.g. with carbon credits) or removed (e.g. with negative emissions technologies[7] including Carbon Dioxide Removal (CDR)) in order to achieve carbon neutrality.

The immediate focus of cities should be on delivering transformational GHG mitigation action and increasing resilience. However, medium-term planning will require careful consideration of additional mechanisms to realise cities' carbon neutrality goals.

All pathways that limit global warming to 1.5°C in the SR15 include CDR measures[8], which vary greatly in terms of maturity, scalability, costs, risks, co-benefits and trade-offs. Research on these topics is still limited, with existing measures subject to multiple feasibility and sustainability constraints[9]. Further, while many carbon offset project protocols and standards have been launched recently, few cities have offset their residual emissions. Carbon neutrality is still a new and challenging topic for most cities.

Securing support and partnerships for the required transformational action and accelerated delivery will entail actions beyond the experience of municipal governments, cities will need to engage with internal and external stakeholders throughout the carbon neutrality planning and implementation processes. Effective communication, however, can be challenging when concerning the complex nature of climate change and carbon neutrality, and therefore must be explained using clear and simple words in ways that resonate.

Furthermore, experts use a significant amount of specialised vocabulary to talk about carbon neutrality, climate action, and carbon offsetting, which can create communication challenges. Formulating simplified definitions that the public will understand, including how those terms and concepts interrelate and how they relate to the local context, culture, and values will be essential.

For these reasons, and in the context of the update of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC 2.0), this document provides guidance on different approaches that cities may take to achieve carbon neutrality. The intention is to update the guide as new technologies and best practices emerge. The shared definitions, guidance, and best practices in this document have been developed in collaboration with cities, civil society partners, and expert organisations. These will help cities develop strategies for carbon neutrality and inform cities engaging in the GPC update process.

[4] Annex B: Carbon Protocols and Standards reviewed for this document

[5] Not just at the municipal operations level but including all those who are responsible for emissions in the city such as the private sector, citizens and government institutions

[6] Emissions remaining at the close of an accounting period after all technically and economically feasible mitigation opportunities have been implemented

[7] The removal of GHGs from the atmosphere by deliberate human activities (i.e. in addition to the removal that would occur via natural carbon cycle processes). For CO_2, negative emissions can be achieved with direct capture of CO_2 from ambient air and sequestration (DACS), bioenergy with carbon capture and sequestration (BECCS), afforestation, reforestation, biochar, among others

[8] To date, only a few published pathways include CDR measures other than afforestation and BECCS

[9] IPCC SR15

Cities must act immediately and decisively on climate change. The longer cities wait, the more expensive and difficult it will be to reduce emissions and, as a result, more natural and human systems will be exposed to significant risk.

Objectives

This initial guidance document for *Cities* aims to:

1. Establish a shared understanding of city carbon neutrality aligned with existing accounting protocols and emerging international consensus on carbon neutrality

2. Identify common principles on:

- Mechanisms for addressing residual emissions, and
- Measuring and reporting both gross and net emissions[10] in cities, to ensure transparency, environmental integrity, and alignment with emerging global mechanisms.

3. Provide guidance, including through shared international best practices, on:

- Timing of strategies, recommended limits to residual emissions and offsetting, and transparency on the approaches taken to achieve carbon neutrality;
- Environmental integrity principles that should be exhibited when choosing projects to cancel out residual emissions;
- Residual emissions offsetting approaches (e.g. mechanisms, types of projects, roles for the city and partners, wider project benefits available to cities), and
- Reporting on progress.

How to use this guidance

Cities looking to understand the recommended definitions and minimum recommended guidelines for carbon neutrality should read Section I and Section II. Section I provides key definitions for city carbon neutrality. It also outlines the carbon neutrality process at a high-level and the potential roles cities may take to reduce residual emissions and achieve carbon neutrality. Section II includes guidelines on how to plan, report on progress and achieve carbon neutrality.

This guidance recognises that each city has its own individual context. The guidance outlines *Essential* elements of planning for and implementing carbon neutrality in cities, as well as *Best Practice* elements to provide guidance on how to strengthen carbon neutrality strategies.

Essential	Strategies and practices that cities should adopt in the planning and implementation of carbon neutrality
Best practice	Strategies and practices that are highly recommended for cities in the planning and implementation of carbon neutrality

[10] Reporting gross vs. net emissions enables transparency regarding residual emissions cancelled out through mechanisms such as carbon credits

Cities interested in learning about the practices of offsetting and employing negative emissions technologies should refer to section III which provides guidance on offsetting, key principles and methodologies, while section IV focuses on negative emissions technologies. To provide flexibility to cities, and because some areas of practice have yet to be tested, these sections provide more general guidance on specific factors to take into consideration in the decision-making process and some of the options available to cities.

This guidance focuses on achieving **citywide carbon neutrality** and can be used in the early stages of climate action planning, i.e. in parallel to the climate action plan development, to help define carbon neutrality, or to understand residual emissions and how and when to address them in the climate action planning process.

Cities can also use the guidelines as part of their efforts to achieve municipal carbon neutrality, or carbon neutrality for local government operations. The principles outlined in this guidance can be tested by cities looking to compensate for residual emissions from local government operations.

As different approaches are tested and shared across cities, this guidance document will be further developed and updated.

It is expected that further rules will also be developed at the international level, as part of the UNFCCC discussions on the implementation of Article 6 of the Paris Agreement. Article 6 focuses on international cooperation mechanisms such as Internationally Transferred Mitigation Outcomes (ITMOs), which allow for emission reductions from measures implemented in one country to be transferred to and counted towards another country's nationally determined contribution (NDC) to the Paris Agreement.

City of Copenhagen

1. Carbon Neutral Cities - Key Definitions and Approaches

What is Carbon Neutrality for Cities? This guidance proposes the definition of a 'carbon neutral' city[11] , also referred to as an 'emissions neutral' city, as a city that has achieved and demonstrated in a given year[12]:

- Net-zero greenhouse gas emissions from fuel use in buildings, transport, and industry (scope 1);
- Net-zero greenhouse gas emissions from the use of grid-supplied energy (scope 2);
- Net-zero greenhouse gas emissions from the treatment of waste generated within the city boundary (scope 1 and 3), and
- Where a city accounts for additional sectoral emissions in their GHG accounting boundary, net zero greenhouse gas emissions from all additional sectors in the GHG accounting boundary.

Alternatively, for cities that solely account for emissions using a consumption-based approach, a 'carbon neutral city' will have achieved and demonstrated net-zero greenhouse gas emissions from all sectors in the GHG accounting boundary.

Claims of carbon neutrality are time sensitive and must be continuously achieved by demonstrating net-zero greenhouse gas emissions in all relevant scopes and boundaries on an annual basis.

In alignment with "BASIC "[13] of The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), the scopes and sectors identified above represent the minimum guidelines required for carbon neutrality goals. Where feasible, the definition of carbon neutrality should also include minimised greenhouse gas emissions occurring outside the city's geographic boundary because of goods and services consumed by city residents, businesses and government (scope 3). Consumption based inventories have uncertain and expansive boundaries that overlap with production based approaches like Scope 1, 2, and 3. For this reason, cities must clearly define their GHG accounting boundaries, and ensure they are aligned with minimum requirements and as comprehensive as possible.

The GPC, the global standard for measuring GHG emissions from cities, defines carbon neutrality goals as fixed-level[14] goals designed to reach net-zero GHG emissions in a target year, acknowledging that such goals often include the purchase and use of carbon credits to compensate for emissions after annual reductions.

[11] Definition adopted from the Climate Action Planning Framework. Please note that some cities' inventory boundaries may go beyond the minimum requirements for scopes and sectors identified in this definition, depending on the local context

[12] The emissions inventory should include quantification of emissions sources that are significant in the city. In most cities, this will include as a minimum stationary energy, transport, and waste. In some cities, agriculture, forestry, and other land use (AFOLU), or industrial process and product use (IPPU) may be significant too

[13] The BASIC level covers emission sources that occur in almost all cities (stationary energy, in-boundary transportation, and in-boundary generated waste)

[14] Fixed level goals represent a reduction in emissions to an absolute emissions level in a target year (e.g. net zero emissions in 2040). Both fixed level goals and base year emissions reduction goals (e.g. 90% GHG emissions reductions by 2040 compared to 2004 levels) can be used to support city planning for carbon neutrality

For the purposes of achieving city carbon neutrality, relevant terms and high-level definitions to communicating, planning, and implementing for carbon neutrality include:

TERM	DEFINITION
BASIC	The GPC BASIC reporting level covers scope 1 and scope 2 emissions from stationary energy and transportation, as well as scope 1 and 3 emissions from waste
BASIC+	The GPC BASIC+ reporting level covers the scopes included in the BASIC definition, transboundary transportation, and additionally includes emissions from the Industrial Processes and Product Use (IPPU) and the Agriculture, Forestry, and Land Use sectors (AFOLU)
Carbon credit	A carbon credit represents a metric ton of carbon dioxide-equivalent (CO_2e) that is avoided or sequestered outside the GHG accounting boundary (or geographic boundary as a proxy for GHG accounting boundary) and can be used to compensate for a metric ton of residual GHG emissions occurring within the accounting boundary. For the purposes of this guidance document, only project-based carbon credits are considered; carbon credits associated with allowances in compliance schemes (e.g. the EU Emissions Trading System (ETS)) are not
Carbon credit project	Carbon credit projects generate carbon credits – tradeable units representing a verified tonne of CO_2e not released into the atmosphere or a verified tonne of CO_2e removed from the atmosphere
Carbon credit providers	Carbon credit providers issue carbon credits for carbon credit projects and track the transaction of credits over time
Carbon credit registry	Formal validation and tracking of local, national or globally-sourced projects that generate tradeable carbon credits from a registered/credible/ established carbon credit provider. Carbon credit registries also oversee independent 3rd body verification to ensure that the assessment and subsequent additionality designation was done correctly and in accordance with the registry program standards and project-specific protocols
Carbon Dioxide Removal (CDR)	Carbon Dioxide Removal measures refer to processes that remove CO_2 from the atmosphere by either increasing biological sinks of CO_2 or using chemical processes to directly bind CO_2. CDR is classified by the IPCC as a special type of mitigation
Citywide emissions	GHG emissions occurring within the GHG accounting boundary used for the city's GHG inventory, in line with the minimum requirements for scopes and sectors identified in this document
Consumption-Based GHG Accounting	A complementary approach to the sector-based approach to measuring city GHG emissions focused on the consumption of goods and services (such as food, clothing, electronic equipment, etc.) by residents of a city, whereby GHG emissions are reported by consumption category
Crediting period	The period of time during which a carbon credit project generates verifiable and/or certifiable carbon credits. After the end of the crediting period, the project can be re-evaluated against current standards for renewal, otherwise the project will cease to produce carbon credits
Emissions avoidance	Emissions avoidance projects prevent, destroy, or reduce the emission or release of GHGs into the atmosphere as compared to a baseline
Emissions sequestration	Sequestration projects remove GHG emissions from the atmosphere as compared to a baseline
Environmental integrity	Environmental integrity is a principle that demonstrates how well a carbon credit substitutes for a GHG reduction that would otherwise be made by the entity purchasing the carbon credit. See Section 3.2 for more on environmental integrity principles
Geographic boundary	A city's geographic boundary accounts for emissions activity occurring within the city's geographic borders
Greenhouse Gas (GHG) accounting boundary	Identifies the gases, emissions sources, scopes, sectors and/or consumption categories, and time span covered by a GHG inventory
Greenhouse Gas (GHG) inventory	A report that quantifies GHG emissions and sources
Gross emissions	Gross emissions include all relevant emissions in a GHG accounting boundary (e.g. Basic or Basic+ in the GPC) and excludes any GHG emissions reductions from carbon credits purchased or sold
Municipal emissions	GHG emissions occurring within a city's municipal GHG accounting boundary
Negative emissions	Negative emissions can be achieved through the removal of GHGs from the atmosphere by deliberate human activities (i.e. in addition to the removal that would occur via natural carbon cycle processes). Negative emissions are also referred to as 'GHG emissions removal'. For CO_2 in particular, negative emissions can be achieved through Carbon Dioxide Removal measures such as direct air capture of CO_2 from ambient air and sequestration (DACS), bioenergy with carbon capture and sequestration (BECCS), afforestation, and reforestation, among others
Negative emissions technologies (NETs)	Negative emissions technologies remove CO_2 from the atmosphere to be sequestered
Net emissions	Net emissions include the gross level of emissions less all applicable GHG emissions reductions claimed from carbon credits retired outside the GHG accounting boundary (or geographic boundary as a proxy), and adding GHG emissions from carbon credits sold resulting from projects within the GHG accounting boundary (or geographic boundary as a proxy). The reporting of net emissions is what allows cities to track progress against their carbon neutrality (zero net emissions) goal

