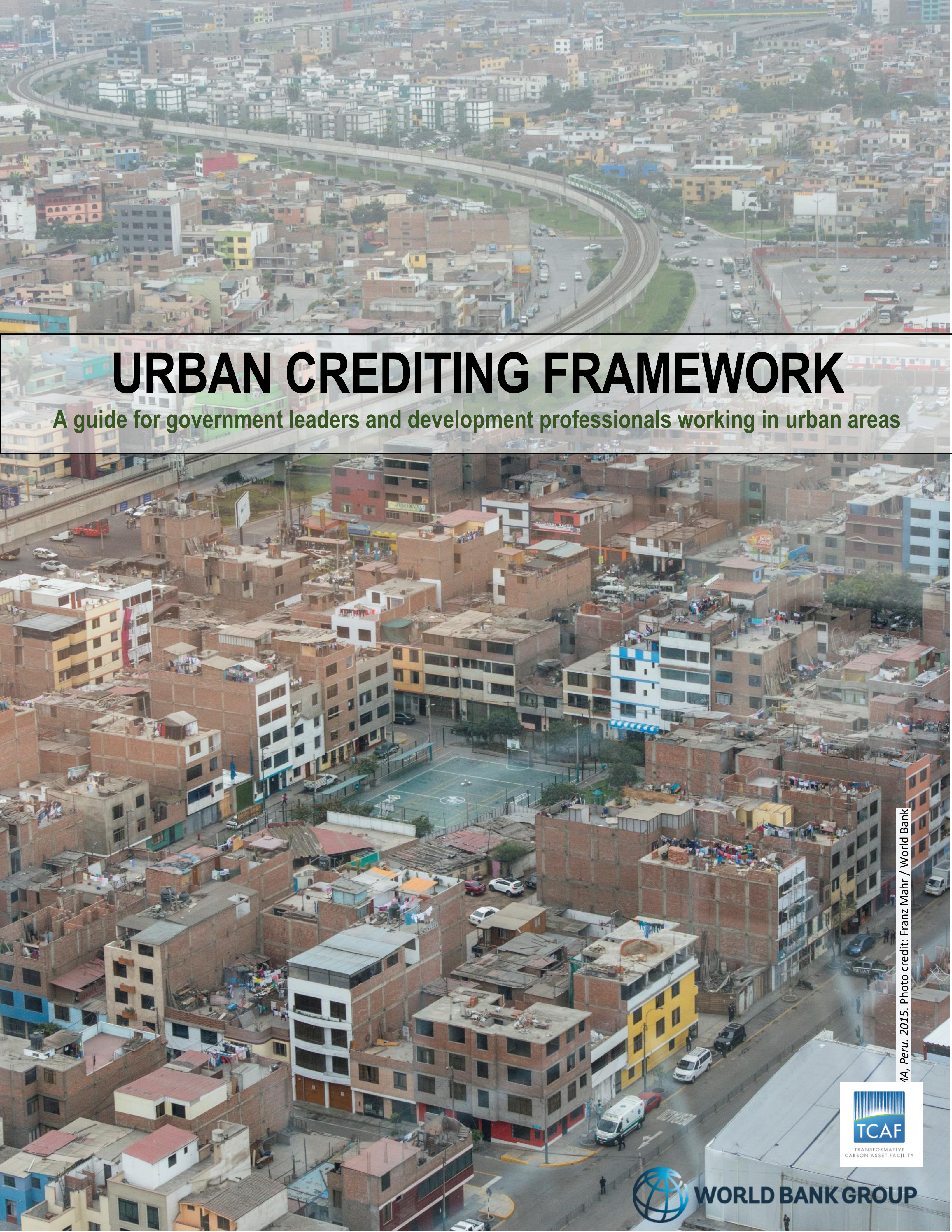
URBAN CREDITING FRAMEWORK

A guide for government leaders and development professionals working in urban areas



MA, Peru. 2015. Photo credit: Franz Mahr / World Bank

TCAF
TRANSFORMATIVE CARBON ASSET FACILITY

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Contents

Acronyms and Abbreviations

EE	Energy Efficiency
ERPA	Emission Reduction Purchasing Agreement
ER	Emission Reduction
GHG	Greenhouse Gas
MRV	Monitoring, Reporting and Verification
NDC	National Determined Contributions

Executive Summary

Climate change is the most defining crisis of our time. No urban or rural areas across the world are immune to the impacts of climate change. Rising temperatures are fueling environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption, conflict, and terrorism. Sea levels are rising, the Arctic is melting, coral reefs are dying, oceans are acidifying, and forests are burning. Human activity around the world (especially in urban areas) is producing Greenhouse Gas (GHG) emissions at a record high, with no signs of slowing down[1]. This rise in GHG emissions leading to global warming is directly and indirectly impacting global population (especially most vulnerable population), assets, livelihoods, food security, water security, ecology, and much more.

Cities are both trigger and antidote for climate change. Globally, urban areas consume between 67% and 76% of global energy and generate about three-quarters of global GHG emissions[2]. With rapid urbanization (55% of world population lives in cities), more and more people are moving to urban areas every day, especially in Africa and South Asia which account for 90% of projected increase in urban population in next 30 years[3]. The expansion of urban land consumption has already outpaced population growth by as much as 50%, and it is expected that additional 1.2 million km² of urban land will be built upon in next three decades. More than 90% this urban expansion will be in the developing countries, especially around or near hazard-prone areas where half a billion urban residents are already living at risk of climate-change events.[4] The speed and scale of urbanization brings challenges, including meeting increased demand for affordable housing, well-connected transport systems, and other infrastructure, basic services, as well as jobs, particularly for the nearly 1 billion urban poor who live in informal settlements to be near opportunities. This rapid increase in population and urban land consumption will overburden the existing infrastructure, services and systems that exists in cities, and can lead to unplanned, unmanaged and most often carbon-intensive growth, both within and beyond city boundaries. *(Refer Chapter 1)*

Despite most GHG emissions attributed to cities, they can still play an increasingly important role in tackling climate change especially, rapidly growing cities, where most of the infrastructure and housing for the new residents is yet to be built. Cities play an increasingly important role in tackling climate change, because their exposure to climate and disaster risk increases as they grow. Rapidly growing cities presents itself a window of opportunity to reduce future emission trajectory and choosing to avoid future lock-in to high energy—and emissions—pathways by planning, constructing/retrofitting and developing low-carbon infrastructure and housing in these rapidly growing cities. To achieve proposed emissions reduction by participating countries in its Nationally Determined Contribution (NDC), there is an urgent need to recognize importance of transformation (spatial, economic and political) required in urban areas to reduce GHG emissions. Although over 9,000 cities and local governments (representing more than 800 million people) have committed to climate action through the Global Covenant of Mayors, and have pledged to collectively reduce 1.3 billion tons of CO_2 emissions per year (~276 million cars off the road) in coming

[1] https://www.un.org/en/un75/climate-crisis-race-we-can-win
[2] Seto KC, et al. 2014: Mitigation of Climate Change: Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Chap 12. IPCC; Geneva, Switzerland: 2014. Human settlements, infrastructure, and spatial planning; pp. 923–1000.
[3] United Nations, Department of Economic and Social Affairs, Population Division (2019). World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations.
[4] World Bank (2020). Urban Land and Housing Market Assessment: A Toolkit

decade[5], yet getting to that goal of GHG emissions will need a major revamp of current growth trajectory across regions. *Cities will have to transform the way they are designed, planned and managed.*

Spatially, Cities either grow horizontally (often beyond existing boundaries to adjoining municipalities, provinces or rural areas) [6] ***or vertically (change in population density) or both.*** To ensure that GHG emission reduction is considered holistically, cities need to manage energy consumption and emissions from different sectors, activities and policies that is aimed at the metropolitan or urban agglomeration level and one that consider population density and growth rate, along with other key characteristics. This also raises the importance of partnership modalities and collaboration across nearby regions, along with innovative partnering with relevant agencies, ministries, organizations (C40, urban coalition etc.), agencies for overcoming multiple barriers to ER.

Cities are heterogenous and constantly evolving, the approach for GHG emission reduction needs to be contextually appropriate, shift over time and adaptable to the needs of the city. Cities are quite unique, and they differ in size, population growth rate, existing infrastructure and service provision, risk to disaster, pandemic, conflict and climate change events, existing institutional structure, legal mandate, municipal finance, their priority needs and so forth. To explain this phenomenon, let's take an example of recent COVID-19 pandemic, which has led all city stakeholders (including communities) to re-think how to better plan, build, manage and retrofit our cities for adapting and responding to such unprecedent crisis in future. Some cities like Maidugiri had to face compounded risks last year, where pandemic collided with floods, sudden influx of forcibly displaced, health emergency, conflict and other day-to day issues of service provision and urban management from rapid population growth. *(Refer Chapter 2).*

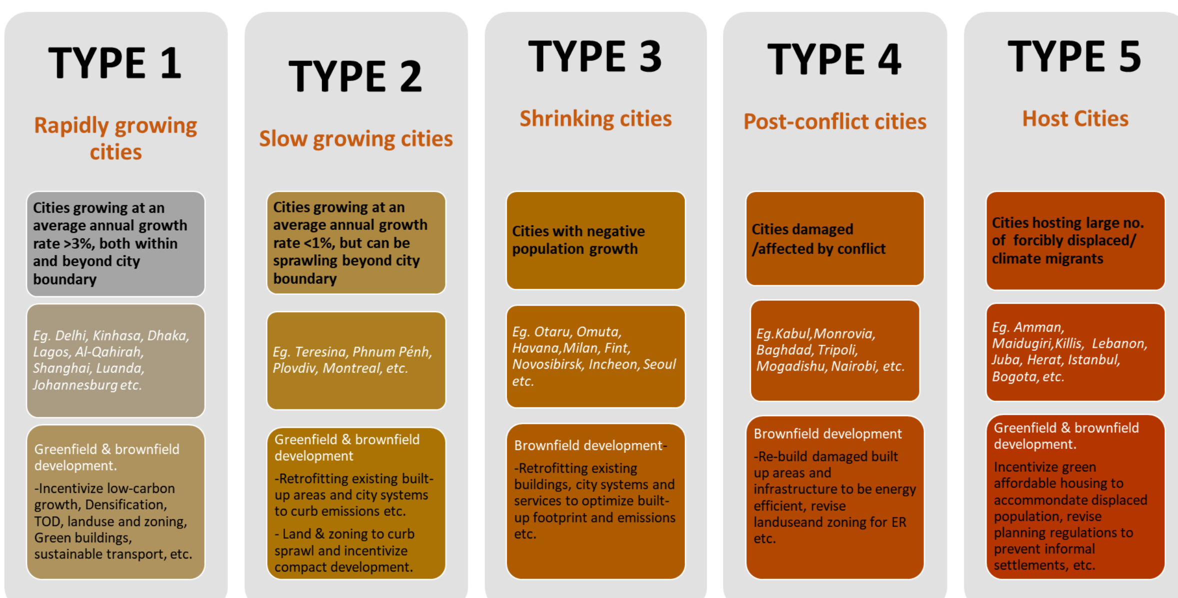

Figure 1: Type of Cities, their examples and sample measures for ER for each type. [7]

[5] UN Habitat. 2019. Climate Action summit 2019. https://unhabitat.org/un-habitats-climate-action
[6] https://www.worldbank.org/en/news/feature/2014/05/12/think-outside-boundary-cities-metro-approach
[7] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank

Apart from climate-change mitigation, GHG Emissions Reductions (ER) in cities are closely linked to multiple hidden dividends that are often undermined in decision-making and long-term development planning., but cities may face multiple challenges in strategizing/planning/implementing any changes for ER. Reducing carbon emissions can lead to a healthy city – one that prioritizes health and well-being of residents with cleaner air, improved accessibility, improved affordability, mitigating adverse impacts of climate change, and so forth. While City and regional decision-makers are well placed to alter the urban emissions pathways through local actions, they may face varied implementation challenges depending on city typology, existing capacity, existing institutional and policy context, political will, competing priorities, existing policies, resistance from carbon-intensive industries, and so forth. *(Refer Chapter 3).*

Table 1: Summary of challenges and opportunities per type of city to apply ER measures in urban sector[8]

TYPE OF CITY	CHALLENGES	OPPORTUNITIES
Type 1: Rapidly growing cities	• Lack of financial and technical resources at local level to cope up with increase in population growth and subsequent demand for services and infrastructure. • Competing priorities of the city to cater to its growing population. • Population growth is usually accompanied by increase in informal settlements, sprawl, peri-urban areas that will increase in all emissions - building, transport, energy. • Rapid Population growth could lead to change in land use that may extend settlement areas beyond city boundary or into environmentally sensitive areas, bringing in new jurisdictional challenges and exacerbating existing institutional, municipal finance and coordination challenges.	• Potential to pilot smaller neighborhood/community-level retrofits/new programs to encourage energy efficiency and climate-smart solutions. (eg. NYC 80 x 50 program) • Spot Zoning regulations to incentivize densification and mixed-use development to reduce cost burden for new infrastructure in peri-urban areas/Greenfields (as the unit cost is density sensitive and not population sensitive). • Potential to build/improve/extend sustainable public transportation and non-motorized transit network to reduce emissions and encourage transit-oriented development. (eg. Colombia BRT) • Potential to introduce low-carbon housing options/solutions and housing finance for newer population moving to the city.
Type 2: Slow growing cities	• Slower population growth may skew the market supply and demand metrics for infrastructure and services, making it harder to introduce newer technologies/solutions or to	• Window of opportunity to establish/revise existing urban planning standards, zoning regulations, incentives, energy codes etc. for encouraging compact city form and sustainable development. This usually is harder to achieve in a

[8] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank

	incentivize switch to climate-smart solutions. • The investment cost of sustainable public transportation solutions/TOD/renewable energy switch may not be lucrative for the investors/city due to delayed cost of recovery time.	fast-growing city due to the sheer amount of new population and their infrastructure needs. • Piloting sustainable waste management strategies, reducing urban heat index, building retrofits for reducing emissions, incentives for electric/hybrid vehicles, introducing bike networks ec. may be more manageable to implement in a slow growing city. • Potential to introduce sustainability/urban crediting in city's priorities and budget.
Type 3: Shrinking cities	• Declining population in the city may lead to underutilization or abandonment of existing infrastructure (that may be under-maintained) in the city. This may often lead to increase in emissions per resident, as both existing infrastructure and services would still have to be up and running for remaining population.	• Potential to introduce smart usage of underutilized/underused infrastructure through either partial shutdown or retrofitting to reduce emissions. • Potential to incentivize compact growth by reducing the settlement footprint and encouraging residents to move towards city core. • Potential to convert existing infrastructure to green infrastructure, for eg. abandoned factories/transit stations (brownfield), if remediated well, can be converted into an urban park.
Type 4: Post-conflict/disaster cities	• Massive destruction or localized damage to the city and its infrastructure. • Fragile institutions, low level of public trust among citizens. • Low political will to integrate/plan for ER. • Poor technical and financial capacity at municipal level. • Competing priorities of the city to cater to its conflict-affected population and economy- local economic development, improving human development,	• Potential to re-build/rehabilitate the damaged infrastructure in a more sustainable way. • Potential to introduce green building principles and energy codes to disaster-recovery housing. • Potential to assess hotspots of disaster and climate -change and make the case for constructing/rehabilitating more resilient and climate-smart infrastructure.

	social safety nets, improving security, mitigating disaster risk, etc.	• Potential to improve urban planning standards and zoning regulation based on identified disaster risk. • Potential to utilize donor funding/assistance from international organizations/humanitarian agencies to fix the city.
Type 5: Host cities	• Sudden influx of forcibly displaced or climate migrants, can overburden existing city infrastructure and service delivery – but this influx could be temporary. • Since displaced settle alongside host communities, the city may not have enough information or data to estimate the influx, their status, and their location. • Competing priorities of the city to cater to its forcibly displaced or climate migrants, who may be more vulnerable population than local population and may lack access to services, jobs, public amenities, healthcare, housing etc. • Sudden change in land use as displaced may settle in city peripheries, environmentally sensitive or risk-prone areas, accompanied by increase in informal settlements, sprawl, peri-urban areas that will increase in all emissions - building, transport, energy • Forced displacement and climate migration within country or nearby border towns, can bring new institutional, legal, jurisdictional, finance and coordination challenges.	• Potential to utilize donor funding/assistance from international organizations/humanitarian agencies to fix the city. • Potential to introduce climate-smart solution/strategies for planning new infrastructure to accommodate this influx of population. • Potential to introduce/encourage smaller decentralized climate-smart service provision that can reduce the total emissions and provide flexibility to scale down once the displaced population moves out. • Potential to encourage climate-smart programs/initiatives to integrate/employ new population and promote climate-efficient local businesses and industry standards.

There are four broad areas of GHG emission reduction in urban areas that may fall under purview of city or sub-national government, namely energy efficient building, climate smart urban form, low carbon transport and low carbon infrastructure and services. Within each of the four areas of intervention for ER (refer figure above), there are range of policies, programs, and projects that could be used positively for GHG reduction. Some of the measures and examples under each sector are listed below in section below and more broadly in Chapter 4.

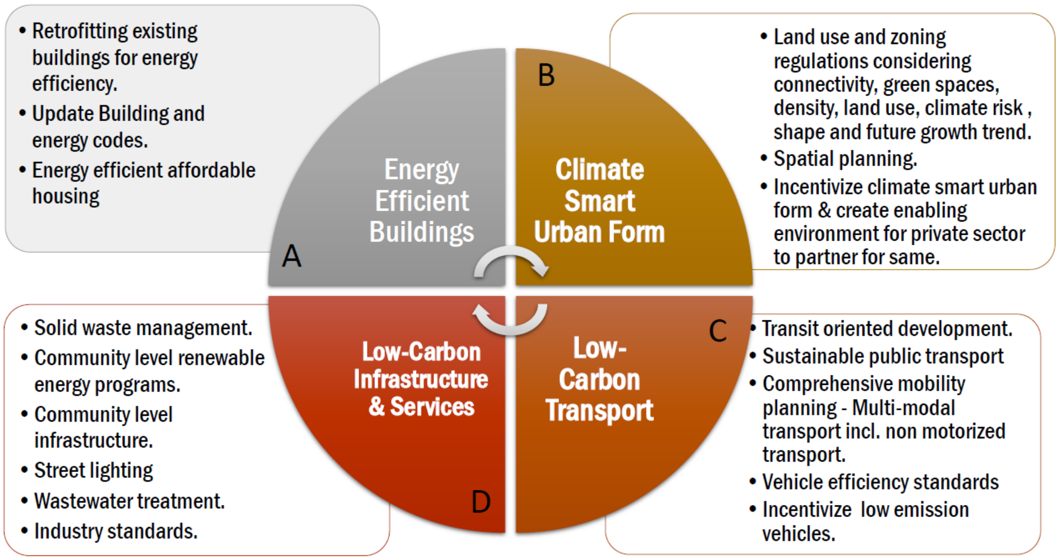

Figure 2: Four broad areas to reduce GHG emissions in cities.[9]

A. *Energy Efficient Buildings:*

136 countries have referenced building sector in their NDCs[10]. Investors, developers, owners, and governments will have to work together to meet demand for buildings in a way that is economically beneficial and aligned with global climate goals. Buildings and land use are the biggest contributor of GHG emissions in an urban area. For example, in New York City, more than 68 percent of GHG emissions can be attributed to the energy used to power, heat, and cool buildings[11].

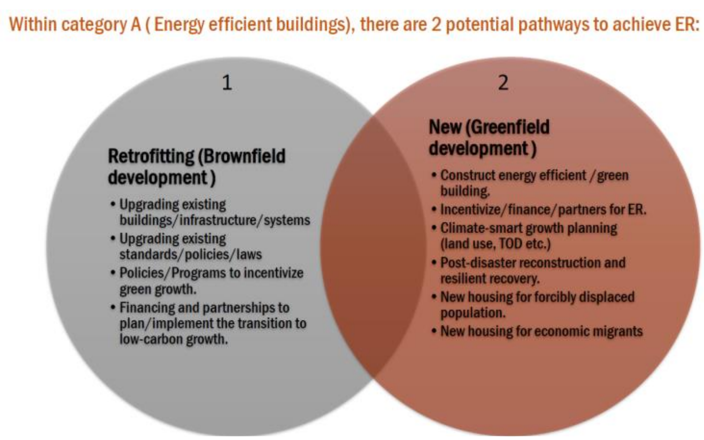

Figure 3: Two broad categories for energy efficiency measure in cities. [12]

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[9] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank
[10] IEA (2019), Perspectives for the Clean Energy Transition; IFC (2018); 2 IEA/UNEP (2017), Global Status Report 2017; 3 https://www.usaid.gov/energy/efficiency/economic impacts 4 IFC (2019). Green Buildings A finance and policy blueprint for emerging markets ; 5 World Green Business Council (2013), The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants.
[11] City of New York (2016). New York City's Roadmap to 80 x 50. OneNYC.
[12] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank

Implementing energy efficiency measures in buildings (both existing and new) could significantly reduce energy consumption and associated CO2 emissions. For instance, projected additional 230 billion square meters of new building construction in coming decades (equivalent to adding the floor area of Japan every year until 2060[13]) offers a significant opportunity to integrate energy efficiency into building design from the outset, helping to maximize the financial benefits that come from energy savings, avoid higher carbon emissions for decades that stem from inefficient energy use and to avoid the need for costly retrofits later.[14] The green buildings sector represents a $24.7 trillion investment opportunity by 2030 across all emerging market cities with a population of more than half a million people. [15] While building green could range from savings of 0.5 percent to 12 percent in additional costs, green buildings can decrease operational costs by up to 37 percent, achieve higher sale premiums of up to 31 percent and faster sale times, have up to 23 percent higher occupancy rates, and have higher rental income of up to 8 percent.[16] Similarly, retrofitting existing buildings represents another sizeable investment opportunity and plays a key role in reaching global climate goals. The retrofit market is expected to grow at a compound annual growth rate of 8 percent from 2018 to 2023. [17] Energy efficiency retrofits have shown attractive returns on investment, even for short term investors. This is because in addition to generating direct cost savings, these measures positively affect the overall value of buildings.[18]

Refer detailed case study of New York city in Annex 1.1, where the city has incorporated series of measures to reduce building emissions by 80% in next 30 years (mostly accounting for existing buildings), and from energy efficiency program from Mexico in Annex 1.2 (mostly accounting for new housing). However, it should be noted from case studies that such a transformational change to reduce emissions from buildings in urban space involve multiple stakeholders from city authorities to local communities, takes a long time and involve long set of measures both at public and private sector level, and involves thinking through and overcoming every implementation challenge from financing to policy environment, one by one.

B. Climate smart urban form:

Land use contributes ¼ GHG emissions, that includes CO2 emissions from deforestation and much more.[19] Land use/ Climate smart urban form is one of the top performing climate change strategies one that becomes even stronger when combined with other transportation strategies supporting compact development. As compact land use patterns result in fewer vehicle miles traveled (VMT), in terms of both the length and the number of vehicle trips, than sprawling land use patterns, it leads to substantial reduction in VMT (~40%) and GHG emissions. The key to successful compact development is a land use pattern that has a high quality pedestrian network, and a variety of land uses within walking distance of each other again since most trips of all modes are not work or work-related trips, compact development makes destinations like church, school, and shops more convenient to access with limited vehicular

[13] IEA/UNEP (2017), Global Status Report 2017
[14] https://www.usaid.gov/energy/efficiency/economic impacts
[15] IFC (2019). Green Buildings A finance and policy blueprint for emerging markets
[16] IFC (2019). Green Buildings A finance and policy blueprint for emerging markets ; and World Green Business Council (2013), The Business Case for Green Building: A Review of the Costs and Benefits for Developers, Investors and Occupants;
[17] Environment + Energy Leader (2018), Energy Retrofit Systems Market to Grow 8% by 2023
[18] Environment + Energy Leader (2018), Energy Retrofit Systems Market to Grow 8% by 2023
[19] Shukla et. al. Technical Summary, 2019. In: Climate Change and Land: an IPCC special report on climate change, desertificat ion , land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

trips. Research indicates that doubling residential density reduces VMT by 5 to 12 percent, or by as much as 25 percent when combined with other changes. But it should be noted that low emission land use planning is not a linear process but rather a continual and iterative one which may involve multiple sectors, actors and jurisdictions. [20] For example, a study of 50 small to medium sized Japanese cities revealed that: (i) higher level of regularity of urban settlement shape and compactness of urban settlements lead to lower residential CO_2 emissions; (ii) Although denser settlement may lead to lower CO_2 emissions from the residential and passenger transport sectors, but high-density urban settlements in mono centric form may increase CO_2 emissions from the residential sector. *(Refer case study in chapter 4)*

C. Low-carbon transport:

While urban form significantly impacts travel behavior, there is considerable influence of transit on urban form and the shared impacts of transit on urban form. Therefore, Urban design and development patterns can play a vital role in reducing transport demand and can facilitate an efficient organization of the required urban transportation system. In a denser compact city form, public transport can be organized more efficiently and the distances between destinations
(majority of which are non-work-related short trips) will encourage either public transport or non-motorized transit option such as walking/cycling. Measures to reduce emissions from transport could include clean energy public transport, non-motorized transport,
encouraging transit-oriented development through densification, land value capture, etc.
Refer detailed case study from Bogota BRT in Annex 1.3 highlighting the city's journey to shift from existing inefficient transit system biased towards private transit options to a sustainable public transit and TOD. There were multiple challenges, particularly implementation and operational, that had to be tacked on the way to reap the benefits of overall project and reduce transport related emissions of the city.

D. Low Carbon infrastructure & services:

Sustainable Waste management: There is a strong relationship between solid waste generation and GHG emissions, specifically methane that is released from landfilling of biogenic carbon. Few approaches to sustainable waste management could include low carbon landfill design and operation; organic waste diversion; thermal treatment of waste; and source reduction, reuse, and recycling. Refer case study from City of Cape Town in Annex 1.4, where the city is actively trying to reduce emissions through effective
management of waste along the value chain.

Industry and other city-wide infrastructure and service delivery: Measures to reduce emissions at industry level could include carbon pricing, mandatory EE standards for industries and grants/subsidies for energy efficiency investments (including CHP) and investment in clean fuels (renewables, waste, natural gas, etc.); for energy audits, training, and for benchmarking activities; etc. Other city-wide infrastructure and service delivery could include: Community level renewable energy programs; Community level decentralized infrastructure; energy efficient Street lighting; Wastewater treatment; raising community level awareness of low carbon development solutions; introducing sustainability research programs and curriculum; etc. also may fall under the municipal governments and often is a more manageable scale to bring about transformational change in emission reduction.

[20] Urban Land Institute. Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions. Washi ng ton, D.C.: Urban Land Institute, 2010

Different cities are at different juncture and therefore, it is important to recognize that there will be different entry-points and different types of implementation arrangements, financing mechanism, partnership modalities and so forth, that a particular city needs to follow for emission reduction. A framework approach for urban carbon crediting, that starts with a rapid diagnostic of city typology and its existing systems, to critically examining various options and selecting most appropriate points of entry to start discussion on ER with decision makers/stakeholders, and collaboratively developing a short-term and long-term comprehensive approach for proposed change in policies, regulations, practices, partnerships, financing and so forth to achieve ER within a city and its surrounding region. *(Refer Chapter 5)*.

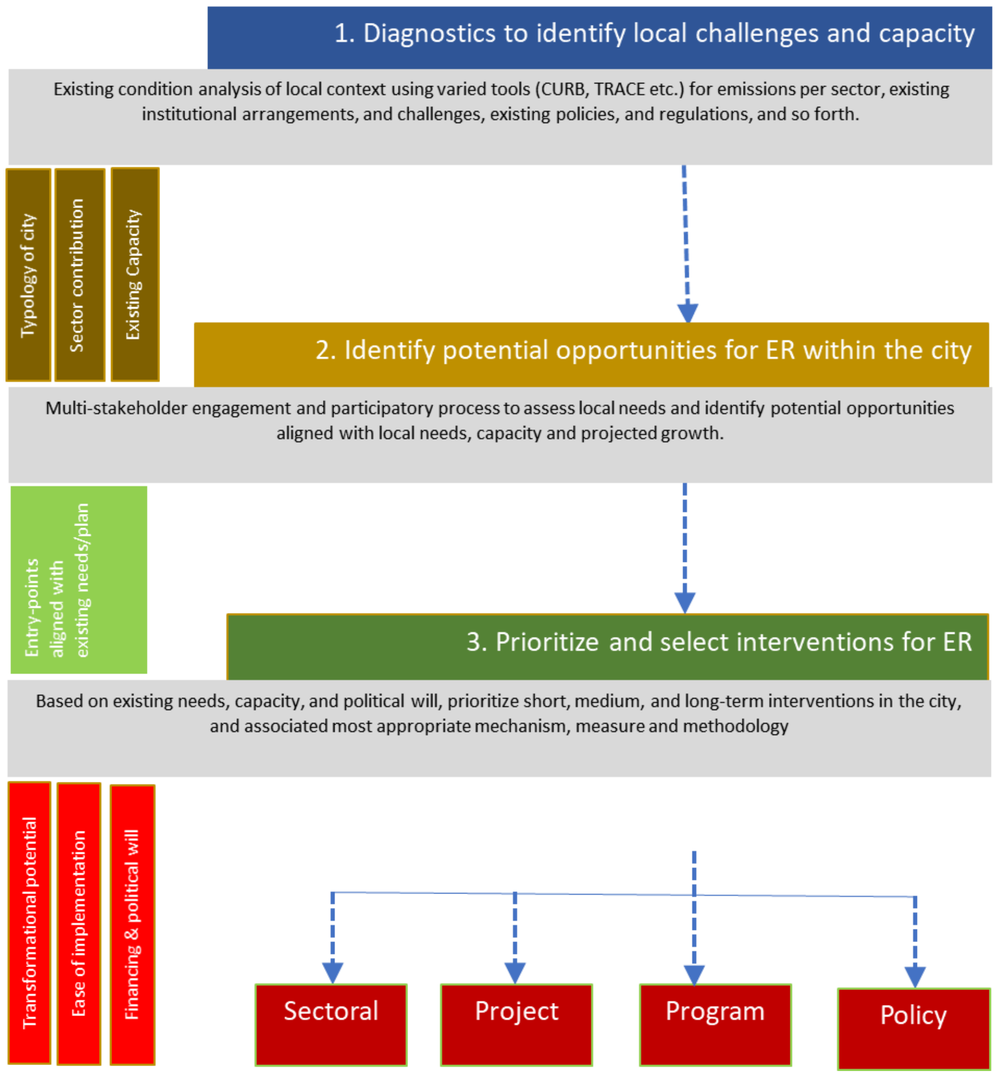

Figure 4: Sequential process to select ER projects/program/policy for urban crediting at city-level.[21]

GHG emissions reductions in an urban area can contribute to meeting the national NDC targets, or be converted into carbon credits, which can then be sold and exchanged internationally. Carbon credits can

[21] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank

help achieve carbon neutrality, by addressing both residual emissions & accelerating emission reduction while longer term infrastructure, regulatory and economic changes take place in background. Crediting programs can be sectoral (sectoral crediting within the City Authorities jurisdiction or involving several cities); or jurisdictional (involving measures and regulations that impact more than one sector). Urban crediting can bring transformational change by enabling local authority/decision-makers to make informed decisions, help mitigate their financial risk, increase financing for infrastructure improvements needed in the city, accelerate urban emission reduction, provide improved MRV systems and increase global/regional visibility.

Result-based financing for emission reduction with TCAF is a one such model to: bridge financing gap at city level; reduce barriers to private sector involvement and share risk; and to provide incentives to city and sub-national/national government to achieve emission reduction beyond their NDC commitments. The Transformative Carbon Asset Facility (TCAF) provides funding through emission reduction transactions to stimulate, in client countries, the establishment of robust regulatory frameworks for carbon pricing, and to promote sustainable development. It is a multi-donor trust fund established in 2017 with the total capitalization of $220 million. It provides both technical assistance for project preparation and results-based payment in the range of $30-50 million that rewards the mitigation impacts caused by policies, investments, and actions/measures. Refer to two TCAF cases studies in Chapter 6: (i) Target-based crediting in the management of organic waste in South Africa; (ii) Jurisdictional crediting at the margin in Amman, Jordan.

01. Urban Context

More than half of the world's population lives in urban areas, and it is projected to increase to 68% by 2050. Rapid urbanization has transformed the planet from just 30 percent urban in 1950 to crossing 55 percent today, and it is projected that more than two-thirds of the population (~ 7 of 10 people) in the world will live in urban areas by 2050. An additional 2.5 billion people (comparable to the combined populations of India and China) will add or move to cities in next 30 years, with nearly 90 percent of the increase concentrated in Asia and Africa. [22]

Almost half of the world's urban residents live in medium to small sized cities (<500,000 inhabitants), which are also growing the fastest. Globally, 58 percent of urban dwellers (~2.4 billion) reside in urban settlements with fewer than 1 million inhabitants, which are projected to add another 400million people in coming decade. Similarly, one in five urban dwellers currently live in a medium-sized city (1 - 5 million inhabitants) which are expected to add another 300million by 2030.[23]

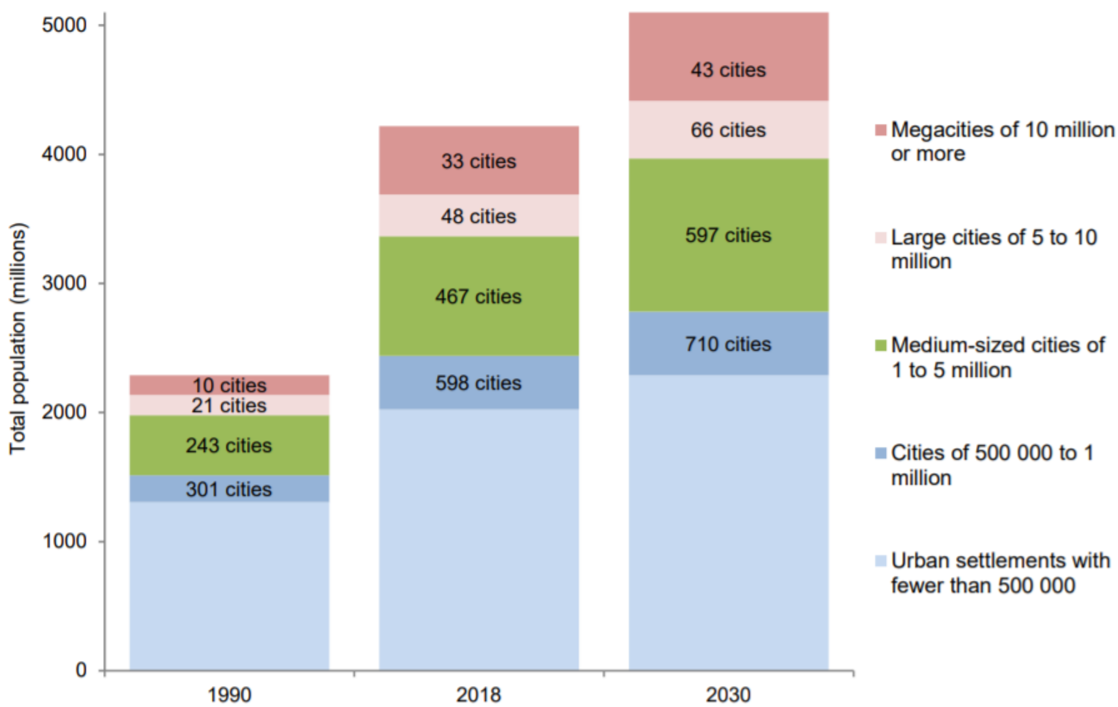

Figure 5: Population and number of cities of the world, by size class of urban settlement, 1970, 1990, 2018 and 2030 (Source: UN DESA 2018)

African and Asian cities are growing at a much faster pace and will account for 90 percent of the urban population increase. There are regional variations in projected urban growth, with all African cities expected

[22] United Nations, Department of Economic and Social Affairs, Population Division. 2019. *World Urbanization Prospects: The 2018 Revision* (ST/ESA/SER.A/420). New York: United Nations.
[23] Ibid 22

to grow at an exceptionally accelerated rate, with average rates higher than 3 percent, regardless of the city size. Some African cities are almost doubling in size every census. Moreover, all ten fastest-growing cities with growth rates ranging from 5.2 percent to 5.9 percent per year are in Africa[24]