Net-zero emissions	A state where annual residual GHG emissions are completely cancelled out through offsetting or removed through carbon dioxide removal (CDR) or emissions removal measures. The achievement of net-zero emissions is also referred to as carbon neutrality
Offsetting	A mechanism for cancelling out residual GHG emissions by developing, funding, or financing carbon credit projects (and retiring associated credits) that avoid or sequester[15] GHG emissions outside of the City GHG accounting boundary and exhibit the environmental integrity principles outlined in this document[16]. Cities must retain the beneficial ownership rights to the GHG emission reductions claimed from the project, and those reductions must be retired or otherwise cancelled, such that they may not be used again
Performance Standard	Performance Standards are an approved set of thresholds, requirements or expectations a project must meet and gauge the additionality of a project
Project Protocols	Project protocols are sector-specific guidance documents that provide information including eligibility criteria, performance standards, GHG accounting equations and formulas, monitoring, procedures, and reporting and verification requirements
Residual emissions	Annual GHG emissions remaining at the close of the accounting period
Scope 1	GHG emissions from sources located within the city's geographic boundary[17]
Scope 2	GHG emissions that result from the use of electricity, heat steam and/or cooling within the city's geographic boundary
Scope 3	All other GHG emissions that occur outside the city's geographic boundary as a result of activities taking place within the city's geographic boundary
Target year	The calendar year for which a city aims to achieve carbon neutrality
Transformational climate actions	Actions which reshape whole systems so that they are decarbonised and resilient to climate chang Transformational actions relate to decarbonising the electricity grid, optimising energy use in buildings, enabling next-generation mobility, and improving waste management.[18]

[15] Emissions avoidance projects prevent, destroy, or reduce the emission or release of GHGs into the atmosphere as compared to a baseline. Sequestration projects remove GHG emissions from the atmosphere as compared to a baseline

[16] While individual cities may choose to use the term 'offsetting' to also refer to projects undertaken within the city GHG accounting boundary, GHG reductions from those projects will be directly reflected in the citywide emissions inventory (e.g. reduced overall emissions) rather than used to cancel out citywide residual emissions. For this reason, the term 'offsets' in this protocol will refer exclusively to projects that take place outside of the city GHG accounting boundary and which aim to cancel out the city's residual emissions

[17] Definitions of Scope 1, 2 and 3 are taken from the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

[18] Further details can be found in the Focused Acceleration – A strategic approach to climate action in cities to 2030

1.2 Potential approaches

Cities should make efforts to update emissions reduction trajectories periodically, maintain an up-to-date estimate of target year residual emissions based on planned and implemented action, and consider new mechanisms to maximise the effective reduction of gross emissions to stay on a carbon neutrality pathway.

At a high-level, the process of achieving carbon neutrality should include the following steps:

- Develop an evidence-based climate action plan setting the city on a pathway to meeting carbon neutrality by 2050 or earlier;
- Set an ambitious interim GHG emissions reduction target based on a robust GHG emissions inventory, e.g. BASIC, BASIC+, a business-as-usual trajectory that accounts for projected population and economic growth, and a breakdown of GHG emissions reduction opportunities by sectors;
- Prioritise and accelerate transformational climate actions;
- Engage other governments, businesses and communities in the planning and delivery of climate actions to ensure fairness, accessibility, and equitable distribution of benefits;
- Establish, monitor, and update estimates of target year residual emissions in line with GHG emissions inventory updates and/or climate action plan progress reporting, and
- Reduce or compensate for residual emissions to eliminate net emissions and achieve net-zero emissions.

Cities have different powers and challenges, and thus will take different approaches to addressing both overall emissions reductions and target year residual emissions to achieve carbon neutrality. Given differences in city context (e.g. GHG reporting boundary, economic and technological feasibility, procurement restrictions, city powers and portfolios), different approaches to eliminating residual emissions may be taken, such as:

City of Durban

- **Catalyse additional climate action** to reduce gross emissions, or emissions within the GHG accounting boundary. This can be achieved by implementing climate actions within the city's powers and mobilising other parties (e.g. agencies, private stakeholders) to contribute to the citywide carbon neutrality goal. Cities can advocate for carbon neutrality at higher levels of government (e.g. regional, state level) and work with others to develop partnerships and implement a shared carbon neutrality plan. Cities can also pursue extensive renewable energy and energy efficiency policies and programmes;

- **Employ carbon credits[19] outside of the city GHG accounting boundary to cancel out residual emissions**. Traditional projects that can generate carbon credits include afforestation, reforestation, improved forest management, avoided conversion, and urban forestry.

  Approaches include:

  - **Developing carbon credit projects** outside of the city GHG accounting boundary (including local/regional projects that may or may not generate tradeable carbon credits) and taking responsibility for managing the project for the duration of its lifetime;

  - **Investing in carbon credit projects** outside of the city GHG accounting boundary (e.g. provide funding to enable a project to get underway or commit to purchasing a set quantity of future vintages, thereby providing upfront funding for credit registration costs), and

  - **Purchasing carbon credits** from outside of the city GHG accounting boundary (local, national, or globally-sourced projects that generate tradeable carbon credits) from a registered/credible/established carbon credit provider e.g. Verra, American Carbon Registry, Climate Action Reserve.

- **Employ negative emissions technologies**, taking deliberate action to remove GHGs from the atmosphere beyond those removals that would occur via natural carbon cycle processes. For example, direct capture of CO_2 from ambient air (DACS), and bioenergy with carbon capture


City of Stockholm

[19] Any use of carbon credits should adhere to the environmental integrity principles outlined in this document. These principles are discussed in more detail later in the guidance, along with case studies and guidance on relevant issues to consider when planning for carbon neutrality

2. Guidelines

2.1 Greenhouse Gas Emissions Inventory

An emissions inventory identifies the level and sources of emissions in a base year and within a specific accounting boundary, while informing target-setting and enabling progress tracking, and serves as a necessary foundation for cities that pursue climate action.

The following guidance aligns with the scope framework of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Cities should report at either the BASIC or BASIC+ level within the GPC accounting standard[20].

Essential:

- A sector-level inventory should be developed, including details of, or references to, the methodology used, including scope 1 emissions from fuel use in buildings, transport and industry; scope 2 emissions from grid-supplied energy; and scope 1 and 3 emissions from waste generated within the city geographic boundary, in line with the GPC scopes framework;

- The inventory should be from a year to no more than 4 years prior to publication of the city's carbon neutrality climate action plan[21], and

- The inventory should include Industrial Processes and Product Use (IPPU) and the Agriculture, Forestry, and Other Land Use (AFOLU) emissions where a city's economy contains strong contributions from industrial and agricultural sectors.

Best practice:

- The inventory includes IPPU and AFOLU Scopes 1 and 2 emissions;

- The inventory is available for multiple years, including an assessment of and commitment to tracking consumption-based emissions;

- The inventory includes consumption-based[22] or other scope 3 emissions (e.g. emissions from sources such as food, aviation, shipping, construction), and

- Where carbon offset credits are either generated or purchased, care must be taken to avoid double-counting, particularly for consumption-based emissions sources.

[20] From GPC: "The BASIC level covers scope 1 and scope 2 emissions from stationary energy and transportation, as well as scope 1 and scope 3 emissions from waste. BASIC+ involves more challenging data collection and calculation processes, and additionally includes emissions from IPPU and AFOLU and transboundary transportation. Therefore, where these sources are significant and relevant for a city, the city should aim to report according to BASIC+. The sources covered in BASIC+ also align with sources required for national reporting in IPCC guidelines"

[21] This statement refers to the inventory year (i.e. data) and not the year the inventory is published

[22] While consumption-based emissions accounting is an emerging field, if and where cities choose to pursue this approach, all sectors accounted for must achieve net zero

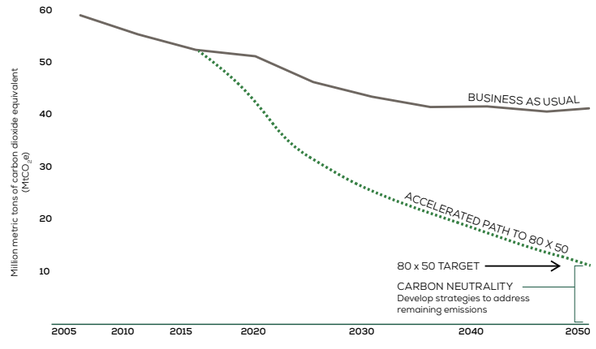
2.2 Business-as-Usual (BAU) and GHG Emissions Reduction Trajectory or Carbon Budget

The development of a robust business-as-usual (BAU) trajectory and a GHG emissions reduction trajectory[23] or carbon budget[24] will enable cities to determine the level of target year residual emissions that will need to be addressed in order to reach a carbon neutrality goal. In order for a city to be carbon neutral, it must ensure that all emissions reach net-zero regardless of control. A list of essential elements and best practices a city should consider include the following:

Essential:

- A plan for carbon neutrality should be supported by the BAU trajectory and GHG emissions reduction trajectory or carbon budget;
- The BAU trajectory must take into account the projected population and economic changes for the city to 2050. The methodology is documented, with transparency on the inputs and assumptions used;
- The GHG emissions reduction trajectory or carbon budget to achieve carbon neutrality should outline an accelerated but realistic reduction (decline or peaking) in total GHG emissions through to carbon neutrality by 2050 or earlier;
- An ambitious interim target and milestones should be set based on the city's GHG emissions inventory and modelling, and
- Target year residual emissions should be identified in the trajectory, once city action is maximised and external actions included. Emissions reduction trajectories, including estimate of target year residual emissions, should be updated every 5 years and informed by the best available. science[25].