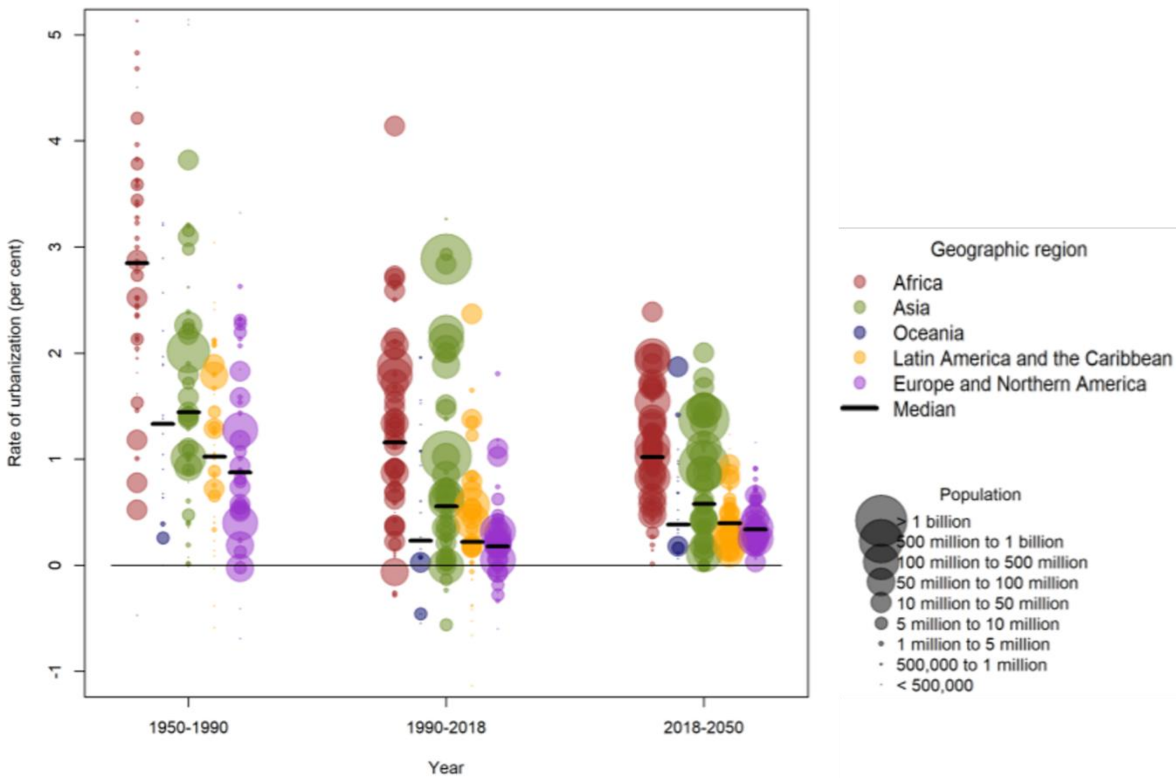

Figure 6: Rate of urbanization in countries by geographic region, 1950-1990, 1990-2018 and 2018-2050 (Source: UN DESA 2018)

With more than 80% of global GDP generated in cities, if managed well, urbanization can contribute to sustainable growth by increasing productivity, allowing innovation and new ideas to emerge. Well-managed urbanization (among other factors), informed by an understanding of population trends over the long run, can help to maximize the benefits of agglomeration, which includes productivity gains, knowledge spillovers and technological innovation that can eventually become a positive force for economic growth, poverty reduction, and human development. For example, each doubling of city size increases productivity by 5 percent, and the elasticity of income with respect to city population is between 3 percent and 8 percent[25]. However, the speed and scale of urbanization bring challenges, including meeting accelerated demand for affordable housing, well-connected transport systems, and other infrastructure, basic services, as well as jobs.

Despite agglomeration benefits, unplanned and unmanaged rapid urbanization can exacerbate risks, increase GHG emissions and contribute to climate change. Decisions about a city's growth pattern will

[24] Ibid 22
[25] Rosenthal, Stuart S., and William C. Strange. 2004. "*Chapter 49 Evidence on the Nature and Sources of Agglomeration Economies.*" In Handbook of Regional and Urban Economics 4: 2119–71. Amsterdam: Elsevier.

strongly influence future greenhouse gas emissions and environmental sustainability.[26] Once a city is built, its physical form and land use patterns can be locked in for generations. In 4 of the 11 world regions, (North America, Europe, India, and China) there is a discernible, consistent declining trend in their urban population densities leading to unsustainable sprawl[27]. The expansion of urban land consumption outpaces population growth by as much as 50%, which is expected to add 1.2 million km² of new urban built up area to the world in the three decades. Such sprawl puts pressure on land and natural resources, resulting in undesirable outcomes such as higher greenhouse gas emissions, environmental degradation, increased risk to disasters especially for most vulnerable population living in hazard zones and so on.

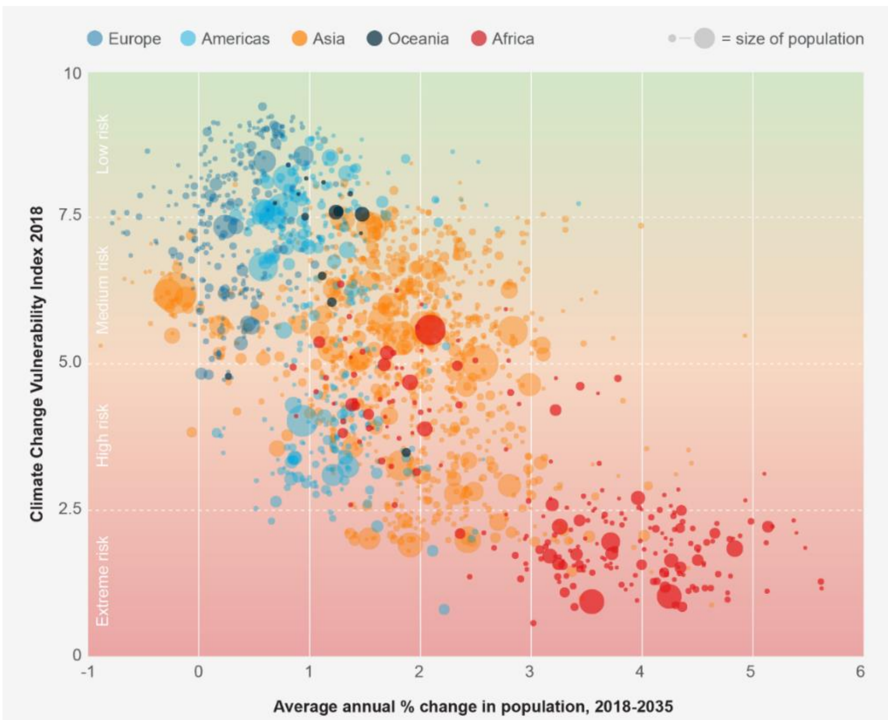

Figure 7: Climate change vulnerability by region (Source: Verisk Maplecroft 2018)

Cities consume 2/3rd of global energy consumption and account for more than 70% of greenhouse gas emissions. Historically, the world has exhibited a strong correlation between the growth in economic activity and population and the increase in energy usage. Urban energy use significantly contributes to climate change, and the urban built environment shapes energy consumption patterns for decades. The most recent Intergovernmental Panel on Climate Change report[28] shows that urban areas consume between 67% and 76% of global energy and generate about three-quarters of global carbon emissions[29].

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[26] Lall, Somik Vinay, J. Vernon Henderson, and Anthony J. Venables. 2017. *"Africa's Cities: Opening Doors to the World."* World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0

[27] Trends in urban land expansion, density, and land transitions from 1970 to 2010: a global synthesis; Burak Güneralp1,4, Meredith Reba2, Billy U Hales1, Elizabeth A Wentz3 and Karen C Seto2 Published 20 March 2020 • © 2020 The Author(s). Published by IOP Publishing Ltd Environmental Research Letters, Volume 15, Number 4

Rapidly growing cities that are already struggling with provision of infrastructure and basic service delivery, especially in developing countries, will face increased challenges to keep up with the pace up of urbanization and population growth [30]. With rapid urbanization in developing countries, cities, their systems, and infrastructure, are often unable to cope with increasing population growth and sprawl amidst existing service delivery challenges. 90% of urban expansion in the developing countries is near hazard-prone areas and built through informal and unplanned settlements – where globally, a billion urban residents live in slums with inadequate access to basic services currently. This proportion of urban population living in unplanned settlements is projected to dramatically increase in coming decades.

Cities are concentrated centers of people, assets, and economic activity, but this concentration also increases their exposure to the impacts of climate change and natural hazards, making urban dwellers (especially urban poor) particularly vulnerable to extreme weather events exacerbated by climate change. Almost half a billion urban residents live in coastal areas, increasing their vulnerability to storm surges and sea-level rise. In the 136 biggest coastal cities, there are 100 million people – or 20% of their population – and $4.7 trillion in assets exposed to coastal floods.

Many cities currently are facing climate emergency, and the impacts of climate change are increasing over time. The effects of the recent changes in the planet's climate, as well as expected future climate risks have pushed about a thousand cities worldwide to declare a climate emergency. Global climate change has already had observable effects on the environment, including accelerated sea-level rise, hot extremes in most inhabited regions, heavy precipitation in many areas, and the higher probability of drought and precipitation deficits in other areas[31]. Of the 1,692 global cities with at least 300,000 inhabitants in 2014, 944 (56 percent) were at high risk of exposure to at least one of six types of natural disaster (cyclones, floods, droughts, earthquakes, landslides, and volcano eruptions), based on evidence on the occurrence of natural disasters over the late twentieth century. Taken together, cities facing a high risk of exposure to a natural disaster were home to 1.4 billion people in 2014. (UN 2016). Lastly, climate migration is leading to increased displacement; for example, 86 million people are projected to be internally displaced in sub-Saharan Africa by 2050, primarily due to crop failure.

Aside from extreme weather events, climate change has direct and indirect effect on urban areas, its population, economy, and local institutions. From direct impacts on the population, livelihoods and infrastructure affected/damaged by extreme weather events, there are indirect impacts on the overall city's economic contribution, service delivery due to damaged infrastructure, local institutions who are constrained by financial and resource constraints due to re-allocation of budget or deferment of priority projects, population displaced due to climate events, interruption in education, etc.

Urban poor are disproportionately affected by climate-change and the extreme weather events. Most often, urban poor settle in precarious conditions in peri-urban areas or informal settlements/ low-income neighborhoods within the city, that are already either unserved or underserved in terms of service delivery and hazard-prone. The reason for the urban poor to settle on urban peripheries or on land inappropriate

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30 WEF. 2015. Global Risks in 2015. Part 2.3 City Limits: The Risks of Rapid and Unplanned Urbanization in Developing Countries. https://reports.weforum.org/global-risks-2015/part-2-risks-in-focus/2-3-city-limits-the-risks-of-rapid-and-unplanned-urbanization-in-developing-countries/

30 WEF. 2015. Global Risks in 2015. Part 2.3 City Limits: The Risks of Rapid and Unplanned Urbanization in Developing Countries. https://reports.weforum.org/global-risks-2015/part-2-risks-in-focus/2-3-city-limits-the-risks-of-rapid-and-unplanned-urbanization-in-developing-countries/

[31] Source: IPCC, 2018 Summary for Policymakers in: Special Report Global warmimg of 1.5C (https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf)

for formal residential development—next to waste sites, low lying areas, along major transport arteries (canals, railways, rivers, or roads), or on steep slopes - is usually a tradeoff to be closer to work or services and lower cost of housing and land. Due to low coping capacity, high rate of poverty and high exposure, urban poor esp. dependent population (eg. women, youth, older adults and disabled) and informal workers are disproportionately affected by extreme weather events. The capacity of urban poor to mitigate, cope or adapt to climate-change risk will vary based on size of city, severity of climate event, capacity of existing city systems, safety nets, and so on.

Global climate change is brought about by the increasing consumption of fossil fuels, mainly as a source of energy. Energy consumption is by far the biggest source of human-caused greenhouse gas emissions, responsible for about 73% worldwide. The energy sector includes transportation, electricity and heat, buildings, manufacturing and construction, fugitive emissions and other fuel combustion. The other top sectors that produce emissions are agriculture, such as livestock and crop cultivation(12%); land use, land-use change and forestry, such as deforestation (6.5%); industrial processes of chemicals, cement and more (5.6%); and waste, including landfills and waste water (3.2%). Within the energy sector, generation of heat and electricity is responsible for most emissions (15 GtCO2e in 2016, or 30% of total greenhouse gas emissions), followed by transportation (7.9 GtCO2e in 2016, or 15% of total emissions) and manufacturing and construction (6.1 GtCO2e, or 12% of total emissions).[32].

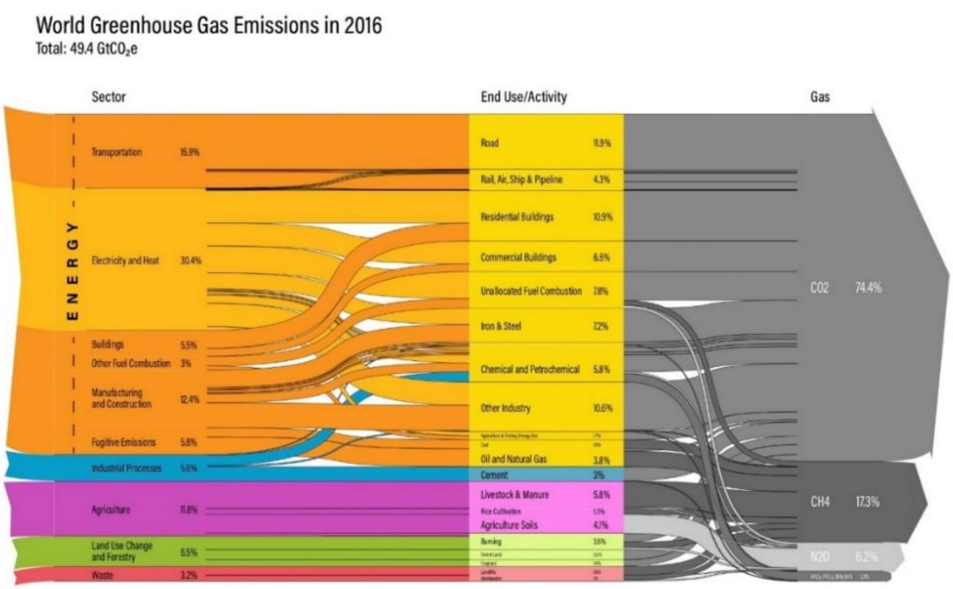

Figure 8: GHG emission of world by sector in 2016 (Source: World Resources Institute)

[32] Source: IEA World Energy Balance 2019

Several credible scenarios describe how energy consumption is likely to evolve. The IEA's *Stated Policies Scenario* reflects the impact of existing policy frameworks and illustrates to today's policymakers the consequences for energy use, emissions, and energy security out to 2040. As defined in this scenario, final energy demand grows by 27 percent between 2018 and 2040, as shown in Table 2 Total worldwide CO_2 emissions in 2017 were 32.6 Gt[33]. Despite rapid changes in the power sector, there is no decline in annual power-related CO2 emissions in the Stated Policies Scenario. Worldwide GHG emissions projected to grow to 35.6 Gt in 2040, from 33.2 in 2018, an increase of 7 percent. A key reason is the longevity of the existing stock of coal-fired power plants that account for 30% of all energy-related emissions today.

					Change	
Sector	2000	2018	2030	2040	2018 to 2040	
Industry	1881	2898	3460	3839	941	32%
Transport	1958	2863	3327	3606	743	26%
Buildings	2446	3101	3455	3758	657	21%
Other	758	1092	1365	1470	378	35%

Table 2: Energy Demand Forecast in 2030 and 2040 in the Stated Policies scenario (Mtoe)

The 2016 Paris Agreement brought almost all the nations together in a common response to the threat of climate change. By subscribing to the agreement, they committed to undertake ambitious efforts to keep a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to try and limit the temperature increase even further to 1.5 degrees Celsius. Over 9,000 cities and local governments representing more than 800 million people have committed to climate action through the Global Covenant of Mayors. By 2030, they aim to collectively reduce 1.3 billion tons of CO2 emissions per year, the equivalent of taking 276 million cars off the road. [34]

Nationally Determined Contribution (NDC) agreed by most countries under Paris agreement are not adequate to limit global warming to within 2 degrees[35], and therefore increasingly the global community is looking to cities to help fill the gap and scale up action to deliver the transformational change that is required, but cities are rarely considered in NDC contribution. National governments mostly defined their NDCs without prior discussions with cities and urban regions. Of the 164 NDCs that were submitted to UNFCC by 2016, seventy percent of them (110) mentioned planned action in cities, as although the national GHG emissions inventories have to be disaggregated by sectors to justify action plans, the NDCs does not require targets at the subnational levels. [36]

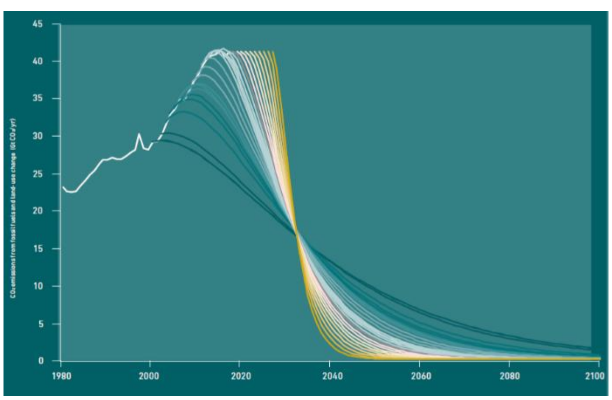

Figure 9: The longer we wait for reducing emissions in the city, the harder it will be.[37]

[33] Source: IEA World Energy Outlook 2018

34 UN Habitat. 2019. Climate Action summit 2019. https://unhabitat.org/un-habitats-climate-action

37 (Source: Center for International Climate Research)

37 (Source: Center for International Climate Research)

02. GHG emission reduction in urban areas

Cities are both a trigger and antidote for climate change. Despite most GHG emissions attributed to cities, they can play an increasingly important role in tackling climate change. Huge gains, in terms of reducing harmful gases, can be made by changing how we plan, build, manage and power our cities and towns. Well designed, compact, walkable cities with good public transport greatly reduce our per capita carbon footprint. Cities are where global and local priorities intersect. Therefore, mitigation needs to increase critically, and cities are meant to play a major role in boosting emission cuts.

Rapidly growing African (and Asian) cities, esp. small and medium-sized cites, have a unique opportunity to leapfrog and avoid carbon-intensive growth trajectories. In rapidly growing cities, where most of the infrastructure and housing for the new residents is yet to be built. "Getting it right" in first go for major investments such as key infrastructure and land use is critical to avoid future lock-in to high energy—and emissions—pathways. Governments need to take immediate action to avoid further lock-in to inefficient, climate-vulnerable, and sprawling urban form in rapidly growing cities. The decision about the growth trajectory of rapidly growing cities in developing, while urbanization is still in its early stages, is critical and presents itself a unique window of opportunity to pro-actively plan for low carbon growth and avoid the mistakes of the developed world.

Apart from climate-change mitigation, GHG emissions reductions in urban areas are closely linked to multiple hidden dividends that are often undermined in decision-making and long-term development planning. The decision regarding reducing the carbon footprint and emission reduction of a city or a neighborhood can have multiple benefits at micro and macro level, from higher productivity and contribution to GDP, improved health with better air quality, improved quality of life, sustainable markets, reduced economic burden, etc. For instance, introducing a low carbon city mobility plan not only cuts future emissions, but also brings new jobs to communities while improving lifestyles and health.[38]

- **Adaptation and resilience:** Many cities are considering the need to strengthen their adaptation and resilience to the effects of climate change (for example, to extreme weather events, sea-level rise, water shortages or changes in temperature and precipitation).
- **Air quality and health costs:** Reducing fossil fuel combustion in transport and Buildings can have a significant positive effect on air quality and health
- **Higher productivity and GDP**: Often, cities in developing countries do not offer sufficient or adequate services to cover their population's demands. When that service is improved as part of a mitigation strategy, it can benefit many others in the community. For example, improvements in public transport service to promote a modal shift from private vehicles can allow others to make journeys that they would not otherwise have made. This increased mobility (time-saving and expanded access to markets and services) has a carry-over effect of improving productivity and economic activity, which is rarely quantified in the project's economic evaluation.
- **Improved quality of life:** Making better use of public space, for example, by greater use of improved public transport with less air and noise contamination can have a positive impact on human development.

[38] UN Habitat. 2019. Climate Action summit 2019. https://unhabitat.org/un-habitats-climate-action

There are different sources of GHG emissions based on whether the city is a producer city or consumer city. Emissions from building, land-use, in-boundary transportation, industrial processes etc. that are from sources located within the city boundary are considered scope 1, whereas GHG emissions that occur as a consequence of the use of grid-supplied electricity, heat, steam and/or colling within the city boundary is refereed as scope. Any other GHG emissions that occur outside the city boundary as a result of activities taking place within a city boundary is referred as scope 3 emissions.[39] The approach for scope 3 emissions recognizes the direct and lifecycle emissions associated with the goods and services consumed by city residents, and is boundary free, meaning that the emissions associated with goods and services are accounted for and attributed to the consuming city, as opposed to the producing entity[40]

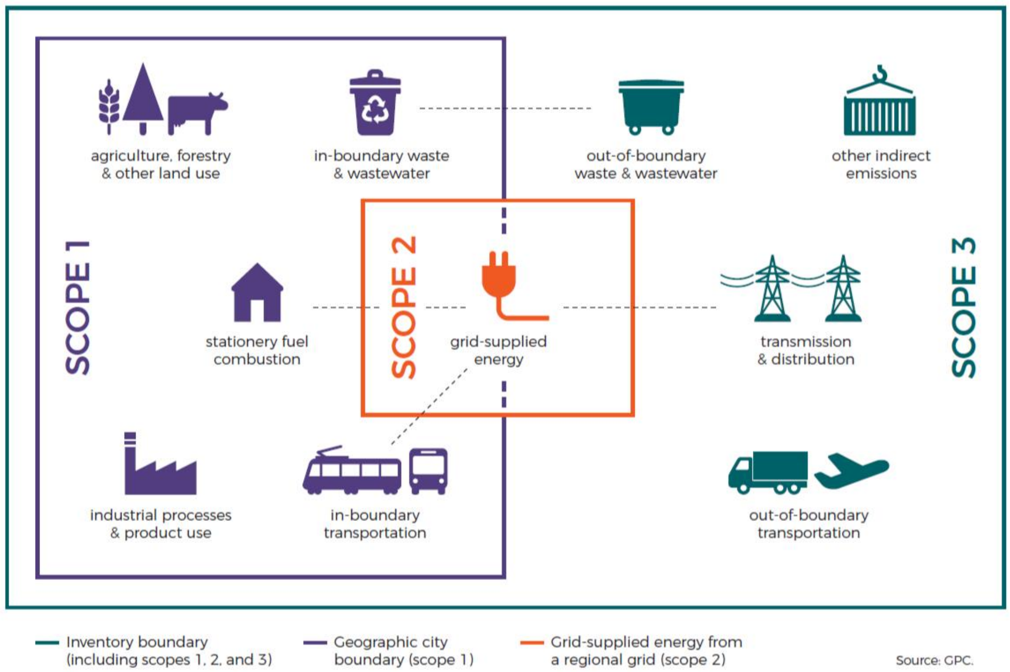

Figure 10: Sources and boundaries of city GHG emissions. (Source: GPC)

Reducing carbon footprint of a city, requires transformational change in way we design, operate and build in cities, the way a city grows and expands both vertically and horizontally, the way cities produces and uses energy, the way and mode of its connection (transit) as well as the way its infrastructure and services that support daily living, including water and waste are designed or operated.[41]

Cities are heterogeneous in nature, and therefore, GHG emissions and measures for emission reduction for each city will differ significantly based on its size and typology across different regions. GHG emissions

[39] Source: WRI, ICLEI and C40 (2014). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. Greenhouse Gas Protocol.

[40] C40 and Arup (2016). Deadline 2020. *How cities will get the job done* - An analysis of the contribution C40 cities can make to delivering the Paris Agreement objective of limiting global temperature rise to 1.5 degrees.

41 Abubakar IR, Doan PL (2017) Building new capital cities in Africa: lessons for new satellite towns in developing countries; Bulkeley H, Castán Broto V, Maassen A (2014) Lowcarbon transitions and the reconfiguration of urban infrastructure; Gu C, Tan Z, Liu W et al (2009) A study on climate change, carbon emissions and low-carbon city planning; Liu ZL, Dai YX, Dong CG et al (2009) Low-carbon city: concepts, international practice and implications for China.

will vary across different sizes of city - from small towns that accommodate less than 300k people, to mega cities with more than 10million people – and different typology of city – from rapidly growing city to a host city (refer **Error! Reference source not found.**). A type 1 city is very different from a type 5 city – even though both may have rapid population growth, one is driven by natural migration and fertility over time and other faces sudden influx of displaced population (mostly conflict-affected or climate migrants) in a short span and therefore the needs/priorities of the city and its local institutions will be very different. Moreover, the type of measures for different type of cities will differ. For eg. a Type 3 city which is experiencing negative population growth will need measures such as retrofitting existing spaces and city systems, as against to a type 4 city which will need rebuilding of damaged infrastructure in a more sustainable way.

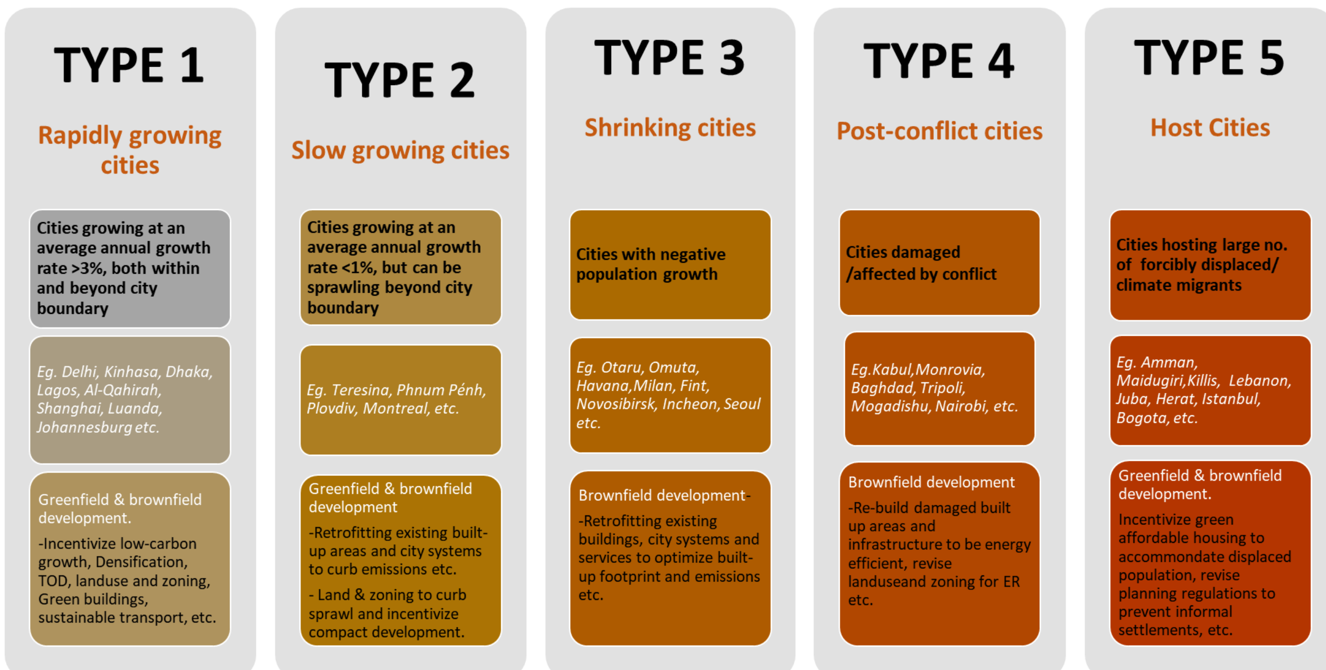

Figure 11: Type of Cities, their examples and sample measures for ER for each type. [42]

Measures for emission reduction will differ based on these five typologies of city. Rapidly growing cities, esp. small and medium-sized cities which are doubling in size every census or cities facing an influx of migrants (Type 1 and Type 5) , pose a window of opportunity where greenfield development within or beyond city boundaries to accommodate new residents can follow a low-carbon growth trajectory from the start. On the other hand, cities that are already developed and growing at slower pace or shrinking in population size (Type 2 and Type 3 city) as well as post-conflict damaged cities presents itself with an opportunity to retrofit or rehabilitate the city's assets ((brownfield development) – land, buildings and infrastructure- to accommodate either new population or improve quality of life for existing residents and achieve emission reduction. (Refer figure above).

[42] Author's interpretation (Swati Sachdeva, Urban Specialist ET Consultant- The World Bank

Spatially, Cities either grow horizontally (often beyond existing boundaries to adjoining municipalities, provinces or rural areas) [43] ***or vertically (change in population density) or both.*** To ensure that GHG emission reduction is considered holistically, cities need to manage energy consumption and emissions from different sectors, activities and policies that is aimed at the metropolitan or urban agglomeration level and one that consider population density and growth rate, along with other key characteristics. This also raises the importance of partnership modalities and collaboration across the region, to efficiently achieve higher emission reduction. Moreover, often times, cities can surpass the barrier or obstacles to ER by partnering with relevant agencies, ministries, organizations, agencies etc. – such as the Coalition for Urban Transitions, advocating for the need of integrated actions across the levels of the government, that seem to be a prerequisite to realize the full contribution of cities to the deep decarbonization, C40 etc. Refer figure below:

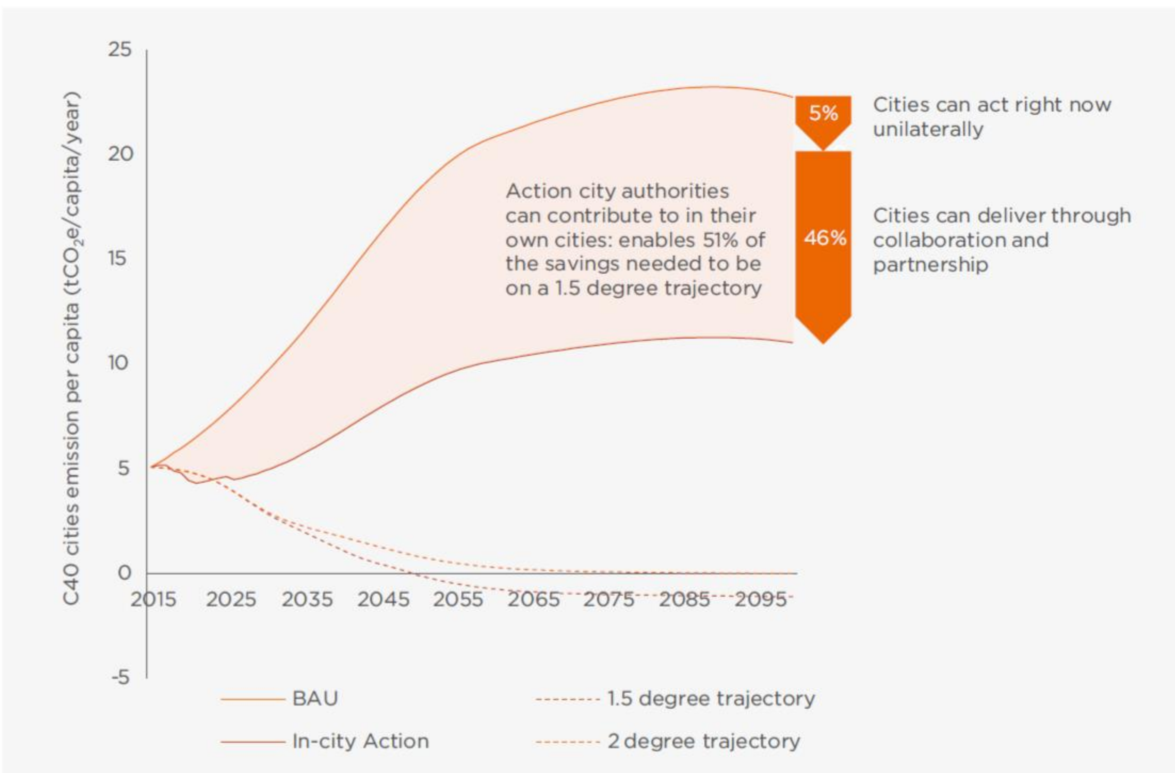

Figure 12: Cities can exceed their emission reduction targets by efficiently partnering and collaborating with other cities, region, countries, agencies, donor organization and so forth. [44]

[43] https://www.worldbank.org/en/news/feature/2014/05/12/think-outside-boundary-cities-metro-approach

[44] C40 and Arup (2016). Deadline 2020. How cities will get the job done - An analysis of the contribution C40 cities can make to delivering the Paris Agreement objective of limiting global temperature rise to 1.5 degrees

03. Challenges to GHG emission reduction in urban areas

City and regional decision-makers are well placed to alter the urban emissions pathways through local actions. From compact and transit-oriented development, building regulations, land use planning, efficient waste management, improved service delivery using low emission alternatives, to high co-benefits mitigation projects such as energy efficiency affordable homes, city and regional decision makers can either alter the existing (and future) emission trajectory or influence the change in emission pathway through other local stakeholders.

But while local decision-makers and stakeholders may have an ambitious plan to reduce emissions in the coming decade, they may face varied implementation challenges at the city-level depending on the city type, existing institutional and policy context, political will, and type of intervention. While all sectors have emission reduction potential within cities' boundaries, the ability of the municipal government to mitigate those emissions from sectoral or multi-sectoral interventions varies considerably between different typology of cities. The degree of autonomy and mandated functions under local government, municipal finance, political context, and overall urban management of the city define or influence the possible scope of urban mitigation policies and actions in a city. For example, existing energy efficiency programs may face many challenges, including limited financing by users, substantial subsidies, lack of coordination among many individual actors, and inadequate information on energy performance of end-use appliances and the likely savings from demand-side investments.[45]

- **Challenges per type/tier of cities and their capacity:** Depending on size and typology of city, their existing priorities, budget allocation, capacity constraints and so forth, the national and municipal governments may not be equipped or inclined to implement GHG emission reduction projects or programs. For example, the municipal government in a rapidly growing small-sized secondary city may have low technical and financial capacity to identify, diagnose, design or implement GHG ER projects, and are usually pre-occupied in responding to other city priorities such as providing services to the growing population or responding to a disaster. Additionally, municipal government may be financially constrained to plan, design or implement ER projects. Due to low human capital and low salaries, etc., the staff in local government is often technically constrained when it comes to GHG emissions. Additionally, with low budget allocation from central ministry, low own-source revenue (OSR) potential, debt and other pressing priorities, cities are often under-resourced and may lack financial capacity to even allocate a team or funds for planning or considering ER projects.

- **Challenges per type of institution – tiers of govt:** The degree of autonomy, mandated functions, and relationship under each tier of government in different cities would present challenges to achieving ER. For example, local governments often do not have the power or authority to raise revenues, plan, or

[45] Skea J, Nishioka S (2008). Policies and practices for a lowcarbon society.

implement projects. Policies and programs – their role and autonomy are often dictated national government who works at the policy level and may not consider cities while agreeing to NDC commitment. But there is still a lot of potential within local government to change perceptions, local level/bottom-up mitigation activities to bring change, partner with the international community, and so forth.

Moreover, the multiple dimensions and sources of GHG emissions and their diverse effects on climate change makes climate action and response a multi-scale and multidimension decision issue[46], but the city government (especially for resource constrained context) may not be able to handle the complexity on their own.

- **Challenges per sector:** Within each sector, there may be challenges to achieve emission reduction at the city-level. For example, changes to energy policies or regulations may be under national line ministry or utility, and therefore municipal government may not have the legal authority, mandate or budget to implement any interventions for energy efficiency at the city level without a special permit.