An example of a typical emission reduction trajectory



[23] For more resources, see www.c40knowledgehub.org

[24] The carbon budget approach involves setting an amount of permissible emissions over a period of time to keep within the 1.5 degrees Celsius temperature threshold. The budget and actions are distributed across cycles (e.g. 3-year or 5-year cycles), sectors, and institutions, and updated on a regular basis, in line with monitoring and evaluation. Carbon budgets allow a greater level of precision than a target-based goal in creating necessary emissions trajectories, targets, and milestones

[25] C40 Climate Action Planning Framework

Best practice:

- The BAU trajectory incorporates sector-specific trends and considerations, appropriate to the local context, including anticipated changes to sectoral energy intensity and to the carbon intensity of the local electricity grid. The trajectory is provided in 10-year interval projections (or higher frequency) breakdowns. Multiple BAU scenarios are described based on varying plausible future factors;
- The target trajectory incorporates estimated impacts of existing and planned policies. It acknowledges the limits to the city's own ability to reduce emissions within its boundary by including the reduction that will be achieved through national policies at other levels of government (state, national, etc.)[26];
- The expected aggregate impact of specific major climate actions is projected against interim milestones through 2050. Gaps between projections and targets and/or carbon budgets and milestones are publicly communicated and addressed via additional policies and programmes;
- Where possible, sectoral targets are set, which - after accounting for any residual emissions - should sum to the citywide carbon neutrality scenario;
- Carbon budgets and milestones are identified for specific major climate actions, sectors or city projects and programmes, and
- Where possible, carbon budgets are used that are aligned with a global carbon budget that has the potential to limit global temperature rise to 1.5 degrees[27 28].

[26] While resources on forecasting state and national trends to 2050 are limited, best practice for forecasting should entail an assessment of the impact of the home country's Nationally Determined Contributions under the Paris Agreement through 2050

[27] Using a "contraction and convergence" carbon budgeting approach, Deadline 2020 established C40 cities' shares of overall global carbon budgets, following 3 principles: equality, responsibility, capacity. See Deadline 2020 Appendix for more information. Carbon budgets are more stringent than set date targets because they ensure a set amount of carbon is not surpassed over a multiple year period rather than ensure reductions to a specific amount in a single year period (target)

[28] For more information on 1.5°C-compatible city carbon budgets, see Deadline 2020 – How Cities Will Meet the Paris Agreement: https://www.c40knowledgehub.org/s/article/Deadline-2020-How-cities-will-get-the-job-done?language=en_US

2.3 Transparent Strategy for Addressing Residual Emissions: Limits, Principles, Timing, and Benefits

Aggressive emissions reductions are required in the near term in order to align with the Paris Agreement, acknowledging that different cities will have different peaking and reduction timeframes according to their circumstances (e.g. development status). Cities should work to directly reduce emissions within their control as well as work with others to address emissions sources not directly controlled. These reductions, and all climate actions, should be conducted with integrity and in a manner that is transparent to the general public.

A city should similarly pursue a publicly available strategy to address residual emissions and work towards a carbon neutrality goal.

2.3.1 Limits

When using or planning for the use of carbon credit projects to cancel out residual emissions, a limit on the maximum quantity of credits used should be defined by the city for the purposes of prioritizing and maximizing direct reductions in gross emissions. Specifically, the number of credits should be reduced year over year as the city implements additional greenhouse gas mitigation strategies. Below are best practice limits for the use of carbon credits that cities may consider setting in order to ensure that gross emissions reductions are prioritised and maximised:

- An absolute emissions level for which carbon credits can be used to compensate, e.g. 5 million tCO_2e;
- A level set using base year emissions, e.g. maximum percentage of base year emissions that can be offset, such as achieving at least 80% reductions in gross emissions by 2050 and pursuing carbon credits to fill the gap to net zero;
- A level based on performance, e.g. if the city achieves emissions reductions by X%, then it can offset up to Y tons of emissions, such as for every 10% of gross emissions reduced over a base year, an additional 5% can be compensated for via carbon credits;
- A level based on climate spend, e.g. for every dollar spent on local climate action to reduce gross emissions, X dollars may be spent on carbon credits to facilitate additional net emissions reductions, or alternatively, for every dollar spent on carbon credits, X dollars must be spent on local climate action to reduce gross emissions, and
- A level based on the emissions reductions needed in order to align with a city's set emissions reduction trajectory or carbon budget, e.g. carbon credits are used to fill the gaps until adequate gross emissions reductions can be achieved.

2.3.2 Principles

In order for carbon credits to contribute to a city's carbon neutrality goals, the following environmental integrity principles are essential and should be demonstrated: real, additional, permanent, measurable, independently audited and verified, unambiguously owned and transparent. These principles are defined and detailed in section 3.2 Environmental Integrity – Key Principles and Methodologies.

Carbon Dioxide Removal technologies should not be undertaken without careful consideration of the potential ecological and ethical impacts. These principles and considerations are defined and detailed in section 4. Negative Emissions Technologies.

2.3.3 Timing

Depending on different powers and constraints within which they operate, cities may decide to wait until close to the target year before carbon offsetting ('Late Carbon Credit' scenario) or start offsetting ahead of their target year ('Early Carbon Credit' scenario). Similarly, cities may consider testing new negative emissions technologies to drive their availability and scalability through and beyond the target year. There are a series of potential benefits and disadvantages or risks to both approaches and cities should carefully consider the approach that works best for them, depending on their local and regional context. The table below provides examples of factors to consider when assessing different timing approaches. The list is not exhaustive, and impacts will vary from city to city. Some of these factors are specific to carbon offsetting (marked with an *) or negative emissions technologies (marked with an **), while others may apply to both carbon offsetting and negative emissions technologies.

Table 1: Examples of factors to consider when assessing different timing approaches:

TIMING	POTENTIAL BENEFITS	POTENTIAL RISKS
Late Carbon Credit/Negative Emissions Deployment	More time to make the most of the available mitigation opportunities More technologies may become available enabling further mitigation in areas currently difficult to mitigate Ability to capitalise on other cities' lessons Ability to source funding to enable offsetting or negative emissions technologies later on Better understanding of feasibility, costs, risks and trade-offs of negative emissions technologies**	Limited ability to test effectiveness of approach ahead of implementation Potential reputational and ethical issues (i.e. if residual emissions are high and cannot be reduced over time, or if technologies fail, city may be seen as irresponsible with consequences to be borne by future generations) Net benefit to global climate change mitigation won't be realised as early as it could be and the global carbon budget may be surpassed Potential market risk – uncertainty regarding the cost and availability of carbon credit projects in the future*

TIMING	POTENTIAL BENEFITS	POTENTIAL RISKS
Early Carbon Credit/ Negative Emissions Deployment	More time for testing of approach and input into a long-term strategy around managing carbon credits (investing, developing, purchasing) or negative emissions Ability to facilitate early action. Many types of carbon credit projects have a longer time horizon for mitigating climate change than in reverse (emitted GHGs take effect faster than sequestered carbon) Advantageous market prices and more availability of high-quality carbon credit projects to choose from* Ability to secure early input from stakeholders regarding their financial responsibility for offsetting* Ability to keep investment and revenue local for those cities developing carbon credit projects* Ability to get early input into feasibility, costs, risks and trade-offs of negative emissions technologies**	Risk of focus shifting away from mitigation Possible drain on resources as steep decline may materialise due to technological breakthrough Potential pushback from community if strategy is not clearly outlined and rationale, including benefits, are not explained High upfront cost – negative emissions technologies may end up being implemented on a regional or national scale which may be more cost-effective** High upfront cost – carbon credit project development if a City chooses to develop the project

2.3.4 Carbon Credit Project Benefits

When considering the range of carbon offsetting options available, cities may choose to prioritise certain projects over others, in line with their priorities, procurement requirements, and the level of buy-in from local stakeholders.

All carbon credit projects must meet the following standards:

- Projects are verified and/or validated[29] under rigorous standards by reputable, certified third-party auditors.

Cities may choose to prioritise:

- Local projects (within the home region or country but outside the city's accounting boundary) projects that deliver local/regional jobs and other benefits such as improved resiliency, air quality, and health outcomes;
- Sustainable development projects in developing contexts in line with climate solidarity principles giving consideration to potential risks to local and indigenous populations; or
- Projects (independent of location) that provide carbon mitigation and additional benefits including improved equity, resilience, biodiversity and health outcomes.

The following guiding questions may be used to compare and prioritise different carbon credit providers and types of projects to invest in:

- Does the provider source credits by reputable/established Carbon Credit Registries whose standards reflect the environmental integrity principles outlined in section 3.2 of this document?;
- Does the provider develop regional based projects in the local area, and can the provider sell from projects based in the local area?;
- How many credits can be provided or supplied? A portfolio of projects provides diversification to protect against the failure of an individual project;
- Does the provider support sustainable development in the Global South through carbon credit projects? (This ensures compatibility with climate solidarity principles);
- Do projects have wider benefits including improved equity, resilience and health outcomes?;
- Does the project type have a strong history of additionality and quality, or have projects of this type suffered from questions about their climate benefit or detrimental environmental or social impacts (e.g. flooding valleys associated with large scale hydro power)?, and
- What is the cost of the carbon credits?

[29] Not all programmes undergo a separate validation step

The following is a non-comprehensive list of existing standards for carbon credit projects (these standards have not been qualified and should be assessed for suitability by cities):

- Carbon Registry;
- Clean Development Mechanism;
- Climate Action Reserve;
- Gold Standard;
- Verified Carbon Standard, and
- Verra.

The following existing protocols and standards may be of use in providing relevant additional benefits criteria (these standards have not been qualified and should be assessed for suitability by cities):

- Climate, Community and Biodiversity (CCB) Standards;
- Forest Stewardship Council certification;
- SOCIALCARBON Standard, and
- Others: W+ standards, Water benefits standards, Fairtrade Standards, etc.

Guidance for Transparent Strategy for Addressing Residual Emissions

Essential:

- Steep and rapid reductions in greenhouse gas emissions - recognizing that different cities will have various peaking and reduction timeframes[30] - are necessary for the attainment of carbon neutrality in all cities by 2050 in order to achieve the goals outlined in the Paris Agreement. For the purposes of transparency and clear communication, cities will develop and make public a strategy for their GHG emissions reduction targets, including the short, medium and long-term actions they will be taking to meet their goals and prioritizing transformational actions for immediate delivery;

- If applicable, the strategy should communicate the rationale for the use of carbon offsetting or carbon removal on the path to carbon neutrality including limits set, environmental integrity principles and ethical considerations, and their timing, and

- Cities should consider all direct and indirect social and environmental impacts of a carbon credit project, along with potential educational, economic development, and resiliency benefits. Any harmful impacts from projects should be avoided or mitigated.