- **Challenges per type of intervention - Program vs. project vs. Policy:** Each type of intervention, whether a policy, program or project to achieve ER, will have its own set of challenges and is co-dependant on challenges faced by city type and its institutions. Moreover, 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.[47]

- **Challenges for financing – municipal finance and budget allocation:** Most often, cites in developing world do not have sufficient budget to take extra burden of incorporating GHG emissions in ongoing/new projects amidst other competing city priorities, and do not have the autonomy to generate own-source revenues or to raise revenue from a public-private partnership or international community. Therefore, municipal finance is extremely critical to understand the way the local government finances and manages its city, and one of the biggest barriers to implementing city-level actions for ER.

- **Challenges for private sector participation and financing – regulations, procurement, policy, disincentive, etc.:** Most often, cites in the developing world do not have autonomy or power to efficiently leverage the potential of public-private partnerships to implement ER projects.

- **Challenges of data:** Most cities are limited in terms of a reliable and complete dataset on existing sectors and their contribution go GHG emission, and this makes climate action or setting a target extremely difficult to monitor ER.

[46] Ismaila Rimi A., Yakubu Aliyu B. (2019) Low Carbon City: Strategies and Case Studies. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Sustainable Cities and Communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71061-7_24-2

[47] C40 (2017). Defining Carbon Neutrality for Cities & Managing Residual Emissions – Cities' Perspective & Guidance.

OBSTACLES TO IMPLEMENTING COMPACT DEVELOPMENT

To implement compact development, government fragmentation and sectoral silos can stymie attempts to build in more compact ways, because this type of development is more complicated than other types. Regulatory barriers include exclusionary zoning, large minimum lot sizes, engineering standards for street design and parking, and other impediments to change. Financial challenges include reluctance on the part of lenders to participate in more complicated mixed-use projects; compact development can also be more expensive to build than other kinds of development, and may require the integration of transit and other expensive infrastructure. Challenges are local, regional, and national in scale. At the local level, land development regulations can get in the way of building in compact ways. At the regional level, jurisdictional competition can steer development away from close-in locations, and at the national level transportation and housing investments and priorities can work against the effort to build more compact places. [48]

Additionally, there are other substantial barriers that cities may face for emission reduction, such as:

- Misalignment: Most NDCs of participating countries were developed along a sectoral basis without consideration of the city level mitigation potential and did not include specific city-level emission reduction targets.
- Ambition: Ambition varies considerably from city to city. Many city authorities, particularly in developing countries, are focused on using their limited funding and resources in resolving high-priority issues link directly with their communities and their needs. Often funding and resources are only sufficient to tackle the most pressing issues, and GHG emissions reduction does not qualify for attention. However, there are shining examples of cities that have targets that are more ambitious than those set by the respective national governments in NDCs
- Complexity: The cross-cutting nature of sectors present in cities can be a challenge in separating emission responsibilities between cities and other actors, in defining city-level targets and in aligning them with national NDC obligations.
- Inclusiveness: Most sectors present emission reduction opportunities that are not contained wholly within city boundaries. Transport, industry, buildings, electricity generation, water, and waste management all have important components that are not encompassed by such geographical areas and require integrated sectoral solutions to be applied.
- Politics: Differences in political alignment between the stakeholders involved in local action can inhibit building consensus around cities accepting responsibility for resolving what may be seen as unrelated international commitments made by national authorities.

For GHG mitigation actions to be considered as a city-level priority, its hidden co-benefits such as improving quality of life, health, and economy need to be highlighted better. Successful ER

[48] Urban Land Institute. Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions. Washington, D.C.: Urban Land Institute, 2010.

projects/programs/policies should aim to align sectors with maximum mitigation potential, with existing and most-pressing needs of the respective city, its socio-economic and political context, as well as existing technical and financial capacity of the local government agencies and other stakeholders.

Extra burden on the city's limited resources and budget needs to be unraveled as many mitigation actions provide improved services at a lower cost than traditional higher GHG emitting alternatives. For example, solar PV today generates electricity at a lower levelized cost than a coal-fired powerplant, and this will come down further over time. A recent IRENA[49] report forecasts the solar project development cost per kilowatt of capacity installed will fall from $1,210 in 2018 to $340-834 in 2030 and $165-481 in 2050. The price of solar electricity is expected to fall further from an average $0.085/kWh in 2018 to $0.02-0.08/kWh by the end of the next decade and $0.01-0.05 by mid-century.

It should be noted however, that climate finance can also be an opportunity to fix the city (improve infrastructure and improve service provision) and can boost higher productivity.

Many of the ER measures can be realized by each developing country[50] without international assistance and can form part of their unconditional NDC. Other measures that reduce GHG emissions may have a higher up-front cost or be restricted by other barriers. Lastly, to cope up with additional resources needed for ER integrated projects or programs, carbon crediting can help bridge this financial gap.

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[49] Source: International Renewable Energy Agency Future of Solar Photovoltaic (PV) report: Deployment, investment, technology, grid integration and socio-economic aspects, Nov 2019 (https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Nov/IRENA_Future_of_Solar_PV_2019.pdf)
[50] In the context of non-Annex I countries

04. Opportunity for GHG emission reduction in urban areas

Within Cities, there are four broad areas for GHG emission reduction that may often fall under the purview of local municipality, namely:

A. Energy Efficient Buildings
B. Climate smart form
C. Low carbon transport
D. Low carbon infrastructure and services.

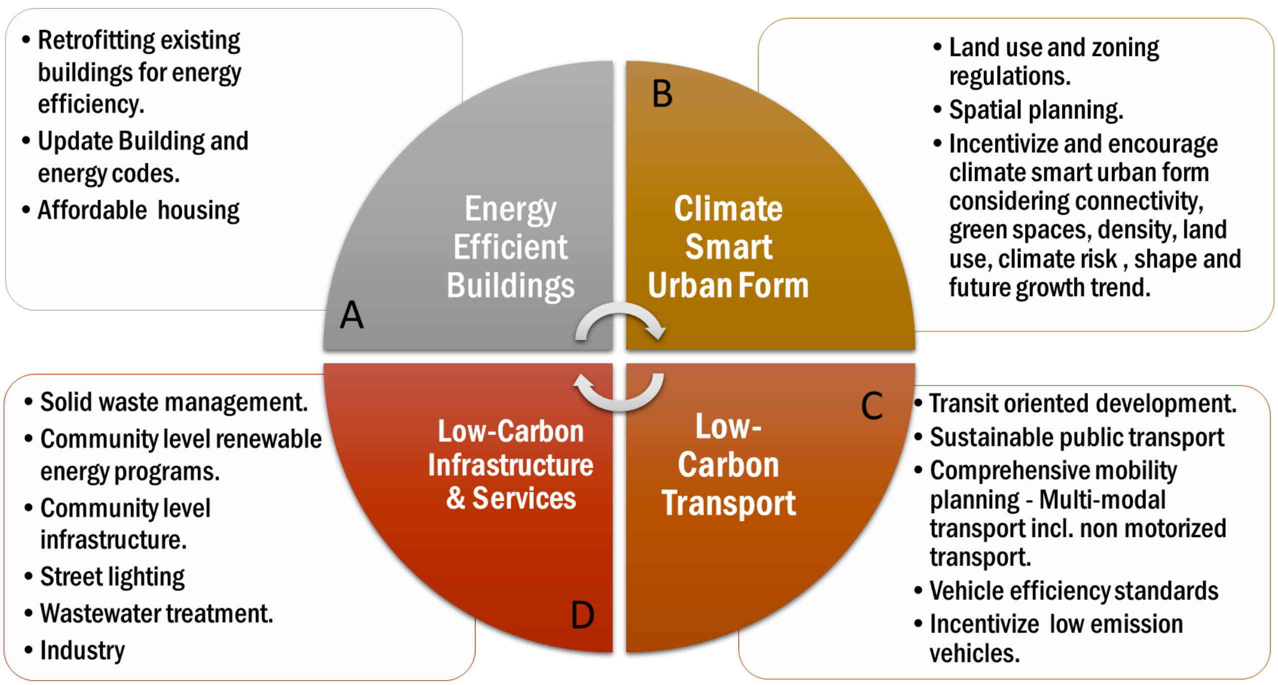

Figure 13: Four broad areas to reduce GHG emissions in cities
(Source: Author's interpretation (Swati Sachdeva, *Urban Specialist ET consultant, SURGP* - The World Bank)

Within each of the four areas of intervention for ER (refer figure above), there are range of policies, programs, and projects that could be used positively for GHG reduction. Some of the measures and examples of successful projects under each sector are listed below:

A. Energy Efficient Buildings:

Implementing energy efficiency measures in buildings (both existing and new) could significantly reduce energy consumption and associated CO2 emissions, where measures to reduce emissions from residential, commercial, or public buildings could include:

- Retrofitting existing buildings for energy efficiency;
- Construct energy efficient and low carbon/green residential/mixed-use buildings;
- Update current building construction and energy codes

- Incentives/Policies/Programs to switch to renewable/low-carbon energy source, energy efficient materials/technologies/appliances
- upgrade appliance standards and energy regulations
- Green building construction finance/ mortgages/ home improvement loans
- Fiscal incentives like tax breaks, grants, subsidies, loans, and rebates, complemented by non-fiscal incentives such as preferential or expedited permitting, density bonuses (such as increased height allowances), or public advocacy[1], and so forth.

Key objective of low energy consumption and energy efficiency in building lies primarily in incorporating energy efficient cooling, heating, and lighting systems. For example, in Nyiregyhaza, a Hungarian city of approximately 120,000 inhabitants, 26.8 TJ of energy per annum was saved by modernizing the heating systems in 12,800 apartments, which achieved overall energy saving of up to 68%. [51]

The projected additional 230 billion square meters of new building construction in coming decades is equivalent to adding the floor area of Japan every year until 2060 [2]. Therefore, new construction offers a significant opportunity to integrate energy efficiency into building design from the outset, helping to maximize the financial benefits that come from energy savings, avoid higher carbon emissions for decades that stem from inefficient energy use and to avoid the need for costly retrofits later.[3]

Green buildings sector represents a $24.7 trillion investment opportunity by 2030 across all emerging market cities with a population of more than half a million people[4]. While building green could range from savings of 0.5 percent to 12 percent in additional costs, green buildings can decrease operational costs by up to 37 percent, achieve higher sale premiums of up to 31 percent and faster sale times, have up to 23 percent higher occupancy rates, and have higher rental income of up to 8 percent.[4,5]

The longer-term benefits of a low carbon building surpass the higher upfront cost of construction. Buildings designed disregarding energy and water efficiency criteria and/or region-appropriate building materials can perform significantly below the average, as they are likely to require higher levels of consumption of energy and water. For example, an average house in Mexico consume approximately 71kWh/m^2. But a poorly designed house in a hot climate may use an additional 1,000 kWh per year, representing about 600 kg of CO_2 unnecessarily released into the atmosphere. Under CTF–IDB" ECOCASA" Program, 43,000 efficient houses are expected to be built, that are expected to deliver energy savings of around 2.4 million MWh and emissions reductions of 1.6 million metric tons of CO_2e, accumulated over 40 years. However, the unit abatement cost of these CTF resources is USD 32 per ton of CO_2e (USD 125 per metric ton of CO_2e for the total Program resources).[52] But supporting low carbon buildings at district, city, or national level, would need a comprehensive approach across the spectrum of construction market, from change in policies, regulations, practices, partnerships and financing. Refer snapshot of case study from Mexico on green housing on next page. Please refer to detailed case study in Annex 1.2

[51] Uhel R, Georgi B (2009) Key to low carbon society: reflections from a European perspective
[52] CTF–IDB "ECOCASA" PROGRAM ECOCASA Program. Mexico Energy Efficiency Program Part II. Proposal for Submission to the CTF Trust-Fund Committee

GREENFIELD – NEW CONSTRUCTION

A. ENERGY EFFICIENT BUILDINGS – case study from Mexico

- ~50 hectares daily expansion of urban areas - Housing represents ~60% of this growth. The expansion of Mexican cities over the past years has significantly increased their carbon footprint.
- > Direct and indirect GHG contributions from residential sector in Mexico in past decades due to inadequate architectural designs, use of energy and GHG emission intensive building materials and technologies; inefficient water use and locations with poor accessibility etc.

Project Objective

CTF–IDB "ECOCASA" PROGRAM aims to provide financing and the incentives that will lower the costs of both developing and acquiring energy efficient houses. There is a menu approach to the measures such as: insulation in roof and walls, reflective paint, efficient gas boiler, efficient refrigerator, solar water heater, energy saving windows, among others.

Project Component 1

Loans for developers:
To provide bridge loans to developers and is geared towards low-and middle-income housing (income between 5 and 12 times the minimum wage). SHF will select an initial pipeline of projects that deliver at least 12 kg CO2e per m² and year or 20% reduction in the expected GHG emissions associated with energy consumption of the houses relative to the baseline, whichever is lower.

Project Component 2

Loans for Local Financial Institutions (LFI):
SHF will facilitate to eligible LFIs the financing of mortgages for the purchasing of houses that meet the CONAVI criteria for Hipoteca Verde.

Results Matrix

- Program is expected to produce around 27,600 houses built and another 1,700 financed, in the first seven years.
- CTF/KfW funds are expected to deliver the construction of additional houses 13,800 houses in second phase, totalizing 43,100 houses built and purchased.
- Expected to deliver energy savings of around 2.4 million MWh and emissions reductions of **1.6 million metric tons of CO2e**, accumulated over 40 years.

Measures for reducing building emissions undertaken by National govt.

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Source: CTF–IDB "ECOCASA" PROGRAM ECOCASA Program. Mexico Energy Efficiency Program Part II. Proposal for Submission to the CTF Trust-Fund Committee

Similarly, retrofitting existing buildings represents another sizeable investment opportunity and plays a key role in reaching global climate goals. The retrofit market is expected to grow at a compound annual growth rate of 8 percent from 2018 to 2023. [53] Energy efficiency retrofits have shown attractive returns on investment, even for short term investors. This is because in addition to generating direct cost savings, these measures positively affect the overall value of buildings.[54] Refer snapshot of case study of New York city below, where city has incorporated series of measures to reduce building emissions by 80% in next 30 years. You can refer to detailed case study in Annex 1.1

BROWNFIELD - RETROFFITING

A. ENERGY EFFICIENT BUILDINGS– case study from NYC (Type 1 city)

- **> 68% of GHG emissions can be attributed to the energy used to power, heat, and cool buildings.**
- **~90% of the total built square footage and building-based emissions is due to existing buildings, new buildings are expected to increase these emission by 9% - By 2050, NYC expected to have 100,000 new buildings.**

13

Source: City of New York (2016). New York City's Roadmap to 80 x 50; OneNYC 2050- Building a strong and fair city. A livable climate

[53] Environment + Energy Leader (2018), Energy Retrofit Systems Market to Grow 8% by 2023
[54] Environment + Energy Leader (2018), Energy Retrofit Systems Market to Grow 8% by 2023

Please refer below to another example from South Africa, where IFC financed low-income housing and provide 10million concessional equity investment to partially cover green technologies:

SOUTH AFRICA:
To address the shortage of low-income houses, in 2015, IFC invested $21 million in a $300 million fund managed by the IHS—a large equity investor in South Africa's affordable housing sector. The fund focused on building, buying, renting, and selling single and multifamily housing, along with converting existing real estate to multifamily housing. To encourage the fund and partner developers to incorporate cost-effective green technologies in the design of their projects without affecting the expected returns to investors, IFC structured a $10 million concessional equity investment with funds from the GEF to partially cover the incremental greening costs. The fund succeeded in convincing developers to adopt green technologies, which have demonstrated 20 percent energy and water savings, lowering utility bills for home buyers and renters.

Today, the IHS Fund has 4,900 EDGE-certified homes, and is on track to exceed its target of 6,000 homes. Another 7,000 homes are being planned for green construction. Furthermore, IHS is expanding into Botswana, Kenya, and Namibia and has announced that all new projects will be EDGE-certified.

Source: IFC (2019). Green Buildings - A finance and policy blueprint for emerging markets

Some example from different countries on Energy Efficient building measures to achieve ER:

- ***CHINA :*** China's Ministry of Housing and Urban Rural Development mandated that all public buildings, including offices, schools, hospitals, and affordable housing in major cities, meet green building standards from 2014 onwards. [55]
- ***MEXICO*** : Since 2011, Mexico's federal organization INFONAVIT ("Instituto del Fondo Nacional de la Vivienda para los Trabajadores "), the fourth largest mortgage institution in the world, has required all of its mortgages to be for green homes or green home improvement measures[56].
- ***LESOTHO*** : Lesotho's updated NDC, released in 2017, commits the country to decarbonizing its buildings sector by implementing climatesmart building codes and standards, launching energy efficiency programs, and encouraging the use of energy efficient appliances. [57]
- ***ARGENTINA*** : In Argentina, residential buildings receive a 10 percent VAT exclusion if they include insulation Class B, solar hot water collectors, and LED lighting up to 140,000 UVA.[58]
- ***JAPAN*** : Tokyo's emissions trading system covers urban facilities, including public institutions, commercial buildings, lodging, educational facilities, medical facilities, and office buildings the latter accounts for four fifths of the covered entities.[59]
- ***BANGLADESH*** : The Bank of Bangladesh has mandated that all commercial banks must provide a discounted financing rate of 9 percent for the extra cost of green measures applied to light industry buildings.[60]
- ***COLOMBIA :*** Colombia's national chamber of construction, Camacol , played a crucial role in including the private sector in the process of creating the first mandatory green building code in Latin America. This multi stakeholder engagement helped raise awareness about the ease, affordability, and operational savings generated by building green, thereby boosting code compliance. [61]
- ***PERU :*** The governments of Arequipa and San Borja in Peru awarded height bonuses to developers based on third party certification of their green buildings, which helped prevent greenwashing, ensured compliance, and directed incentives to eligible recipients. [62]

B. Climate Smart Form:

Land use contributes about one-quarter of global GHG emissions, **most notably CO2 emissions from deforestation**. Land-use changes and unsustainable land management are direct human causes of land degradation, with agriculture being a dominant sector driving degradation. Climate change and rapid urbanization will further increase warming in cities and their surroundings (urban heat island), especially during heatwaves. [63]

About one-quarter of the 2030 mitigation pledged by countries in their initial Nationally Determined Contributions (NDCs) under the Paris Agreement is expected to come from land-based mitigation options. Several countries in their NDC refer explicitly to reduced deforestation and forest sinks, while a few include soil carbon sequestration, agricultural management, and bioenergy. Lack of action to address land

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[55] See http://www.mohurd.gov.cn/wjfb/201703/t20170314_230978.html
[56] Infonavit (2011), GREEN MORTGAGE PROGRAM INFONAVIT MÉXICO;
[57] IEA/UNEP (2018), 2018 Global Status Report;
[58] See https://www.edgebuildings.com/market-players/governments/#toggle-id-2.
[59] Resources for the Future (2016), Pricing Carbon Consumption;
[60] See https://www.edgebuildings.com/market-players/governments/#toggle-id-3;
[61] IFC (2019). Green Buildings -A finance and policy blueprint for emerging markets
[62] IFC (2019). Green Buildings -A finance and policy blueprint for emerging markets
[63] Shukla et. al. Technical Summary, 2019. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

degradation will increase emissions and reduce carbon sinks and is inconsistent with the emissions reductions required to limit global warming to 1.5°C or 2°C, but integrated land use planning is one of the proven measures for rapidly growing cities.[64]

Compact city form/land use patterns is a recognized as one of the top-performing strategy to reduce city-wide GHG emissions, reduce public infrastructure costs (as it is density sensitive and not population sensitive), protect environmentally sensitive lands, and enable a variety of transportation choices (often reduces driving which means lesser GHG emissions).[65] Some of the measures to reduce emissions from territorial development and achieve climate smart form include change in land use planning to reduce sprawl, incentivizing compact city form and densification of existing city core through Zoning regulations, integrating transport system with land use planning to trigger modal shift from private to public transit, etc.

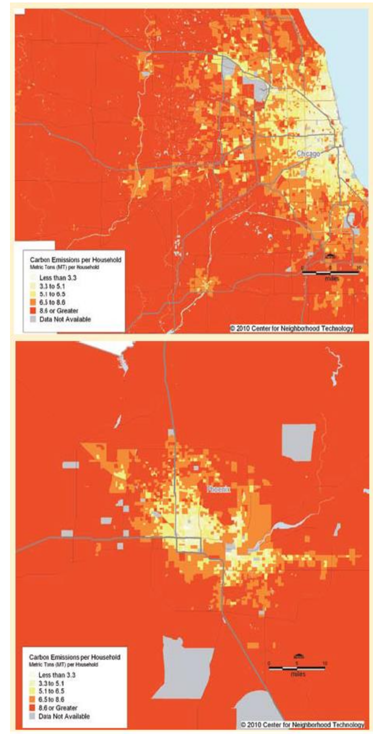

Figure 14: Carbon Emissions per Household in Chicago, Illinois (top), and Phoenix, Arizona (below)

Compact land use patterns result in fewer vehicle miles traveled (VMT), in terms of both the length and the number of vehicle trips, than sprawling land use patterns, and thereby can reduce GHG emissions. This reduction in VMT appears incrementally over a long period of time. As the amount and quality of compact development increases, the reduction in VMT accelerates. [66] Doubling residential density reduces VMT by 5 to 12 percent, and when this increase in density is combined with other changes, such as an increase in mixeduse development and transit improvements, this could lead to about 25 percent reduction in VMT. [67] For example, refer to the map of emissions from Chicago and Phoneix city on right, which highlights that the areas with the highest emissions from driving tend to be in the more recently developed areas on the outskirts of the metropolitan region.[68]

To have a significant effect on GHG emissions nationally, compact development must make up a significant proportion of future development[69], especially for rapidly growing cities. But varied economic, political, institutional, legal and socio-cultural barriers, including lack of access to resources and knowledge may restrict their uptake in a city.[70]

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[64] Shukla et. al. Technical Summary, 2019. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.
[65] Urban Land Institute. Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions. Washington, D.C.: Urban Land Institute, 2010.
[66] Urban Land Institute. Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions. Washington, D.C.: Urban Land Institute, 2010.
[67] Driving and the Built Environment
[68] Center for Neighborhood Technology, 2010
[69] Urban Land Institute. Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions. Washington, D.C.: Urban Land Institute, 2010.
[70] Shukla et. al. Technical Summary, 2019. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

Case study on Japanese cities to identify relationship between urban form and CO2 emissions[71]

Context: Japan's total Green House Gases (GHGs) emissions in fiscal year 2008 were 1282 million tons of CO2e, which led the government to set ambitious targets for GHG mitigation, including a law that mandated cities to prepare climate change mitigation action plans to actively pursue carbon mitigation.

Methodology: A study of 50 small to medium-sized Japanese cities that met the following criteria: (1) population range of 80,000–450,000; (2) cities that were located beyond the commuting distance of large metropolitan areas; and (3) cities that were not knows as ''industrial' city; (4) cities with comparable income per capita. In addition to analysis of the physical structure of cities, four variables that might have strong impact on CO2 emissions and energy consumptions: average per capita income, city population size, average temperature, and average urban area per capita, were considered. These socio-economic and spatial variables served as independent variables to test their influence on CO2 emissions per capita.

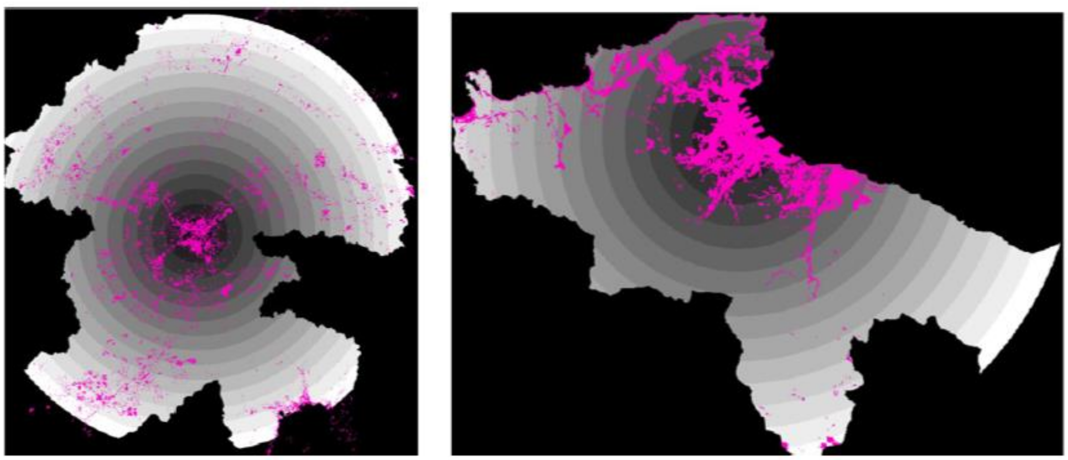

Figure 15: One km radius buffers overlayed with urban extent, Higashi Hiroshima City (left) and Otaru

Analysis results:

- Higher level of regularity of urban settlement shape and compactness of urban settlements (represented by Compactness Index) lead to lower residential CO2 emissions.
- Although denser settlement may lead to lower CO2 emissions from the residential and passenger transport sectors, but high-density urban settlements in mono-centric form may increase CO2 emissions from the residential sector.
- Residential CO2 emission per capita was negatively correlated to income and positively to city-size (in terms of population), while the pass-transport CO2 per capita was positively correlated to the dense and mono-centric settlement form and population density.

[71] Makido et. al (2012). Relationship between urban form and CO2 emissions: Evidence from fifty Japanese cities. Urban Climate journal.

Low emission land use planning is not a linear process but rather a continual and iterative one which may involve multiple sectors, actors and jurisdictions. When developing a land use plan, a clear understanding of the scale, regulatory frameworks and sectors that will influence the plan is necessary. For example, many Asian countries/cities have laws or policies that dictate how and when land use planning should be done (e.g., Indonesian Law 26/2007 on Spatial Planning). Other countries may have more general strategies (e.g., Vietnam's National Green Growth Strategy for the period 2011-2020 with a vision to 2050) to reduce carbon emissions while promoting economic growth but may lack any specific policy that ensures land use planning process. Another caveat may be that although land use or spatial planning may fall under municipal government or one ministry, but it may involve lands or resources administered by a variety of different sectors that have jurisdiction over land and livelihoods affected by land use planning decisions including land management, social, economic, transportation or energy. Lastly, these sector and jurisdiction claims may also overlap with land tenure claims and there could be an issue when two or more land tenure systems coexist (legal pluralism).[72]

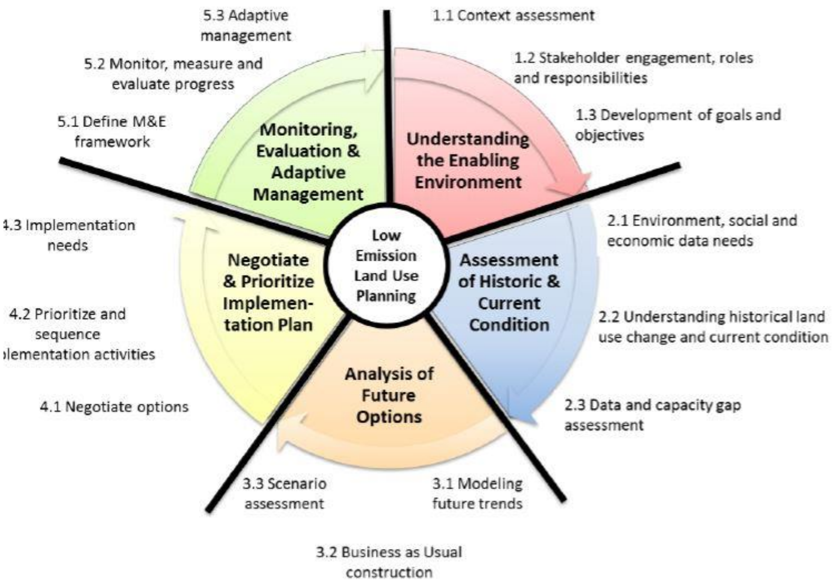

Figure 16: General low emission development planning framework

Considering the complex land use patterns within a jurisdiction, it may be important to map the scope and scale of these transitions at both the jurisdictional level and for the broad functional land use zones (i.e forest, conservation, agricultural, settlement, wetlands, reserved parks, etc.) within the jurisdiction. Mapping transitions within a land use zone level can also aid multi-stakeholder discussions and planning of the low emission land use plan. [73]

[72] Barber et. al. (2015). Guidance on Low Emission Land Use Planning. USAID Lowering Emissions in Asia's Forests (USAID LEAF) program and the United States Forest Services (USFS) International Program.

[73] Barber et. al. (2015). Guidance on Low Emission Land Use Planning. USAID Lowering Emissions in Asia's Forests (USAID LEAF) program and the United States Forest Services (USFS) International Program.

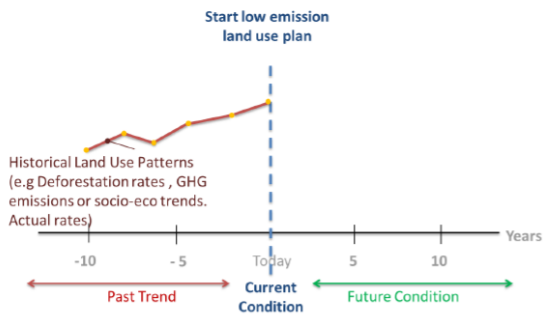

Figure 17: Quantification of Historical rates of changes (Source: Guidance on low emission landuse planning)

Case study on change in landuse and Urban heat index in Shanghai over past few decades[74]

City context: Type 1 city (rapidly growing); Mega city-size (23million population) [75]

Since China's economic reform in the late 1970s, Shanghai, the country's largest city has experienced rapid population growth. Population density has also significantly increased from 1734 persons per square kilometer to 3632 persons per square kilometer during 1970–2010 in Shanghai, with an increasing rate of 419 persons per square kilometer per decade. This increase of population density in also a result of additional floating population in recent decades.

With rapid economic growth, the city has also experienced high rate of change in land use and land cover during the last three decades, and this change is mainly urban expansion and cultivated land reduction – with cultivated land decreasing rapidly at a rate of 53.5 thousand hectares per decade. During 1992–2010, total area occupied by buildings has increased rapidly at a rate of 433.3 million square meters per decade.

The rapid urban sprawl and the change of land use have resulted in remarkable heat island phenomenon in Shanghai, China in recent years (Li et al., 2002; Zhang et al., 2010). Therefore, to cope with the adverse effects of UHI, Shanghai government has made great efforts to launch the large-scale construction of urban green system and strengthen scientific and reasonable urban comprehensive planning in recent years. After 2000, public green area, including parks and roadside green, has increased rapidly from 5820 hectare in 2001 to 16,053 hectares in 2010, with an annual rate of 1103 hectare in Shanghai, which has helped in mitigating the UHI.

Figure 18: Variation of annual UHI index and public green area in Shanghai during 1972–2010.

[74] Cui & Shi (2012). Urbanization and its environmental effects in Shanghai, China. Urban Climate Journal.
[75] ShanghaiMunicipal Statistics Bureau, 2011

C. Low carbon transport

While urban form significantly impacts travel behavior, there is considerable influence of transit on urban form and the interactive impacts of transit on urban form. [76] There is an increasing recognition of the association between travel behavior and land use patterns or urban form and travel behavior which is the basis for concepts such as smart growth, new or green urbanism, compact cities, eco-cities, low carbon cities, and transit-oriented development. [77]Urban design and development patterns can play a vital role in reducing transport demand and can facilitate an efficient organization of the required urban transportation system[78], where in a denser compact city form, public transport can be organized more efficiently and the distances between destinations (majority of which are non-work-related short trips) will encourage either public transport or non-motorized transit option such as walking/cycling. [79] A sprawled city is more likely to be private automobile dependent.

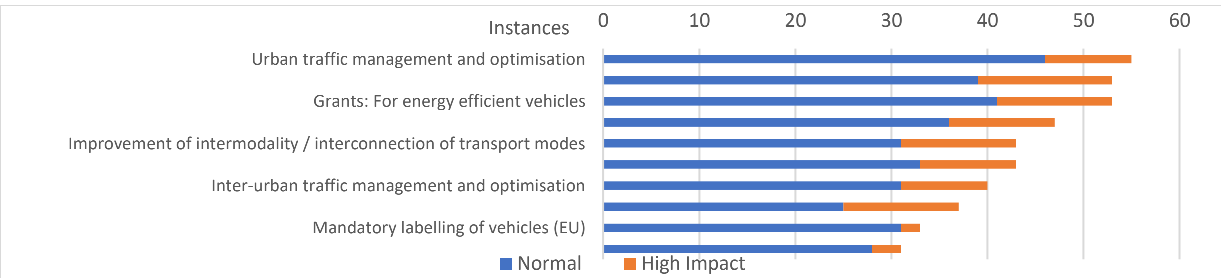

Figure 19:Top 10 measures by number of instances in 31 European counties to improve energy efficiency in the transport sector.[80]

Measures to reduce emissions from transport could include clean energy public transport, non-motorized transport, encouraging transit-oriented development through densification, land value capture, etc. Refer snapshot of example from Bogota BRT below, highlighting the city's journey to shift from existing inefficient transit system biased towards private transit options to a public transit-oriented development. There were multiple challenges, particularly implementation and operational, that had to be tacked on the way to reap the benefits of overall project and reduce transport related emissions of the city. Please refer to Annex 1.3 for detailed case study.

[76] Ismaila Rimi A., Yakubu Aliyu B. (2019) Low Carbon City: Strategies and Case Studies. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Sustainable Cities and Communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71061-7_24-2

[77] Abubakar IR (2013) Role of higher institutions of learning in promoting smart growth in developing countries: University of Dammam as a case study. In smart growth: organizations, cities and communities; Bulkeley H, Castán Broto V, Maassen A (2014) Lowcarbon transitions and the reconfiguration of urban infrastructure.

[78] Ismaila Rimi A., Yakubu Aliyu B. (2019) Low Carbon City: Strategies and Case Studies. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Sustainable Cities and Communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71061-7_24-2

[79] Abubakar IR and Aina YA (2016) Achieving sustainable cities in Saudi Arabia: juggling the competing urbanization challenges. In: Population growth and rapid urbanization in the developing world.

[80] ODYSSEE-MURE project involves a network of 37 partners from 31 countries who comprehensively monitor, since 2000, the efficiency trends and policy evaluation in EU countries, Norway, Serbia, and Switzerland. The MURE (Mesures d'Utilisation Rationnelle de l'Energie), database, is structured by final energy consumption sectors and provides an overview of the most essential energy efficiency policy measures. While all the measures are applied in urban areas, they are applied, in different countries, by national, regional or local governments, depending on which has the jurisdictional coverage in each case.The project reports 155 measures applied in the 31 countries, which achieved around 225 Mtoe of energy savings in 2017 compared to 2000 (i.e. 20% reduction of final energy consumption). Most of these savings come from buildings, mainly households (50%), 30% from industry, 17% from transport and 4% from services. Not all measures were applied in every country.

C. LOW-CARBON TRANSPORT– case study from Bogota (Type 1 & 5 city)

- **Mayor proposed integrated mobility strategy in 1998, where 80% of city travel (5 million people) were proposed to divert to new TransMilenio (TM) BRT system. City plans to phase out and replace diesel buses with hybrid/electric models by 2024.**

Challenges to implement BRT project

1. Opposition from private sector: small bus owners and drivers coordinated worker strikes as they feared loss of income
2. Limited financial resources and technical capacity at municipal level.
3. High capital and operational cost to introduce new mass transit system.
4. Lack of incentives to improve quality of transit system, unaffordable and mismanages transit system.
5. Lack of Political will and institutional fragmentation.
6. Lack of awareness and support from communities

Measures to overcome barriers

1. TM encouraged participation of small operators and provided them incentives to play an effective role in the public-private partnership for bus operations and fare collection with rights and responsibilities defined by the concession contracts.
2. City mobilized resources by raising gasoline taxes, launching against tax evasion, increasing its property tax base, and reducing capital investments in the City"s Telecommunication Company, as well as leveraging existing infrastructure, financing sources and partnerships for funding.
3. TM is designed to recover 100% of its costs through passenger fares. The private operator can earn profits when demand for ridership increases and incurs cost in the case that the demand for ridership declines.
4. Concession-based contract aimed at regulating service operations and eliminating rents to avoid fare-hikes. Design features to accommodate high volumes of passengers that makes the BRT affordable.
5. Strong leadership of the City Mayor, who mobilized a team to bring about municipal reforms for effective service delivery by promoting cost efficient schemes. Collaboration between the national and local government was crucial..
6. Campaign, which encouraged civic behavior and strived to create a sense of belonging for the inhabitants of the city

Results

- 32% reduction in travel time, 40% reduction in emissions, 92% reduction in accident rates & fuel savings of 47%.
- Generated 277,044 Certified Emission Reduction credits under the Kyoto Protocol's CDM – expected additional income from the sale of CER credits ~25 USD by 2012.
- Property values around BRT stations have a 15 to 20% price premium over other areas in the city.
- ~1.5 million passengers travel on the BRT system everyday.