Best practice:

- Targeted communications are developed which focus on the city's carbon neutrality goals and milestones, in order to engage different communities and groups, and raise awareness on the potential opportunities and challenges from the use of offsetting or negative emissions measures including carbon dioxide removal mechanisms;

[30] As outlined in C40's Deadline 2020 Programme

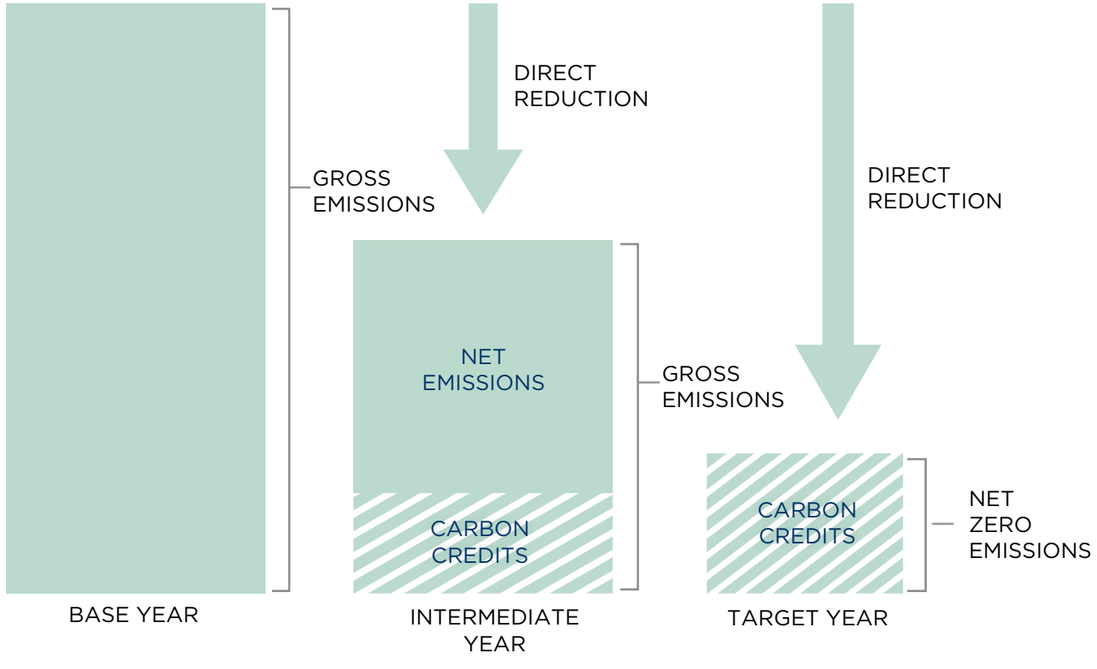
- All else equal (e.g. quantity of emissions offset or removed), sectors and project types are prioritised that can create significant wider benefits for the habitats and communities where projects take place, whether local, regional or globally-sourced, and

- Regional partnerships are considered for achieving carbon neutrality on a wider scale, going beyond the city geographic boundary.

2.4 Reporting on Gross Emissions and net Emissions

To ensure transparency and enable meaningful and accurate reporting of progress made towards their carbon neutrality goal, cities should separately report both net and gross emissions. Gross emissions include all relevant emissions in all covered scopes (e.g. BASIC or BASIC+ in the GPC), and do not take into account any GHG emissions reductions from carbon credits retired or sold. Net emissions are equal to the gross level of emissions less all applicable GHG emissions reductions claimed from carbon credits purchased and retired from projects outside the city's GHG accounting boundary (or geographic boundary as a proxy), and adding GHG emissions from carbon credits sold from within the city's GHG accounting boundary (or geographic boundary as a proxy). The reporting of net emissions is what allows cities to track progress against their carbon neutrality goal. There are currently limitations to international reporting as gross and net disclosure is not always an option. This limitations in reporting must be resolved for cities to be able to claim carbon neutrality.

ACHIEVING CITYWIDE CARBON NEUTRALITY



The table below illustrates reporting of gross versus net emissions, depending on whether carbon credits are only purchased or also generated through the development of local carbon offset projects.

APPROACH	GROSS EMISSIONS (tCO_2e)	NET EMISSIONS (tCO_2e)
Carbon credits purchased and retired from outside the geographic boundary ($mtCO_2e$): 5,000,000	40,000,000	40,000,000 (5,000,000) 35,000,000
No credits generated within the geographic boundary		
Carbon credits purchased and retired from outside the geographic boundary ($mtCO_2e$): 5,000,000	40,000,000	40,000,000 (5,000,000)
Carbon credits generated within the geographic boundary and sold outside the boundary ($mtCO_2e$): 500,000		500,000 35,500,000

Essential:

- Gross emissions levels are reported separately from any reductions achieved through the purchase and retirement of carbon credits, following international best practice standards for quantification, monitoring and reporting of GHG emissions reductions or removals. Any GHG carbon credits sourced from projects located within a GHG accounting boundary and retired to offset emissions in a different geographical boundary should not be considered when calculating the source region's gross inventory. To calculate net emissions[31], any GHG carbon credits sourced from projects within an GHG accounting boundary and retired to offset emissions in a different geographical boundary should be accounted for by adding those emissions back into the city's net emissions to avoid double-counting the reductions.

  Cities should separately provide a short overview of all carbon credit project(s) developed or invested in including information on the type and location, unique ID, credits sold or claimed (tCO_2e), vintage year, and verification date and verifier.

Best practice:

- Verified and public reporting of gross and net emissions on a sectoral basis, and
- Creating a registry for the city to understand offsetting activities at different levels within the city (e.g. by private companies or individuals) and an explanation of how those activities have or have not been factored into the city's gross and net emissions reporting.

[31] Net emissions cannot include reductions from carbon credits claimed by another city and thus these must be added back to the net emissions

3. Carbon Credits - Guidance and Environmental Integrity Principles

3.1 Guidance on Mechanisms, Eligible Projects and City Roles

3.1.1 Mechanisms

Offsetting with carbon credits can take many forms in the context of addressing GHG emissions. More detailed definitions of offsetting with carbon credits as a sequestration and/or avoidance mechanism are provided below, as well as examples of projects that a city may choose to pursue that fall under each category of carbon credits. Carbon credits associated with sequestration projects, which remove greenhouse gas emissions from the atmosphere against a baseline, and greenhouse gas destruction projects are preferred to carbon credits that avoid greenhouse gas emissions through reduction against a baseline, as these approaches reduce the risk of double counting emissions reductions. To properly account for net emissions without risking double counting avoidance projects, cities need a more robust system for tracking carbon credits both purchased and/or retired and sold in their jurisdiction. Section 3.1.2 provides information on types of offsetting that are *beyond the scope of this guidance document*—chiefly, those types of offsetting projects that were not developed, funded or financed to cancel out citywide residual emissions.

3.1.1.1 Sequestration

Sequestration includes the removal (or uptake) of GHG emissions from the atmosphere and long-term storage in carbon sinks (such as oceans, forests or soils) through physical or biological absorption or sequestration, resulting in a net removal of CO_2 from the atmosphere.

Sequestration projects may include:

- Afforestation (planting new forests on lands that historically have not contained forests or restoring tree cover in minimally covered area);
- Reforestation (planting of forests on lands that have previously contained forests but that have been converted to some other use);
- Improved forest/urban management (change in management/harvesting practices that maintain and/or increase the stocking rate of carbon in the forest over a long time frame (e.g., 100 years) by increasing a forest's age or productivity;
- Agricultural and land management strategies increasing soil carbon sequestration (land management changes which increase the soil organic carbon content), and
- Mass timber in construction.

3.1.1.2 Avoidance

Avoidance includes the prevention, reduction or destruction of GHG emissions released into the atmosphere compared to a baseline.

Avoidance may be through GHG reduction or destruction. Projects may include:

- Destruction of industrial pollutants or agricultural by-products (i.e. manure management with anaerobic digesters, destruction of landfill methane and others);
- Destruction of ozone depleting substances and/or hydrofluorocarbons (HFCs) in countries that have halted their production under the Kigali Amendment to the Montreal Protocol[32];
- Renewable energy (hydro, solar, tidal, wind, biomass, geothermal)[33]. With renewable energy projects, it is important to consider only carbon credits expressed on a tCO_2e basis, and not zero carbon electricity on a MWh basis, which are addressed later in this document *(see section 3.3 Achieving Carbon Neutrality – Understanding the Use of Renewable Energy Credits*). Cities should understand when existing renewable portfolio standards, binding emissions caps (e.g. the Regional Greenhouse Gas Initiative (RGGI) or the Western Climate Initiative (WCI) in the United States), or other programs would call into question the ownership of any electricity-related emission reductions;
- Energy efficiency (fuel switching, energy efficiency supply/demand side, transport modal shift);
- Reduced emissions from changes in agricultural management (change in nitrogen use, rice cultivation practices, and livestock management to reduce enteric fermentation);
- Changes in organic waste management;
- Avoided emissions of biological carbon through changes in land use, such as avoided conversion of grassland or forestland to crop cultivation, along with the associated avoided direct GHG emissions from cultivation activities;
- Avoided deforestation (avoiding the conversion of forest to non-forest), and
- Circular Economy investments as an avoidance measure (reducing emissions both from end use waste and upstream emissions from transport).

3.1.2 Carbon Offesetting - Eligible Projects

The projects available for cities that can generate carbon credits and be used towards a carbon neutrality goal will partly depend on the GHG accounting boundary that the city adopts (e.g. BASIC versus BASIC+ for the GPC). To avoid double counting, only carbon credits originated outside of the city's GHG accounting boundary can be used to reduce net emissions. Where it is not possible to track carbon credit movement into and out of the GHG accounting boundary, a city's geographic boundary may be used as a proxy. A few example scenarios are provided below:

[32] The Kigali protocol replaced the Montreal Protocol in 2016

[33] These projects are less likely to be additional, irrespective of whether they involve an increase in renewable energy

City A is reporting at the GPC BASIC level (excludes IPPU and AFOLU and scope 3 emissions from stationary energy and transportation).

City B is reporting at the GPC BASIC+ level (including scope 1 IPPU and AFOLU, as well as scope 3 emissions from stationary energy and transportation).

Both City A and City B can purchase carbon credits from globally-sourced projects outside their GHG accounting boundary to reduce their net emissions, such as:

- Landfill gas capture/combustion project;
- Rice cultivation projects;
- Destruction of ozone depleting substances such as chlorofluorocarbons (CFCs);
- Livestock projects: capturing and destroying methane from manure management systems through the installation of a biogas control system on dairy cattle and swine farms;
- Carbon sequestration through afforestation and reforestation, and
- Soil carbon sequestration through agricultural management practices.

Both cities are also able to use regionally-sourced (i.e. outside the city's geographic boundary but within the region) projects such as:

- Methane recovery associated with food produced regionally and imported by the city (e.g. recovery and destruction of manure and wastes from agricultural activities at rural households/ small farms located within the wider city region e.g. installation of domestic biogas digester), and
- Soil carbon sequestration through regional agricultural management practices that reduce emissions and increase food productivity.

Both cities can use carbon credits related to any other emissions occurring outside the geographic boundary as a result of city activities.

Only City A who does not include IPPU and AFOLU in their GHG accounting boundary (BASIC) is able to consider the use of carbon credits from projects that are within the city's geographic boundary, but outside the city's GHG accounting boundary, for example from carbon sequestration projects from urban forests in their own city. If City B, who does account for IPPU and AFOLU, were to pursue the same projects, the associated emissions removals or reductions would be accounted for in their gross emissions reporting. If City B attempted to use these credits towards their net emissions reporting, they would be double counting.

3.1.3 Projects outside the scope of this guidance document

In certain instances, individual cities have used the term 'offsetting' to refer to projects undertaken within the city's GHG accounting boundary. Any such projects that take place within the city's GHG accounting boundary cannot reduce net emissions nor cancel out a city's residual emissions; instead, these projects impact the level of gross emissions reported in the citywide emissions inventory. In other words, wherever there are exchanges of carbon credits within the city's geographic or GHG accounting boundary that use the term 'offset' or 'carbon credit' these will not impact gross-to-net calculations. Examples of such projects that take place within the city GHG accounting boundary are:

- C40 Cities Climate Positive Development Programme[34]: large-scale urban communities projects that have net-negative operational GHG emissions associated with energy, waste and transportation. 'Offsetting' is mainly by investing in projects that reduce emissions in neighbouring communities (e.g. better transit or lower carbon energy). Climate Positive 'Credits' are awarded as part of the programme, and
- City carbon 'offset' funds that result in direct emissions to gross reductions within the city GHG accounting boundary.

The 2016 London Plan includes a London-wide zero carbon standard for residential and non-domestic major developments. The zero carbon standard includes a required 35% on-site carbon reduction target beyond Building Regulations. Since some buildings find it easier than others to achieve this 35% reduction, any shortfall is made up as a cash-in-lieu payment from the developer to the relevant planning authority offset fund. London planning authorities (LPAs) are required to establish a CO_2 'offset' fund (COF) and identify suitable projects to be funded.