Source: World Bank (2016). Bogota, Colombia – Bus Rapid Transit for Urban Transport. ESMAP EECI Good Practices in Cities. Energy efficient cities Initiative;
Asian Development Bank (2016). Case study: Efficient City Transport for Those Who Do Not Own Cars. https://development.asia/case-study/efficient-city-transport-those-who-do-not-own-cars

D. Low carbon infrastructure and services.

- ***Infrastructure and Service Delivery:***
  Sustainable Waste management: There is a strong relationship between solid waste generation and GHG emissions, specifically methane that is released from landfilling of biogenic carbon[81]. Few approaches to sustainable waste management could include low carbon landfill design and operation; organic waste diversion; thermal treatment of waste; and source reduction, reuse, and recycling. [82] Other measures to reduce emissions from waste could include organic waste treatment at household or city-level, waste to energy, an incentive to effectively manage solid waste through the value chain (collection, transfer, recycle and disposal) at the municipal level, promote circular economy etc.
- ***Industry:*** Measures to reduce emissions at industry level could include carbon pricing, mandatory EE standards for industries and grants/subsidies for energy efficiency investments (including CHP) and investment in clean fuels (renewables, waste, natural gas, etc.); for energy audits, training, and for benchmarking activities; information campaigns (by energy agencies, energy suppliers etc. to their end-users); voluntary cooperative agreements to reduce energy consumption and CO_2 emissions of processes and adoption of cross-cutting technologies (such as industrial motors) etc.
- ***Other city-wide infrastructure and service delivery:*** City-wide infrastructure such as Community level renewable energy programs; Community level decentralized infrastructure; energy efficient Street lighting; Wastewater treatment; raising community-level awareness of low-carbon development solutions; introducing sustainability research programs and curriculum; etc. also may fall under the municipal governments and often is a more manageable scale to bring about transformational change in emission reduction. Additionally, service delivery through public utilities or private small-scale providers, can be incentivized for energy efficient and climate-smart programs/ solutions and initiatives.

81 Mohareb E, Hoornweg D (2017) Low-carbon waste management. In: Dhakkal S, Ruth M (eds) Creating low-carbon cities.
[82] Ismaila Rimi A., Yakubu Aliyu B. (2019) Low Carbon City: Strategies and Case Studies. In: Leal Filho W., Azul A., Brandli L., Özuyar P., Wall T. (eds) Sustainable Cities and Communities. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71061-7_24-2

Refer snapshot of case study from City of Cape Town below, where the city is actively trying to reduce emissions through effective management of waste along the value chain. Please refer to detailed case study in Annex 1.4.

D. LOW CARBON INFRASTRUCTURE AND SERVICES – case study from Capetown

Source: City of Capetown: Climate change policy

The City has made institutional and strategy changes to reduce its high carbon footprint by 2040, which includes mix of soft and hard measures.

CARBON EMISSIONS TARGETS*	2020	2030	2040
Electricity efficiency	-3,7%	-7,7%	-9,3%
Transport efficiency	-3,2%	-7,2%	-11,2%
Cleaner electricity supply	-6,2%	-13,9%	-15,9%
Total carbon reduction off business-as-usual	-13%	-29%	-37%
Tonnes of CO_2/USD million GDP	820	600	490
Tonnes of CO_2/capita	5,4	5,3	-

*The energy and carbon emissions targets are conditional on the Energy2040 modelling assumptions remaining constant.

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To achieve proposed emissions reduction by participating countries in its Nationally Determined Contribution (NDC)[83], there is an urgent need to recognize importance of transformation (spatial, economic and political) required in urban areas to reduce GHG emissions. Although over 9,000 cities and local governments (representing more than 800 million people) have committed to climate action through the Global Covenant of Mayors, and have pledged to collectively reduce 1.3 billion tons of CO2 emissions per year (~276 million cars off the road)[84] in coming decade, yet getting to that goal of GHG emissions will need a major revamp of current growth trajectory across regions. Cities will have to transform the way they are designed, planned and managed.

Cities need to incentivize low-carbon, compact and sustainable development, and municipal governments need to play a more prominent role. As evident from some of the case studies above, city/municipal governments have a much bigger role to play in achieving ER. Although broader policy and regulations are often under the purview of the national government, line ministries, or utilities, yet enforcement, service delivery, and city-scale programs/projects are under the purview of municipal government in most countries. Many rapidly urbanizing countries, especially in Africa, are undergoing decentralization, moving away from highly fragmented or centralized institutions to a more streamlined functional government where municipal governments would play a bigger role in the coming years.

Table 3: Typical functions under the mandate of municipal and national agencies (Source: Author's interpretation)

Sector/responsibilities	National/Sub-national govt	Local govt.
Service Delivery	Utilities providing services (electricity, water and sanitation), regulations, tariffs and standards.	Local service delivery, Maintenance, supervision of leakages, community-scale planning, decentralized services, etc.
Urban Planning	National planning standards, building codes, development planning and budgeting, land acquisition and registry,	Spatial development plans of city, land use planning, update, and enforcement of city-level planning regulations (zoning), land value capture, infill development, brownfield development, etc.
Transport	Traffic regulations, allowable emissions and tariffs, etc.	Street design and re-organizing, public transit, bike lanes, incentives for green transit options, awareness,
Waste management	Landfill tax, Regulations on waste collection and disposal, waste management policies,	Waste collection service, household collection tariffs, landfill management, waste pickers, recycling etc.

[85] As identified by SEI, see: Broekhoff, Derik, Peter Erickson, Carrie Lee. 2015. What cities do best: Piecing together an efficient global climate governance. Working Paper. Stockholm Environment Institute.

05. Framework for urban carbon crediting

GHG emissions reductions in an urban area can contribute to meeting the national NDC targets, or be converted into carbon credits, which can then be sold and exchanged internationally. Crediting programs can be sectoral (sectoral crediting within the City Authorities jurisdiction or involving several cities); or jurisdictional (involving measures and regulations that impact more than one sector).

Urban crediting can bring transformational change by enabling local authority/decision-makers to make informed decisions, help mitigate their financial risk, increase financing for infrastructure improvements needed in the city, accelerate urban emission reduction, provide improved MRV systems and increase global/regional visibility. To quantify the amount of emissions that were prevented or reduced, the mitigation activity is compared to a baseline which is determined by the type of intervention, existing condition, and business as usual scenario. Identifying urban mitigation opportunities

As discussed in chapter 2,3 and 4, every city is unique, and it has different priorities and challenges. For the successful inclusion of GHG mitigation projects and policies, it is essential that they are aligned with the real needs of the city and its residents. As discussed in chapter 2 and illustrated in Figure 20, there are many options for cities that allow large-scale urban mitigation. Depending on the city type and level of decentralization, many of these key areas may be candidates to the local authority for mitigation action.

Successful urban carbon crediting is a result of resolving an issue that is important to local stakeholders in a way that significantly reduces GHG emissions. How this can be brought about and what can be achieved varies considerably from city to city.

Core roles of the city in urban mitigation

The institutional and governance structures of cities vary widely, leading to different levels of control over the activities that cause GHG emissions and allowing the cities to adopt one or more of the following three core roles[85]:

- **As policy leaders and architects**—where the city defines and implements its own program, notably through spatial planning and transport policy interventions.
- **As a critical implementer of nationally applied policies**—particularly with regard to residential and commercial buildings sectors.
- **As a strategic partner**—taking actions to enhance the effectiveness of policies enacted at higher levels of government. For example, cities can enhance national efforts in industry, buildings and other sectors through local regulation, permitting, economic and fiscal incentives, infrastructure development, and more broadly, through education and information sharing.

Through the CDM process, most carbon crediting was project-based, with support for individual investment projects where baselines, and monitoring, reporting, verification (MRV) systems were based on technology. While this approach generated mitigation of over 2 billion tCO_2e, only just over 109 million tCO_2e were reduced in an urban context, with landfill gas being the largest contributor (57.8 million tCO_2e)[86]. This lack

[85] As identified by SEI, see: Broekhoff, Derik, Peter Erickson, Carrie Lee. 2015. What cities do best: Piecing together an efficient global climate governance. Working Paper. Stockholm Environment Institute.
[86] UNEP DTU CDM pipeline: http://www.cdmpipeline.org/

of involvement of cities has been because of the sectoral nature of the crediting mechanism, and misalignment with other city priorities. However, the Paris Agreement invites cities to scale up climate action, and over two-thirds of participating countries' Nationally Determined Contributions (NDCs) mention urban action.

While there are still opportunities in project-based crediting, most large-scale mitigation activities are likely to involve the following three crediting approaches[87]:

i. **Programmatic**: Supports a larger number of similar projects with scale-up through replication. An example could include multiple BRT lines in one or several cities.
ii. **Policy**: Supports a policy intervention such as an energy efficiency standard or energy/carbon pricing policies. This often involves baselines and MRV based on econometric modeling and can have a high transformative impact.
iii. **Sectoral/ Jurisdictional**: Supports enhanced achievement of sectoral or jurisdictional mitigation benchmarks and targets. Here the baselines and MRV are typically on an aggregate level, and even though it tends to be large scale, it can be challenging to separate the mitigation results from the noise generated by other external factors.

When the scale is small this involves numerous procedures and high transaction costs, and many measures may be needed to attain a significant energy-saving or GHG mitigation level. This often involves numerous procedures and high transaction costs, increasing the complexity of achieving energy efficiency or GHG reduction goal. On the other hand, measures applied to large targets, such as the whole jurisdictions, have lower relative transaction costs and complexity, but their effects may be more challenging to quantify.

Annex 2 contains a list of 55 measures that not only satisfy the needs of local context but have also positively contributed to a reduction in GHG emissions. Figure 20 illustrates how these city-level options for large-scale mitigation can be functionally grouped.

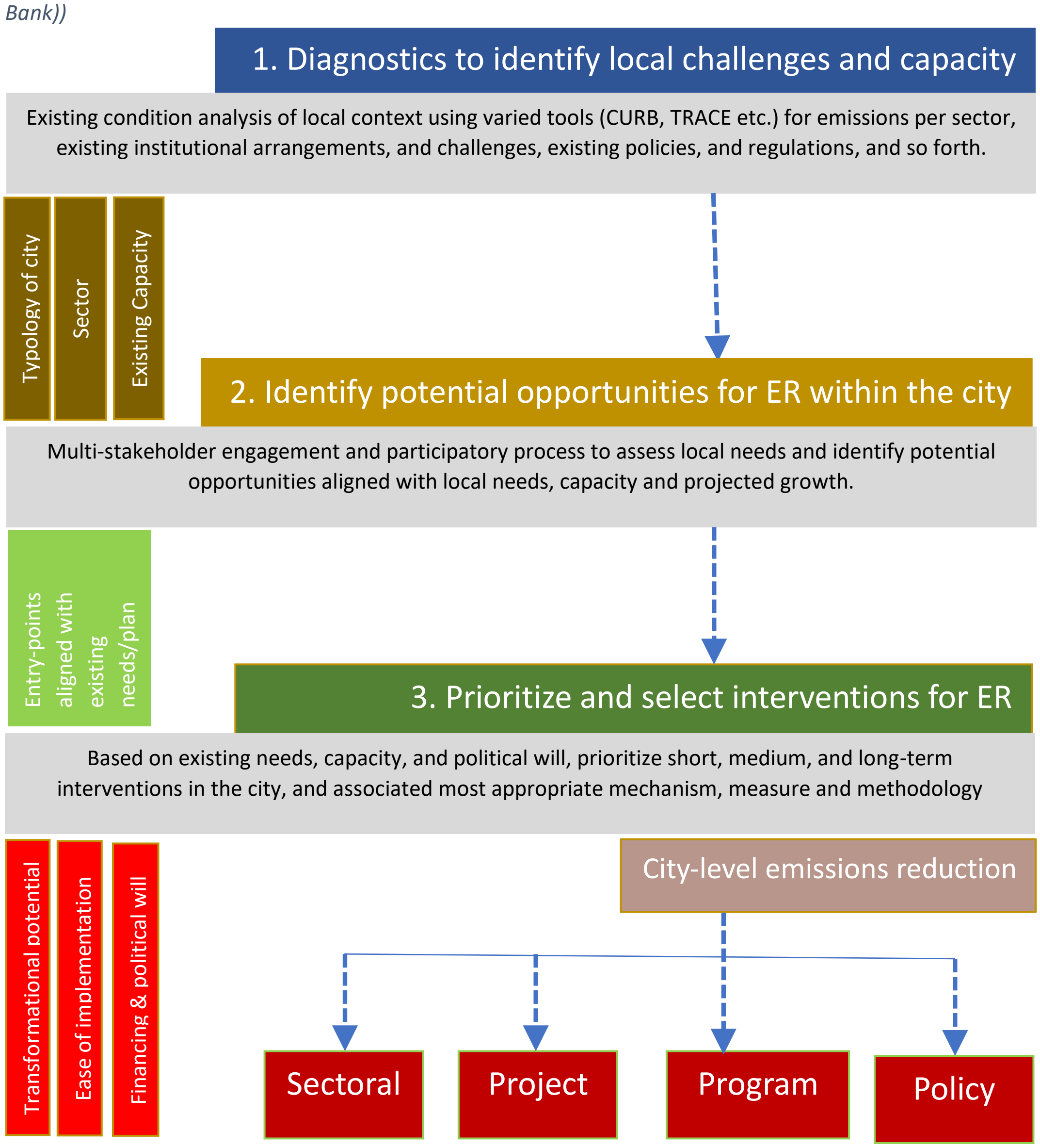
> Definitions
>
> Climate finance refers to local, national or transnational financing—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change (UNFCCC).
>
> Carbon crediting or payments for emission reductions refer to the process of converting emission reductions into carbon credits which can be sold and exchanged internationally through an Emission Reduction Purchase Agreement (ERPA).
>
> Payments for carbon credits can be provided in two ways:
>
> 1. using concessional climate finance (results-based climate finance or RBCF) or through;
> 2. carbon market transaction.
>
> In ther first case, RBCF, the ERs remain in host country for host country NDC compliance. In the second case carbon market transaction the ERs are transferred to donors for their own NDC compliance.
>
> TCAF is a hybrid instrument that leaves a share of the ERs in the host country for its compliance (about 50%). This is because about half of TCAF donors are not interested in receiving offsets for their own NDC compliance. These donors want to deliver RBCF to help host countries undertaking mitigation activities

[87] See: Different Approaches To Carbon Crediting World Bank

Figure 20 - There are many options for cities that allow large-scale urban mitigation[88]

[88] Source: Low carbon cities Exploring new crediting approaches to deliver carbon and climate finance, Carbon Partnership Facility of the World Bank.

Figure 21: Sequential process to select ER projects/program/policy for urban crediting at city-level (Source: Author's interpretation (Swati Sachdeva, Urban Specialist ET consultant, SURGP - The World Bank))



Mechanisms that bring emissions mitigation into the city's daily agenda

Identifying opportunities to reduce the emission of GHG cannot be a one-off exercise, but rather a continuous process. It should be noted that successful emissions reduction programs usually involve a coherent package of multiple policy instruments, including normative, financial, and supportive measures, not necessarily implemented at the same time. Many of these opportunities should be identified through a collaborative process. This will not only increase ownership with different stakeholders but also raise awareness and scaling-up opportunities for GHG emission reduction in the future.

Many cities have set up mechanisms to ensure this:

- A green-growth Municipal Task Force

  Establishing a municipal task force can ensure that there is ownership of, and focus on, energy efficiency issues within the municipality, and that it is still considered a priority among other competing city-level priorities, response activities, budgeting, and day-to-day operation.

  The task force can include local government staff (and potentially host a steering committee with other key stakeholders, including representatives from line ministries, private sectors, CSOs, and so forth), who will become energy efficiency champions. It is essential to provide the task force with statutory status as a legal body, key mandate, budget from municipal finance and authority to plan, influence, and implement the city-level projects that may have GHG reduction potential. The task force will be responsible for driving and monitoring all energy efficiency and GHG mitigation related issues, including:

  i. **Monitoring** the city's progress against its energy efficiency targets.
  ii. **Raising awareness** on the importance of energy efficiency and the city's programs and progress.
  iii. **Supporting** municipal employees to access resources and information.
  iv. **Taking a lead** on developing city-wide strategies and coordinating between city agencies

- A green-growth Strategy and Action Plan

  Low-carbon urban development and GHG mitigation strategy will help bring together a diverse range of initiatives into a coherent plan for city-wide action. By presenting a single strategic plan, the approach will also make it easier to monitor progress. The strategy should have measurable and realistic targets, set out timeframes, and assign responsibilities. It should be developed collaboratively by representatives from across the municipality and other groups who will be affected by the strategy.

- A Capital Investment Plan

  The city authority issues an order requiring that technically robust and financially viable low-carbon urban development and GHG mitigation projects are considered explicitly as part of the capital investment planning cycle. This encourages staff to include energy efficiency projects within the capital investment plan. It guides staff responsible for drawing up the capital investment plan on how to liaise with those working to develop energy efficiency projects.

- Procurement policies (Purchasing and Service Contracts)

  Procurement policies (Purchasing and Service Contracts) that require increases in energy efficiency/building material/ standards for products and services over time, and require that the supplier-selection is made considering lifetime costs and not only the lowest initial purchase cost can have an enormous impact on GHG mitigation. All tender documents should include the requirement that bidders demonstrate compliance with or achievement of energy efficiency standards.