Cambridge has adopted a carbon neutral target for 2050 and is considering a similar approach to London. To achieve their targets, buildings will have the option to either take reduction measures (e.g. energy retrofits and upgrades) or to temporarily buy "offsets" by paying into a citywide carbon fund operated by a third-party administrator[35]. Cambridge intends to use the carbon fund to finance or subsidise building energy efficiency upgrades to enable expensive retrofits or upgrades to happen sooner than market factors would otherwise dictate. The cost of purchasing "offsets" from the fund will increase over time, with the city intending to eventually phase out this option entirely[36].

[34] https://www.c40.org/other/climate-positive-development-programme

[35] http://sites.bu.edu/cfb/files/2018/06/MIT-S-Lab-Final-Report.pdf

[36] For more information about the Cambridge Local Carbon Fund concept and the Net Zero Action Plan it is part of, see www.cambridge.gov/netzero

3.1.4 City Roles

As discussed in the background section, a city may take various approaches to carbon offsetting (e.g. purchase, invest, develop). The case studies below illustrate these approaches and the key considerations for deciding what role a city should take in a carbon credit project.

Purchase Carbon Credits

In 2007, the **City of Austin** set a goal to achieve carbon neutral municipal operations[37] by 2020. While the City has been implementing different strategies, achieving a 75% reduction in emissions, analysis showed that it would not be able to eliminate all emissions sources associated with its municipal operations by 2020. To meet the carbon neutrality goal, the City began purchasing carbon credits (removals/avoided emissions) in 2013 to compensate for 5% of municipal operations emissions per year. The City established a scoring matrix to assess third-party-verified carbon credit opportunities that gave priority to offset projects that are closest to Austin and provide additional benefits for the City.

Invest in Carbon Credit Projects

The **City of Palo Alto** entered into a carbon credit purchase agreement with an improved forest management project in its sister city, Oaxaca, Mexico, to purchase carbon credits that were pending registration by a Carbon Offset Registry. The purchase agreement provided financial confidence for the project to move forward with verification and subsequent issuance of credits, a key cost consideration for carbon credit projects. The City retired credits purchased from this project to offset carbon dioxide emissions associated with the City-owned utility's natural gas portfolio, in line with its Carbon Neutral Natural Gas Plan. Additional benefits associated with the carbon project included training activities that raised awareness about climate change and technical capacity building for members of the community-owned forest, leading to 5 full time positions and just over 20 part-time support staff to enable the project administration and monitoring over the longer term.

Develop Carbon Credit Projects

The **City of Austin** is running a pilot city tree canopy project, partnering with a non-profit organisation, City Forest Credits[38], that is generating funding from private companies and individuals that wish to offset their carbon emissions by buying credits for tree planting or preservation. The projects were verified per International Standards Organisation 14064-3[39].

Mexico City registered a forest carbon project that is located within the city. While the property is ejido (community)-owned, the City played a big role in getting the project underway. Where emissions from forests are not accounted for in the GHG accounting boundary, they can be counted toward net emission reductions.

Where cities generate, own, and retire carbon credits from projects outside of their GHG accounting boundary, they are able to include those in their net emissions inventory.

When deciding whether to be a purchaser of credits, investor or a project developer, a city should consider the following:

- The time horizon available for the project review process; cities bound by stricter timelines may be more inclined to purchase credits available from an externally-developed project;
- The intended geographical sourcing for projects; cities may decide to pursue a more active role in developing projects that are undertaken closer in proximity to the city itself;
- The capital costs applicable to the project developer versus the capital costs applicable to the credit's purchaser;
- The level of experience and capabilities that the city has in developing projects; less experience may mean that cities are willing to outsource development of the project to a qualified third-party vendor;
- The availability of existing project protocols (guidance documents that provide information including eligibility criteria, performance standards, GHG accounting equations/formula, monitoring, procedures, and reporting and verification requirements), if any, that apply to projects under consideration by the city; if such standards already exist, the city may find it easier to take on a project developer role, and

[37] While this case study talks about offsetting in the context of achieving carbon neutral municipal operations, the principles applied (e.g. purchase of credits) are the same as those required for compensating for citywide residual emissions

[38] https://www.Cityforestcredits.org/

[39] https://www.iso.org/standard/66455.html

- If engaging in sequestration project types, cities should have a clear understanding of responsibilities associated with the permanence requirement for such project types, depending on which market role the city may take on. Project owners are responsible for ensuring the permanence of reductions credited for in these project types, through ongoing monitoring, periodic reporting and verification activities. Any losses to reductions already credited for (i.e. due to wildfire or intentional over-harvesting) need to be compensated for by the project owner, and that cost can sometimes shift to the purchaser via a higher price per credit.

3.2 Environmental Integrity – Key Principles and Methodologies

In order for carbon credits to contribute to a city's carbon neutrality goal, projects must exhibit environmental integrity. To ensure environmental integrity, a city's emissions should be offset on a tonne for tonne basis – every tonne of avoided or sequestered emissions from eligible GHG carbon credit projects is used to cancel out a tonne of emissions that is produced in the city (i.e. emissions reported in the city's GHG inventory). The following principles indicate the environmental integrity, and thus the eligibility, of carbon credit projects. Under this guidance, it is a requirement that these principles be met for any carbon credits to be used to meet a city's carbon neutrality target.

Specific methodologies and guidance on how to apply or test for these principles will be discussed in greater detail in Section 3.2.1. Section 3.3 additionally explains the differences between carbon credits and renewable energy credits (RECs), and the applicability of each about a carbon neutrality goal.

PRINCIPLE	DEFINITION
Real	Carbon credit projects must result in absolute net reductions of citywide GHG emissions because of actual project activity and not as artefacts of inaccurate, incomplete accounting or double-counting. For the purposes of this guidance document, only project-based carbon credits are considered; carbon credits associated with allowances in compliance schemes (e.g. the EU Emissions Trading System (ETS)) are not.
Additional	Carbon credit projects would not have been realised without the city's investment (or investment by another entity on behalf of the city) in these projects and are beyond any reductions required or incentivised through any city or higher-government commitments and regulation or any action achieved in a business-as-usual scenario (e.g. changes in standard market practice due to financial, economic, social, and technological drivers). In other words, there must not be any legal requirement for the existence of the project and the project must require the revenue from the sale of the carbon credit in order to be self-sustaining.
Permanent	Carbon credit projects should be irreversible and continuously monitored (e.g. monitoring of sinks and ensuring appropriate contracts are in place to cover instances of emissions released back into the atmosphere from a particular project). If a project includes an avoidable or unavoidable potential for reversal(s), a mechanism to compensate for any/all possible reversals should be clearly identified at the project outset.

PRINCIPLE	DEFINITION
Measurable	Carbon credit projects must have the ability to be verified in a scientifically-credible way and accurately quantified relative to a transparent and robust baseline scenario. Quantification and monitoring must be transparent, conservative, and follow established project accounting standards (e.g. World Resources Institute's Greenhouse Gas Protocol for Project Accounting; International Standards Organisation 14064-Part 2), ensuring reproducible results.
Independently audited	Carbon credit projects must be verified by an independent, qualified, third-party verifier subject to an established accreditation system. Where both validation[40] and verification[41] are undertaken for a project, these two assessments must be conducted by separate entities. Verification will be on an ex post basis, verifying emissions reductions that have already occurred.
Unambiguously owned	Carbon credit projects must have clear documentation of ownership rights, maintained on a secure registry, with no more than one credit associated with a unit of GHG emission avoidance or sequestration. Acquisition of these ownership rights by the party looking to offset GHG emissions must occur unambiguously and without contest. Once transferred, all other parties (e.g. project developer, governmental authority/jurisdiction under which the project was developed, credit seller) cede all rights to claim future credit for the same offset in order to refrain from double-counting. Ownership rights and transfer is clear by contractual assignment, being tracked and listed in a publicly available registry. Note: The distinction between citywide carbon neutrality and municipal carbon neutrality is important: Carbon credits used for citywide emissions may not be able to meet the same ownership criteria as carbon credits used for municipal emissions. While local government has the ability to influence gross and net emissions within the city through regulation, local government only has direct control over gross and net emissions within its municipal boundary. If a local business purchases carbon credits to reduce their residual emissions, the city would have limited insight into those claims and would not be able to account for those claims in a citywide net emissions inventory, unless those claims were tracked in a global registry. More on this in section 3.2.1.3.
Transparent	Carbon credit projects and their associated ID number must be publicly and transparently registered. Credits should have unique serial numbers and the crediting process should be clearly documented (e.g. issuance, retirement, project ownership) and GHG emissions quantification methodology. Information on the project validation (where applicable), verification, monitoring and enforcement arrangements (e.g. type of project, duration, location, validated project plan and verification reports for each vintage year, standards used, enforcement mechanism) must also be made publicly available.

PRINCIPLE	DEFINITION
Address leakage:	Carbon credit projects must account for and avoid potential leakages over the life of a project - increases in GHG emissions that occur outside of the project's emissions boundary as a result of the project's implementation (e.g. shift in forest harvesting due to avoided deforestation). Any material and avoidable or unavoidable increases in GHG emissions – leakages - must be deducted from the abatement that would otherwise be counted towards the project's carbon credit(s).

Where feasible, cities are also recommended to follow the principles below:

PRINCIPLE	DEFINITION
Synchronous	Carbon credit projects are only considered valid if they are based on a valid baseline scenario timeframe. Credits can only be used to cancel out unavoidable or residual GHG emissions occurring during a distinct period of time that is reasonably close to the period of time during which the GHG emission avoidance or sequestration will take place.
Enforceable	Carbon credit projects should be backed up by enforceable contracts incorporating the environmental integrity principles discussed in this section and in line with the other criteria or recommendations set out in this guidance document.

3.2.1 Demonstrating Environmental Integrity Principles

Ensuring the environmental integrity of carbon credit projects is important for upholding the ability of associated carbon credits to be an effective mechanism in meeting a carbon neutrality goal. Current methodologies and general market practices for additionality, permanence, unambiguous ownership and transparency are discussed in greater detail below. Further, additional detail on project registries is presented below as well.

3.2.1.1 Methodologies for Additionality

Carbon credit projects should demonstrate additionality under the most stringent requirements in order to count towards cities' carbon neutrality goals. Existing methodologies for testing additionality can be divided into three broad approaches:

- Programmatic Approach / Uniform Assessments / Top-down - this approach assesses projects based on whether a specific threshold is reached or exceeded. This threshold is established based on aggregate data of general project and/or technology attributes;
- Single-Project Assessments / Bottom-up – this approach assesses projects on an individual basis, and often relies on some combination of the below tests to prove additionality, and
- A combination approach

ADDITIONALITY ASSESSMENT	TOOL	DESCRIPTION	EXAMPLE
Programmatic Approach / Uniform Assessments	**Benchmarks**	Compare projects under review to a previously established baseline for the relevant project type	For a particular project type such as landfill gas capture, a minimum required project efficiency rate may be established
	Positive technology lists	Outline specific technologies that have been deemed additional if installed in a certain geographic boundary	Power plant cogeneration technologies may be on positive technology lists in regions where use is currently rare

[40] A process to determine that the baseline established, and methodologies used for a project are legitimate

[41] An assessment providing the necessary quantifiable evidence that claimed offsets are real and additional when compared to the baseline scenario

Programmatic approaches incorporate the tools utilised in single-project assessments, below, into determinations for benchmarks and positive technology lists[42].

ADDITIONALITY ASSESSMENT	TOOL	DESCRIPTION	EXAMPLE
Single-project assessments	**Legal and regulatory tests**	Ensure that the project is not already mandated by a law or regulation within the jurisdiction	Landfill gas capture mandated by law in a certain jurisdiction would prevent such projects from passing this test
	Financial investment tests	Check that the project would not have been financially attractive without the revenue generated from the sale of carbon credits	Certain energy efficiency projects that already have significant cost savings without sale of carbon credits would not pass this test
	Barriers analysis	Test whether there are one or more non-financial barrier(s) prohibiting implementation of the project under a project BAU scenario	Local resistance, skill limitations, and institutional obstacles may serve as legitimate non-financial barriers
	Common practices assessment	Stipulates that the main technology/technologies employed in the project is/ are not already commonly used	Certain energy efficiency projects already very common might not pass this test

Advantages and disadvantages of top-down and bottom-up methodologies depend partly on the role that the city chooses to take in the project - purchaser of credits or project developer - and the type of project concerned.

Most project protocols available on the market will rely on a combination of uniform assessments and single-project assessments in order to test for project additionality.

Whether utilising uniform assessments, single-project assessments, or some combination of the two, testing additionality requires the calculation of baselines and modelling the expected business-as-usual scenario.

[42] The legal and regulatory tests, financial investment tests, barriers analysis, and common practices assessments are all part of the process used when developing a standardised (top-down) protocol. So, the difference is not in the use of those tests, it is in the point of application. In a bottom-up approach, general guidance is given for each of those tests, and the individual projects must provide evidence/rationale for how they meet that general guidance. In a top-down approach, the tests are applied to an entire sector during protocol development, resulting in very prescriptive guidance, resulting in less flexibility around eligibility, but also far less work for the individual projects to demonstrate eligibility. So, the benchmarks and positive technology lists are a result of the application of the tools listed under "single project assessments

A number of issues are important to deliver additional emission reductions[43]:

- The length of crediting period;
- Criteria for the renewal of the crediting period;
- Approaches for determining indirect emission effects, such as leakage effects;
- The way in which perverse incentives[44] for both project developers and policy makers are addressed;
- The extent to which double counting of emission reductions within the mechanism and with other mechanisms and pledges is avoided. This is particularly important in the context of renewable energy projects e.g. double counting as a result of the sale of both RECs and carbon credits;
- Whether potential non-permanence of emission reductions is sufficiently addressed;
- Whether monitoring provisions are appropriate, and
- The effectiveness of the regulatory framework for third-party validation and verification.

Some projects are likely to have better additionality than others[45]. While additionality will ultimately depend on the local conditions and protocols used to certify projects, some general recommendations are provided below based on a review conducted by the European Commission of CDM projects[46].

- **Methane projects** (landfill gas, coal mine methane) have a high likelihood of being additional. However, both project types face issues with regard to the determination of baseline emissions and perverse incentives[47] and may lead to over-crediting.

- **Industrial gas projects** (HFC-23, adipic acid, nitric acid) may be additional as long as the mitigation is not otherwise promoted or mandated through policies. These projects rely on an end-of-pipe abatement technology solution and do not normally generate significant revenues other than from the sale of credits.

- **Biomass power projects** have a medium likelihood of being additional overall because the assessment of additionality very much depends on the local conditions of individual projects (e.g. domestic incentive scheme for increased use of biomass in electricity generation; markets where biomass power is already competitive with fossil fuel generation). However, where these conditions are not prevalent, projects can be additional, particularly if credits for methane avoidance can be claimed. Biomass projects also face other issues, in particular with regard to demonstrating that the biomass used is renewable.

- **Most energy-related project types** (wind, hydro, waste heat recovery, fossil fuel switch and efficient lighting) are unlikely to be additional, irrespective of whether they involve the increase of renewable energy, energy efficiency improvements or fossil fuel switch. These types of projects tend to have a high investment cost and the revenue from the sale of the carbon credits is likely to be small compared to the other project revenue streams. Efficient lighting projects using small-scale methodologies are highly unlikely to be additional because in many host countries the move away from incandescent bulbs is well underway. Cook stove projects tend to generate revenues that are insufficient to cover the project costs or make it economically viable. These projects are also likely to over-estimate the emission.

[43] Öko-Institut, Stockholm Environment Institute and INFRAS, 2016

[44] For instance, perverse incentives for policty makers in host countries not to implement policies or regulations to address GHG emissions - since this would reduce the potential for international crediting

[45] The above list of considerations for additionality is based on a study of the Clean Development Mechanism. The list does not fully encompass the variety of voluntary methodologies available

[46] Öko-Institut, Stockholm Environment Institute and INFRAS, 2016

[47] For instance, perverse incentives for policy makers in host countries not to implement policies or regulations to address gross GHG emissions – since this would reduce the potential for international crediting

3.2.1.2 Permanence

Permanence is an essential environmental integrity principle for any carbon credit but should not be confused with a "permanence" in achieving carbon neutrality. That is, even if a city reaches net-zero emissions in a given year through the use of carbon credit projects, that city should be mindful of the need to reduce residual emissions generated in the subsequent year through additional gross emissions reductions or with carbon credits.

Existing offsetting protocols provide varying levels of guidance for project permanence methodologies. Recommendations and implications for cities are provided below based on market practice:

- Sequestration projects should have a lifespan of at least 100 years[48] to be classified as permanent;
- Avoidance projects do not necessarily have one specific minimum lifespan and can range from 40 to 100 years. Cities should make a determination of what lifespan length achieves the principle of permanence based on the best available information;
- All projects should be re-evaluated on a regular basis to ensure that a project continues to display permanence over its intended lifespan;
- If there is potential for reversal before the set number of years, the project must have guarantees to ensure that any losses are minimised and compensated for through insurance mechanisms. These mechanisms may include:
  - *Buffer* accounts or reserve pools, in which a certain percentage of carbon offset credits that a project produces are withheld, and these credits are only used as compensation in the event that previously verified, or future expected, credits are eventually negated.
  - *Legal mechanisms*, such as deed restrictions and conservation easements, which help to ensure that the geographic area in which the project takes place continues to be protected, and
- Specific rules and conditions for reversal compensation are detailed in individual project protocols available on the market. Regardless of which insurance mechanism(s) is (are) chosen, project permanence guarantees that an equivalent amount of reductions will be replaced by these mechanisms in the event that some or all reductions are lost. In addition, contracts should clarify which party (i.e. the project developer or the credits purchaser) is responsible to compensate for any/all losses of expected credits should the project fail to meet its permanence criteria.


City of Melbourne

3.2.1.3 Unambiguously Owned and Transparent

Mechanisms to prevent double-counting may be implemented by various parties, from offset protocol developers and carbon registries, to the entities purchasing the carbon credits and governments (subnational, national, or international level), or a combination of them. These mechanisms include:

- A **registry** that lists the quantity, status (cancelled, retired, or banked), ownership, location, and origin of carbon credits held by a jurisdiction, company or individuals regardless of boundary, sector or scheme;
- A **transaction log** that records the details of each transaction between registry accounts, including the issuance, holding, transfer, and acquisition of the carbon credits. These are not typically made public by private parties, but cities should endeavour to make transactions transparent wherever possible;
- **Agreements** between buyers and sellers that specify which party has the exclusive right to claim each unit and specifies what percentage, if any, is shared;
- **Legal mandates** that disallow double-counting and employ penalty and enforcement systems;
- **Information sharing** to identify units that are already registered in other programmes;
- **Industry guidelines** to specify commonly agreed rules for avoiding double counting. For instance, the four major voluntary carbon registries have recently been working together with environmental NGOs and industry representatives to develop common practices and guidelines for the avoidance of double-counting through double-claiming, double-issuance and double registration, and
- A **blockchain** that stores information about transactions and identifies dates, times, participants, and credit status.

Project registries used by cities for projects that address residual emissions should adhere to the following quality and integrity standards:

- GHG emissions must be publicly and transparently registered with unique serial numbers to clearly document the offset crediting process (e.g. generation, transfer, retirement, cancellation, ownership) and GHG emissions quantification methodology, and
- The project monitoring and enforcement arrangements (e.g. type of project, duration, standards used, tests done, measurement, location, price, enforcement mechanism) must also be made publicly available.

[48] Under the Clean Development Mechanism (CDM) sequestration projects are time-limited and have to be replaced periodically

3.3 Achieving Carbon Neutrality – Understanding the Use of Renewable Energy Credits (RECs)

As a city pursues carbon neutrality, it will need to consider a wide variety of available instruments. Carbon credits are one such mechanism described in this guidance document for the specific purpose of cancelling out a city's residual emissions. Renewable Energy Credits (RECs) represent a separate mechanism available to cities in the pursuit of carbon neutrality, however it is important to note that RECs can only be used to address Scope 2 emissions as described in the *GHG Protocol Scope 2 Guidance of the Greenhouse Gas Protocol*[49]. RECs are a different tool from carbon credits and the two should **not** be conflated nor considered interchangeable.

RECs are measured in megawatt hours (MWh) and incremental purchases of RECs, year over year, can show up as reductions in a city's emissions inventory. Critically, RECs **do not require additionality**. They do provide the possessor of the REC with the ability to claim ownership of the environmental attribute – the renewable aspect (low-emissions or emissions-free) – of a MWh of electricity being supplied to the grid. Individual programs specify the list of requirements that a facility must meet to produce recognised RECs; general practice includes that (i) the electricity sector not be under a cap-and-trade scheme and (ii) there be assurance that the RECs have not been double-counted.

To understand why RECs and offsets are not interchangeable, cities should note the following differences regarding:

- **Project type**: RECs originate from generators of renewable electricity, whereas carbon credits originate from qualifying projects that avoid and/or sequester GHG emissions – which may include renewable energy projects;
- **Unit of measurement**: RECs are measured in MWh, whereas carbon credits are measured in metric tonnes of CO_2 avoided and/or sequestered;
- **Additionality requirement**: There is no additionality requirement for RECs but there is an additionality requirement for carbon credits), and
- **Claims**: Owners use RECs to claim possession of a certain amount of low-emissions or emissions-free electricity supplied to the grid, whereas owners use offset credits to claim possession of a certain amount of CO_2 emissions avoided and/or sequestered.

The following practices are recommended regarding the use of RECs:

- RECs represent a powerful tool that a city may use to reduce their gross Scope 2 emissions, but this tool cannot be used to address overall residual emissions;
- RECs may not be classified as carbon credits, and
- If a specific energy generation project (e.g. wind generation) satisfies the requirements for carbon credits as well as RECs, that facility may produce both carbon credits and RECs, but not for the same MWh of electricity produced. A single MWh can either be claimed as a REC or the GHG reductions associated with it can be claimed towards carbon credits, if the applicable requirements for REC or carbon credit generation are met. Other projects such as landfill gas projects may similarly generate both carbon credits by capturing methane and RECs, or Renewable Identification Numbers (RINs), that are associated with energy produced from the captured methane.

[49] https://ghgprotocol.org/scope_2_guidance

4. Negative Emissions Technologies

In addition to the sequestration projects generating carbon credits discussed in section 3.1.1 Mechanisms, other sequestration technologies exist which are commonly referred to as negative emissions technologies (NETs)[50].

These technologies are largely **yet to be tested and proven, none have been** adopted at large scale. Caution should be taken regarding potential ecological and ethical risks of these technologies until further research and testing on proves them to be effective and safe.

Examples of these technologies:

- **Direct air capture and sequestration** (DACS): chemical process by which CO_2 is captured directly from the ambient air, with subsequent storage.
- **Bioenergy with carbon capture and storage** (BECCS): applying carbon dioxide capture and storage (CCS) technology to a bioenergy facility. Depending on the total emissions of the BECCS supply chain, carbon dioxide may be removed from the atmosphere.
- **Adding biochar**[51] to soils as opposed to burning as a fuel.
- **Enhanced weathering**: enhancing the removal of CO_2 from the atmosphere through dissolution of silicate and carbonate rocks by grinding these minerals to small particles and actively applying them to soils, coasts or oceans.
- **Plant engineering**: selectively breeding certain plants for traits that increase CO_2 storage in soil.

Ecological and ethical considerations:
Cities should consider any and all potential ecological and ethical side effects resulting from the adoption of NETs based on the best available information at the time. For example, direct air capture and storage (DACS) requires a lot of energy which would have to come from renewable sources in order to be deployed on a large scale. General safety and ethical concerns are included below. This list is not exhaustive and impacts may vary across cities and regions.

[50] NETs are not to be conflated with solar radiation management (SRM), which is a category of methods that aim to reflect some amount of incoming light from the sun using particles injected into the atmosphere. Although NETs and SRM are commonly grouped together under the category of geoengineering, the NETs listed in section explicitly deal with the intentional removal of CO_2 from the the atomosphere while SRM does not deal with CO_2 removal

[51] Stable, carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar may be added to soils to improve soil functions and to reduce greenhouse gas emissions from biomass and soils, and for carbon sequestration.This definition builds from IBI (2018)

POTENTIAL IMPACTS

Ecological impacts	According to many models, the level of scaling up of NETs required to keep warming below 2°C by 2100 would require managing a carbon sink that is larger than the entire land sink today (12 gigatons per year compared with 11 gigatons per year)[52]. It is thought that this could possibly lead to issues such as triggering the melting of permafrost[53]. Moreover, given that carbon storage is not necessarily permanent, carbon in soil may be released as the climate changes.
Displacement of food production	Afforestation, reforestation and bioenergy are land intensive methods. If scaled up, they could result in less land to produce more food for a growing population. This may lead to food shortage and/or increases in food prices.
Disruption of natural ecosystems	Large-scale incentives for bioenergy may convert natural ecosystems to commercial energy or monoculture plantations in ways that do not provide a broader set of services.
Potential increase in global emissions	There is a risk that resources from government, corporate and/or philanthropic resources may be diverted to NETs rather than emission reduction actions. These techniques may not work at the required scale, potentially leading to an overall increase in global GHG emissions.

Cities should also consult the best available research on emissions-removal potentials for various NETs.

[52] https://www.nature.com/articles/d41586-018-06695-5

[53] Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years

5. Conclusion and Outstanding Issues

The decisions we make today matter. To limit warming below 1.5°C, global emissions must fall dramatically by 2030 and reach net-zero as soon as possible. To achieve this ambitious and necessary goal, effective communication and engagement with internal and external stakeholders, throughout the carbon neutrality process is crucial, in addition to a clear representation in realising citywide carbon neutrality.

In collaboration with cities, civil society partners, and expert organisations this document has attempted to provide guidance on how to achieve citywide carbon neutrality. It established a shared understanding of city carbon neutrality, identified common principles on emissions reporting and emission reduction mechanisms, transparency and environmental integrity, and provided an overall guidance, including through shared international best practices. There is, however, further work required to strengthen the workability of this guidance.

Below is a list of the outstanding topics that need to be researched and further developed in this guidance, or elsewhere to further the efforts of cities to achieve citywide carbon neutrality:

1) Additional guidance on effective communications and stakeholder engagement on municipal and citywide carbon neutrality.

2) A global registry that can identify the ownership and status of carbon credits, along with geographic data points on project locations and credit retirement locations, will be necessary for cities to track carbon credit activity (purchases, sales, and retirements) in their cities in order to properly account for citywide net emissions. It will be important for such a registry to be created so that cities can understand offsetting activities at different levels within the city (e.g. by private companies or individuals), providing clarification in terms of how those activities have/have not been, or should/should not be factored into the city's citywide inventory. Such a registry should be developed and managed by an unbiased global-reaching organisation. It could be developed by partnering with and drawing on existing carbon credit registries.

3) Updates to current international reporting that do not currently offer gross and net disclosure options.

4) Additional guidance on the costs of carbon credits.

5) Additional guidance on the ethical implications of different types of carbon credit projects.

6) Additional guidance on the role of carbon credits from allowances in compliance markets in citywide carbon neutrality, if any.

7) Additional guidance on sequestration with appropriate accounting methodologies, e.g. urban forests, and use of mass timber in construction.

8) Additional research on best practices for alignment with emerging global mechanisms, e.g. internationally transferred mitigation outcomes (ITMOs) in Article 6 of the Paris Agreement.


City of Paris

Annex A: Other Relevant Technical Definitions from IPCC SR 1.5

Anthropogenic emissions: Greenhouse gases (GHGs), precursors of GHGs and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land use changes (LULUC), livestock production, fertilisation, waste management, and industrial processes.

Anthropogenic removals: The withdrawal of GHGs from the atmosphere as a result of deliberate human activities. These include enhancing biological sinks of CO_2 and using chemical engineering to achieve long term removal and storage. Carbon capture and storage (CCS) from industrial and energy-related sources, which alone does not remove CO_2 in the atmosphere, can reduce atmospheric CO_2 if it is combined with bioenergy production (BECCS).

Baseline scenario: In much of the literature the term is also synonymous with the term business-as-usual (BAU) scenario, although the term BAU has fallen out of favour because the idea of business as usual in century-long socio-economic projections is hard to fathom. In the context of transformation pathways, the term baseline scenarios refers to scenarios that are based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Typically, baseline scenarios are then compared to mitigation scenarios that are constructed to meet different goals for greenhouse gas (GHG) emissions, atmospheric concentrations or temperature change. The term baseline scenario is often used interchangeably with reference scenario and no policy scenario.

Biochar: Stable, carbon-rich material produced by heating biomass in an oxygen-limited environment. Biochar may be added to soils to improve soil functions and to reduce greenhouse gas emissions from biomass and soils, and for carbon sequestration. [Footnote: This definition builds from IBI (2018)].

Bioenergy: Energy derived from any form of biomass or its metabolic by-products. See also Biomass and Biofuel.

Biofuel: A fuel, generally in liquid form, produced from biomass. Biofuels currently include bioethanol from sugarcane or maize, biodiesel from canola or soybeans, and black liquor from the paper manufacturing process.

Biomass: Living or recently-dead organic material.

Bioenergy with carbon dioxide capture and storage (BECCS): Carbon dioxide capture and storage (CCS) technology applied to a bioenergy facility. Note that depending on the total emissions of the BECCS supply chain, carbon dioxide can be removed from the atmosphere. See also Bioenergy, and Carbon dioxide capture and storage (CCS).

Carbon budget: This term refers to three concepts in the literature: (1) an assessment of carbon cycle sources and sinks on a global level, through the synthesis of evidence for fossil-fuel and cement emissions, land use change emissions, ocean and land CO_2 sinks, and the resulting tmospheric CO_2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that that is estimated to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other GHGs and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs or efficiency.

Carbon dioxide (CO_2): A naturally occurring gas, CO_2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP) of 1.

Carbon dioxide capture and storage (CCS): A process in which a relatively pure stream of carbon dioxide (CO_2) from industrial and energy related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere. Sometimes referred to as Carbon Capture and Storage. See also Carbon dioxide capture and utilisation (CCU), Bioenergy with carbon dioxide capture and storage (BECCS), and Sequestration.

Carbon dioxide capture and utilisation (CCU): A process in which CO_2 is captured and then used to produce a new product. If the CO_2 is stored in a product for a climate-relevant time horizon, this is referred to as carbon dioxide capture, utilisation and storage (CCUS). Only then, and only combined with CO_2 recently removed from the atmosphere, can CCUS lead to carbon dioxide removal. CCU is sometimes referred to as Carbon dioxide capture and use.

Carbon dioxide removal (CDR): Processes that remove CO_2 from the atmosphere by either increasing biological sinks of CO_2 or using chemical processes to directly bind CO_2. CDR is classified as a special type of mitigation.

Carbon neutrality: Achieving net zero carbon dioxide emissions at a global scale through the balance of residual carbon dioxide emissions with the same amount of carbon dioxide removal.

Carbon price: The price for avoided or released carbon dioxide (CO_2) or CO_2-equivalent emissions. This may refer to the rate of a carbon tax, or the price of emission permits. In many models that are used to assess the economic costs of mitigation, carbon prices are used as a proxy to represent the level of effort in mitigation policies.

Carbon sequestration: The process of storing carbon in a carbon pool.

Carbon sink: See uptake.

Clean Development Mechanism (CDM): A mechanism defined under Article 12 of the Kyoto Protocol through which investors (governments or companies) from developed (Annex B) countries may finance greenhouse gas (GHG) emission reduction or removal projects in developing countries (Non-Annex B) and receive Certified Emission Reduction Units (CERs) for doing so. The CERs can be credited towards the commitments of the respective developed countries. The CDM is intended to facilitate the two objectives of promoting sustainable development (SD) in developing countries and of helping industrialised countries to reach their emissions commitments in a cost-effective way.

Zero emissions commitment: The zero emissions commitment is the climate change commitment that would result from setting anthropogenic emissions to zero. It is determined by both inertia in physical climate system components (ocean, cryosphere, land surface) and carbon cycle inertia.

Climate neutrality: Concept of a state in which human activities result in no net effect on the climate system. Achieving such a state would require balancing of residual emissions with emission (carbon dioxide) removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect surface albedo or local climate.

Climate target: Climate target refers to a temperature limit, concentration level, or emissions reduction goal used towards the aim of avoiding dangerous anthropogenic interference with the climate system. For example, national climate targets may aim to reduce greenhouse gas emissions by a certain amount over a given time horizon, for example those under the Kyoto Protocol.

CO_2 equivalent (CO_2-eq) emission: The amount of carbon dioxide (CO_2) emission that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO_2 -equivalent emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a 100 year time horizon. For a mix of GHGs it is obtained by summing the CO_2 -equivalent emissions of each gas. CO_2 -equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO_2 -equivalent emissions and resulting CO_2 -equivalent concentrations.

Deforestation: Conversion of forest to non-forest. For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000). [Footnote: See also information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013) and the report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003).].

Decarbonisation: The process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.

Direct air carbon dioxide capture and storage (DACCS): Chemical process by which CO_2 is captured directly from the ambient air, with subsequent storage. Also known as direct air capture and storage (DACS).

Emission scenario: A plausible representation of the future development of emissions of substances that are radiatively active (e.g., greenhouse gases (GHGs), aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change, energy and land use) and their key relationships. Concentration scenarios, derived from emission scenarios, are often used as input to a climate model to compute climate projections.

Emissions trading: A market-based instrument aiming at meeting a mitigation objective in an efficient way. A cap on GHG emissions is divided in tradeable emission permits that are allocated by a combination of auctioning and handing out free allowances to entities within the jurisdiction of the trading scheme. Entities need to surrender emission permits equal to the amount of their emissions (e.g., tonnes of CO_2). An entity may sell excess permits to entities that can avoid the same amount of emissions in a cheaper way. Trading schemes may occur at the intra-company, domestic, or international level (e.g., the flexibility mechanisms under the Kyoto Protocol and the EU-EUTS) and may apply to carbon dioxide (CO_2), other greenhouse gases (GHGs), or other substances. Emission trajectories A projected development in time of the emission of a greenhouse gas (GHG) or group of GHGs, aerosols, and GHG precursors.

Emission trajectories: A projected development in time of the emission of a greenhouse gas (GHG) or group of GHGs, aerosols, and GHG precursors.

Enhanced weathering: Enhancing the removal of carbon dioxide from the atmosphere through dissolution of silicate and carbonate rocks by grinding these minerals to small particles and actively applying them to soils, coasts or oceans.

Fossil fuels: Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.

Geoengineering: In the IPCC report, separate consideration is given to the two main approaches considered as 'geoengineering' in some of the literature: solar radiation modification (SRM) and carbon dioxide removal (CDR). Because of this separation, the term 'geoengineering' is not used in the IPCC SR15.

Global warming: An increase in global mean surface temperature (GMST) averaged over a 30-year period, relative to 1850-1900 unless otherwise specified. For periods shorter than 30 years, global warming refers to the estimated average temperature over the 30 years centred on that shorter period, accounting for the impact of any temperature fluctuations or trend within those 30 years.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2 , N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Greenhouse gas removal (GGR): Withdrawal of a GHG and/or a precursor from the atmosphere by a sink.

Land use: The total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, conservation and City dwelling). In national greenhouse gas inventories, land use is classified according to the IPCC land use categories of forest land, cropland, grassland, wetland, settlements, other.

Land-use change (LUC): Involves a change from one land use category to another.

Mitigation scenario: A plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures.

Nationally Determined Contributions (NDCs): A term used under the United Nations Framework Convention on Climate Change (UNFCCC) whereby a country that has joined the Paris Agreement outlines its plans for reducing its emissions. Some countries NDCs also address how they will adapt to climate change impacts, and what support they need from, or will provide to, other countries to adopt low-carbon pathways and to build climate resilience. According to Article 4 paragraph 2 of the Paris Agreement, each Party shall prepare, communicate and maintain successive NDCs that it intends to achieve. In the lead up to 21st Conference of the Parties in Paris in 2015, countries submitted Intended Nationally Determined Contributions (INDCs). As countries join the Paris Agreement, unless they decide otherwise, this INDC becomes their first Nationally Determined Contribution (NDC).

Negative emissions: Removal of greenhouse gases (GHGs) from the atmosphere by deliberate human activities, i.e. in addition to the removal that would occur via natural carbon cycle processes. For CO_2 , negative emissions can be achieved with direct capture of CO_2 from ambient air, bioenergy with carbon capture and sequestration (BECCS), afforestation, reforestation, biochar, ocean alkalinisation, among others.

Net negative emissions: A situation of net negative emissions is achieved when, as result of human activities, more greenhouse gases are removed from the atmosphere than are emitted into it. Where multiple greenhouse gases are involved, the quantification of negative emissions depends on the climate metric chosen to compare emissions of different gases (such as Global warming potential, Global temperature change potential, and others, as well as the chosen time horizon).

Net-zero CO_2 emissions: Conditions in which any remaining anthropogenic carbon dioxide (CO_2) emissions are balanced globally by anthropogenic CO_2 removals. Net-zero CO_2 emissions are also referred to as carbon neutrality.

Net-zero emissions: Are achieved when emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as Global warming potential, global temperature change potential, and others, as well as the chosen time horizon).

Ocean acidification (OA): Refers to a reduction in the pH of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO_2) from the atmosphere but can also be caused by other chemical additions or subtractions from the ocean. Anthropogenic ocean acidification refers to the component of pH reduction that is caused by human activity (IPCC, 2011, p. 37).

Ocean fertilisation: Deliberate increase of nutrient supply to the near-surface ocean to enhance biological production through which additional carbon dioxide from the atmosphere is sequestered. This can be achieved by the addition of micro-nutrients or macro-nutrients. Ocean fertilisation is regulated by the London Protocol.

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels", recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020.

Pre-industrial: The multi-century period prior to the onset of large-scale industrial activity. The reference period 1850-1900 is used to approximate pre-industrial global mean surface temperature (GMST) in this report.

Reducing Emissions from Deforestation and Forest Degradation (REDD+): An effort to create financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development (SD). It is therefore a mechanism for mitigation that results from avoiding deforestation. REDD+ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. The concept was first introduced in 2005 in the 11th Session of the Conference of the Parties (COP) in Montreal and later given greater recognition in the 13th Session of the COP in 2007 at Bali and inclusion in the Bali Action Plan which called for 'policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries (REDD) and the role of conservation, sustainable management of forests and enhancement of forest carbon stock in developing countries'. Since then, support for REDD has increased and has slowly become a framework for action supported by a number of countries.

Reforestation: Planting of forests on lands that have previously contained forests but that have been converted to some other use. [Footnote: For a discussion of the term forest and related terms such as afforestation, reforestation and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000), information provided by the United Nations Framework Convention on Climate Change (UNFCCC, 2013), the report on Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003).].

Remaining carbon budget: Cumulative global CO_2 emissions from the start of 2018 to the time that CO_2 emissions reach net-zero that would result in a given level of global warming.

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change (TC), prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions.

Sequestration: See Uptake.

Sink: A reservoir (natural or human, in soil, ocean, and plants) where a greenhouse gas, an aerosol or a precursor of a greenhouse gas is stored. Note that UNFCCC Article 1.8 refers to a sink as any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.

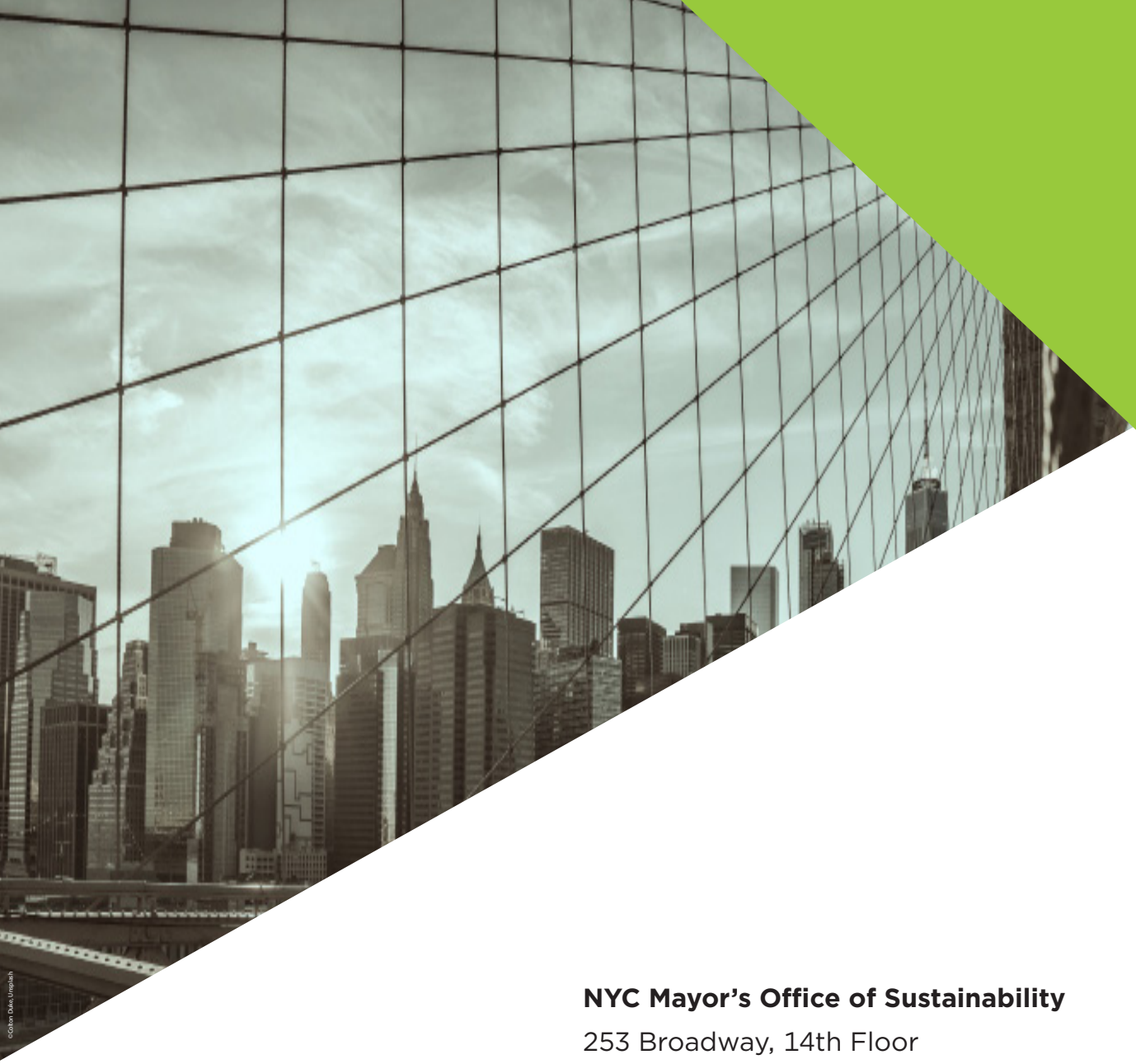
Soil carbon sequestration (SCS): Land management changes which increase the soil organic carbon content, resulting in a net removal of CO_2 from the atmosphere.

United Nations Framework Convention on Climate Change (UNFCCC): The UNFCCC was adopted in May 1992 and opened for signature at the 1992 Earth Summit in Rio de Janeiro. It entered into force in March 1994 and as of May 2018 had 197 Parties (196 States and the European Union). The Convention's ultimate objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The provisions of the Convention are pursued and implemented by two treaties: the Kyoto Protocol and the Paris Agreement.

Uptake: The addition of a substance of concern to a reservoir. See also Carbon sequestration and Sink.

Annex B: Carbon Protocols and Standards reviewed for this document

Special Report: Global Warming of 1.5 °C Glossary	https://www.ipcc.ch/sr15/chapter/glossary/#article
Climate Action Reserve	http://www.climateactionreserve.org/how/protocols/
Verified Carbon Standard	http://www.v-c-s.org/project/vcs-program/
California Offset Program - Air Resources Board (ARB)	https://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm
Regional Greenhouse Gas Initiative	https://www.rggi.org/ and https://www.rggi.org/design/overview
Gold Standard	https://www.goldstandard.org/globalgoals
Climate, Community and Biodiversity (CCB) Standards	http://www.climate-standards.org/
National Carbon Offset Standard (Australian Government)	http://www.environment.gov.au/climate-change/government/carbon-neutral/ncos
Natural Capital - Carbon Neutral Protocol	https://www.naturalcapitalpartners.com/solutions/solution/carbon-neutrality
UNFCCC Clean Development Mechanism (CDM)	https://cdm.unfccc.int/about/index.html
Green-e Climate	https://www.green-e.org/programs/climate
Duke Carbon Offsets Initiative	https://sustainability.duke.edu/offsets/about
South Pole Group Offsets	https://www.southpole.com/sustainability-solutions/carbon-offsets
Social Carbon	www.socialcarbon.org
International Carbon Reduction & Offset Alliance (ICROA)	https://www.icroa.org/rresources
The Nature Conservancy Carbon Offset Programme	https://www.nature.org/ourinitiatives/urgentissues/global-warming-climate-change/help/carbon-offset-program-frequently-asked-questions.xml?redirect=https-301#1
American Carbon Registry	https://americancarbonregistry.org/
I Tree Tools	https://www.itreetools.org/



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