Evaluating and improving the cities' capacity for urban mitigation

In defining the cities role, effective urban carbon crediting is most likely to be achieved when it builds upon the strengths of the local administration. These strengths will vary from city to city and can be very different across functional areas. For example, a city may exhibit a strong capacity in the field of wastewater management but lack strengths in urban mass transport. It is important to ensure before starting that the city has the capacity to follow through. This diagnosis for the chosen mitigation area or activity can help indicate where strengthening may be required.

It should include:

- **Institutional capacity:** does the city have good vertical and horizontal coordination?
    i. Vertical: Good coordination across multiple levels of government at national, state, regional, and city levels, with recognition of the appropriate allocation of responsibility to each level.
    ii. Horizontal: Good coordination of activities and responsibilities across the different sectors of the urban economy, with close involvement of the private sector, civil society, investors, systems operators (energy, water, transport, etc.), and NGOs.
- **Human Resources**: Does the city have access to trained and technically proficient personnel covering the functional areas involved in designing and implementing the chosen activity?
- **Assets and infrastructure**: Does the city have ownership and control of affected land use and infrastructure? Have they successfully undertaken feasibility studies in the past?
- **Policy regulation and enforcement**: Does the city has sufficient autonomy to create policies, regulations, and enforce compliance?
- **Decentralization**: Are the key functions of the city that could be impacted by implementing the activity--such as service delivery, urban planning, and design, multi-modal transport, housing etc.--under local government control, or are they centralized?
- **Finance**: Does the city have the autonomy of raising its own source revenue? Do operational savings accrue to the city in support of other projects? Does the city have previous experience of managing public-private partnerships (PPPs) and other revenue streams such as grants, soft loans, and commercial funding?, Does the city have experience in performance contracting and carbon crediting?
- **Data and information:** Does the city have reliable and accurate record-keeping and sound survey/ monitoring system experience? Does the city have an existing MRV system that can be used for monitoring this activity?

Qualifying the local authority's capacity in each of these areas on a "High/Medium/Low" scale, as shown in Table 4 can help identify where action can be most effective and where additional skills and resources can be brought on-board to strengthen the administration's capacity for implementation.

Table 4 - Example of qualifying a local authority's capacity for implementing a specific mitigation action (Green=High, Yellow=Medium, and Red=Low)

City:	
Area of Opportunity	
	Score
Institutional capacity	Yellow
Human Resources	Green
Assets and infrastructure	Green
Policy regulation and enforcement	Red
Decentralization	Green
Finance	Green
Data and information	Green

Prioritizing urban emissions reduction plans

The following framework is proposed to assist in the selection of programs by cities to reduce GHG emissions. It builds upon a three-vector framework initially developed in 2018 (World Bank 2018) as a heuristic approach to prioritize interventions in an operational setting. It weighs the levels of effort and funding that would be warranted to enable mitigation and resilience-building programs and projects.

The framework has been modified for use in the current context. It seeks to aid the choice of target policies and programs to maximize the impact of carbon crediting in achieving long-term transformative actions to reduce GHG emissions while the demands of local constituents. The framework requires that target policies and projects be qualified on four vectors (see Figure 22). In each vector, higher scores are better.

- Level of ambition
- Ease of Implementation
- Transformational potential
- Attractiveness to investors

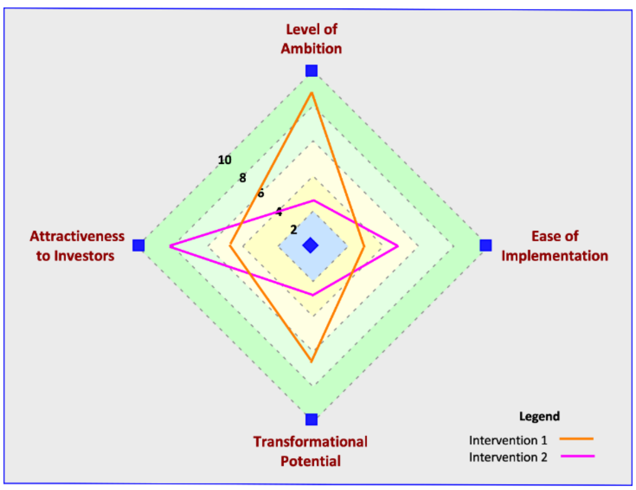


Figure 22 - The four dimensions of the selection framework

The priority of a policy or program is defined by the vertical dimension ('Level of Ambition' - 'Transformational Potential'). A higher overall vertical score (from 0 to 10 in both vectors) indicates the emissions reduction impact that implementing the policy or program is expected to have.

The complexity of achieving this change is given by the horizontal dimension, where the 'Ease of Implementation' vector refers to the complexity for the local government of implementing the change (where 10 is easy, and 0 is impossible). The 'Attractiveness to Investors' vector quantifies the desirability and expected uptake that the policy or program amongst private investors.

Thus, a tall, narrow profile (such as Intervention 1 in Figure 22) indicates a policy or program that would have a significant impact on emissions reduction but could be challenging to implement, whilst a wide and shallow profile (such as Intervention 2 in Figure 22) would represent a policy or program that could be easier to accomplish but with a lower ER impact. A selection of models and tools that can be used in this analysis is to be found in Annex 1.

The distinct levels of intensity of each dimension are given below, and the suitability for carbon finance support is color-coded. Green represents "generally attractive for carbon crediting support"; yellow represents "may require additional arguments to be included for carbon crediting support,"; and blue represents "generally unsuitable for carbon crediting support". Please note that in the following the use of the word 'program' includes policy, programmatic, and jurisdictional level interventions. Also, note that TCAF requires the emission reductions to be "beyond own effort" (NDC unconditional target) and "beyond ERs generated with other external support" ("attribution"). A sizeable (decision altering) financial impact of carbon crediting on the mitigation activity that is credited is not required.

A. LEVEL OF AMBITION

Table 5 - Level of ambition dimension: suitability for carbon crediting support

Intensity	Description	Suitability
High	The program represents additional ambition over and above that which the jurisdiction could be expected to deliver towards the national mitigation objectives of the Paris Agreement. It generates ERs additional to those needed by the country to meet their NDC obligations. Monetizing this excess through results-based carbon financing will not impede the country meeting its NDC obligations.	Green
	The program is a necessary contribution from the jurisdiction in order for the country to achieve the mitigation objectives of the Paris Agreement. It generates ERs additional to those needed by the country to meet their unconditional NDC obligations. Monetizing this excess through results-based carbon financing will not impede the country meeting its NDC obligations.	Green
Moderate	The program is a necessary contribution from the jurisdiction for the country to achieve the mitigation objectives of the Paris Agreement. It can be demonstrated that the country cannot realistically achieve a development pathway compatible with their unconditional obligations if this (or a similar) program is not implemented.	Yellow
Low	The program does contribute to the country meeting its unconditional commitment in its NDC. However, it is not expected that the program will enhance ambition.	Blue
	The program reduces emissions, but only marginally, and does not significantly transform the emissions trajectory of the country	Blue
None	The program is inconsistent with the country's NDC obligations even if it reduces emissions, or the program risks creating a carbon lock-in in terms of emissions	Blue

B. TRANSFORMATIONAL POTENTIAL

Table 6 - Transformational potential dimension: suitability for carbon crediting support

Intensity	Description	Suitability
High	The program expects to achieve a transformative improvement in government processes, economic incentives, or price signals. It will significantly improve access to finance for long-term, low-carbon projects in this or other jurisdictions; or reduce the cost of technologies. If this program is implemented, future mitigation programs will become viable with a degree of external support that is lower than today, and this difference is articulated in the program document.	Green
Moderate	The program expects to provide important foundations for future investments, programs, or projects in this or other jurisdictions, that reduce emissions. It builds technical and institutional capacity that will facilitate future action or improve the incentive structure, and this difference is articulated in the project document. If this program or project is implemented, future mitigation programs in this or other jurisdictions, can be expected to achieve a transformative improvement in government processes, economic incentives, or price signals; significantly improve access to finance for long-term, low-carbon projects; or reduce the cost of technologies will become viable with a degree of external support that is lower than today, and this difference is articulated in the project document.	Green
Low	The program helps build momentum, without affecting the basic incentives or costs in the jurisdiction.	Yellow
None	The program may reduce emissions but does not trigger any improvement in incentives or reduction of barriers to implementation for future projects.	Blue

C. ATTRACTIVENESS TO INVESTORS

Table 7- Attractiveness to Investors dimension: suitability for carbon crediting support

Intensity	Description	Suitability
High	The program is financially viable but has barriers to its implementation or lacks MRV that carbon crediting over an initial period would resolve.	Green
	The program does not have important barriers to implementation but is initially more expensive in upfront costs or operation (CAPEX, OPEX) than alternative (higher-emission) options and requires additional economic support in first years, It is expected to become sustainable after that.	Green
Moderate	The program involves proven technology but only becomes financially viable if climate financing or grant money is available	Yellow
Low	The program is more expensive over its lifetime than alternative (higher-emission) options (for example, investment in a promising but frontier technological solution) and carbon crediting over an initial period would not be sufficient to offset this cost even when blended with other incentives	Yellow
None	The program has significant barriers to its implementation and operation that carbon crediting would not help resolve	Blue

D. EASE OF IMPLEMENTATION

Table 8- Ease of implementation dimension: suitability for carbon crediting support

Intensity	Description	Suitability
High	The program is jurisdiction-wide or sectoral, does not need enhanced institutional or technical capacity and has political support from all stakeholders	Green
	The program is fragmented (at a company or appliance level) and would require significant government stewardship and support. It does not have significant barriers to implementation..	Green
Moderate	The program is needed to unlock a promising frontier technological solution and carbon crediting over an initial period could allow it to move ahead	Yellow
	The program has significant barriers to its implementation and operation that carbon crediting over an initial period would help resolve	Yellow
Low	The program requires higher institutional or technical capacity than that which is available in the jurisdiction or creates significant transition costs or political opposition. Carbon crediting over an initial period would help make the low-emission choice viable.	Yellow
None	The program is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher-emission or lower-resilience) options, but it is not a policy priority in the jurisdiction.	Blue
	The program is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher emission) options, and could easily be implemented without or other external financing support	Blue

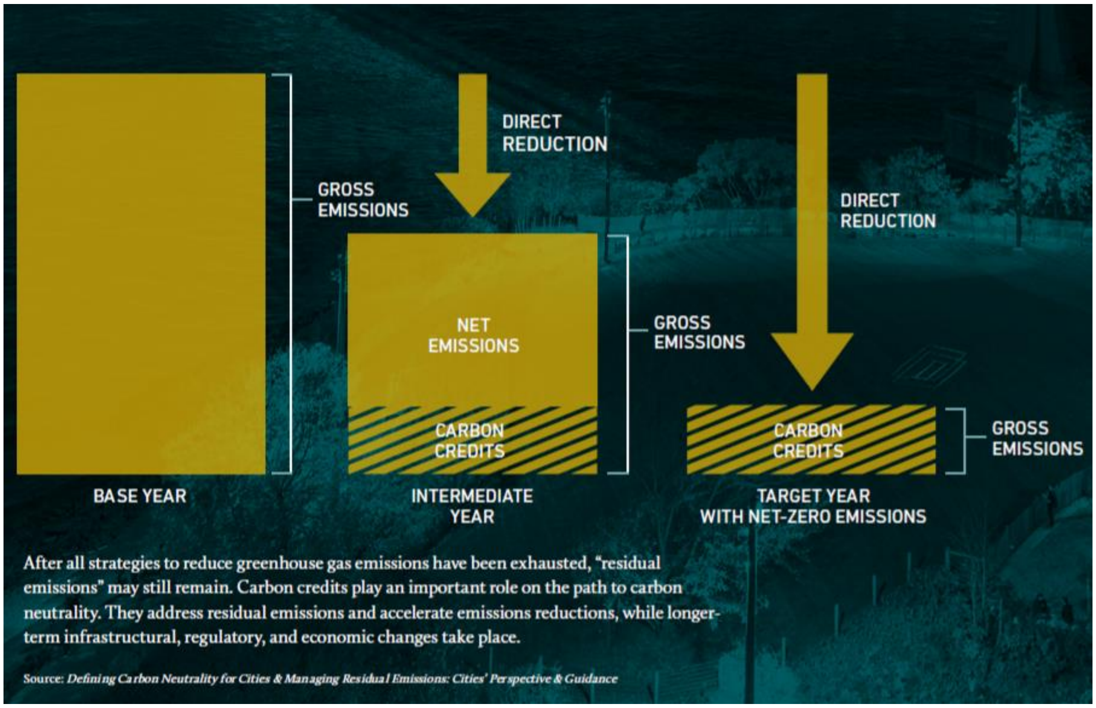
Benefits to the city of developing emissions crediting programs

Often local authorities and associated stakeholders are unaware of the concept of GHG emission crediting and the benefits that it can provide to local programs. This is especially true in many developing countries in Africa and Asia, where rapidly growing, conflict-affected, or disaster-prone cities may already be struggling with the provision of basic services, jobs, and opportunities for its current population, which allows little time for wider concerns.

Carbon crediting can be helpful for a range of purposes, in addition to steering engagement and partnerships for leveraging additional financing for low-carbon growth. The design requirements of the financing mechanism will differ depending on its primary purpose.[89] Through results-based climate finance (RBCF), the city can obtain funding (through demonstrating emissions reductions) that can be used to enhance ambition, reduce investment risk, encourage partnerships, and leverage private sector financing, while at the same time helping to meet NDC commitments.

89 World Bank, 2020. Analytical report on Urban Crediting Methodology. Ministry of Environment of the Hashemite Kingdom of Jordan and Partnership for Market Readiness (PMR). World Bank, Washington, DC.

On the other hand, the city may choose to trade carbon credits internationally and benefit from selling them at an agreed price. With carbon market transactions, the ERs are transferred to donors for their own NDC compliance.



TCAF is a hybrid instrument that leaves a share of the ERs in the host country for its compliance (about 50%). This is because about half of TCAF donors are not interested in receiving offsets for their own NDC compliance. These donors want to deliver RBCF to help host countries undertaking mitigation activities.

In addition to financial support, carbon crediting can provide the local stakeholders and policymakers with other benefits, such as:

i. Provide critical MRV support: Establishing a complete and reliable MRV system that is needed for evaluating the actual policy performance and inform the follow-up policy decision making can open-up other opportunities to improve program operation and implement other impactful mitigation interventions.

ii. Improve overall financial viability and leveraging private sector participation, Carbon crediting can reduce the payback period of EE investment. Greener, low emission initiatives differ in their risk perception from traditional ways of working, and a lack of certainty in outcome translates into higher perceived risks. Private actors usually require higher returns to justify uncertainties or challenges. Through proper arrangements, the revenue generated through carbon crediting can be utilized as an effective means of attracting private participation and reducing costs by reducing the uncertainty in the outcome. Although many "green" projects are economically cost-efficient, this can be a deciding factor in making them financially viable.

iii. **Strengthen and institutionalize the planning process and regulation enforcement in the city's jurisdiction.** Data collected from MRV systems supported by carbon crediting can strengthen and institutionalize the planning process while mainstreaming a "green" development concept. The payment can be used for data analysis and contribute to the central knowledge platform that is needed in each city as a basis for promoting further energy efficiency improvement.

iv. **Provide a "Rallying Flag".** GHG mitigation from "green" projects and policies can require coordination between different private and institutional stakeholders and involve the implementation of other policies and measures. Having a rallying flag that all can agree to be beneficial, can be key to building consensus and momentum to benefit a common goal, even when that goal (GHG mitigation) may not be of maximum priority for several of the actors involved.

v. **Strengthen commitment through enhancing visibility**. Involving the international community and other regional stakeholders in carbon crediting component can strengthen the commitment of local stakeholders with improved visibility of the ER project/policy/program.

06. Application of TCAF Guidelines to Urban Crediting

The TCAF Core Requirements

The Transformative Carbon Asset Facility (TCAF) provides funding through emission reduction transactions to stimulate, in client countries, the establishment of robust regulatory frameworks for carbon pricing, and to promote sustainable development. To achieve this, TCAF has well-defined selection criteria for participating programs.

1. Coherence with national mitigation aims. The program should be consistent with the country's Nationally Determined Contribution (NDC), and fully aligned with domestic policy objectives and sectoral priorities
2. Support increased ambition. The program should enable the country to increase its mitigation target beyond what it would achieve with its own efforts.
3. Achieve a lasting impact. The program should ensure the sustainability of emission reductions after the Facility's support ends.
4. Have sustainable development co-benefits and maintain environmental and social safeguard standards.
5. Demonstrate a high level of the environmental integrity of emissions reductions.
6. Avoid any distortionary effects on international competitiveness or the sector's GHG emissions.
7. Establish a robust baseline for the program.
8. Be ready to implement in the short-term.

Short-listed candidate programs for TCAF support that demonstrate compliance with these criteria should be selected based on:.

- ***prioritization**,* i.e., figuring out which policies or other interventions would achieve the maximum overall TCAF program emissions reduction result.
- ***transformative policy design**,* i.e., working out which policies would obtain maximum transformative impact, which in effect may mean maximizing the implicit carbon price on a sectoral basis; and
- ***political realism**,* i.e., identifying and resolving the political-economic barriers, such as how to overcome or transform, the interest of influential stakeholders in maintaining the status quo.

Key elements in defining the above, are TCAF's requirements on (i) transformational change; (ii) baseline setting; (iii) Monitoring Reporting and Verification (MRV); (iv) additionality and avoidance of double counting; (v) sustainable development; and (vi) crediting parameters and safeguarding against regrets.[90]

The full TCAF core requirements can be accessed at:
https://tcaf.worldbank.org/sites/tcaf/files/TCAF_Core%20parameters_July%202018.pdf

This section illustrates how they are applied to Urban Crediting.

[90] These requirements are defined in the document "Core parameters for TCAF operations": https://tcaf.worldbank.org/sites/tcaf/files/TCAF_Core%20parameters_July%202018.pdf

Blueprint for TCAF programs supporting Urban emissions reduction

The following case study (Jurisdictional crediting at the margin: example Amman, Jordan) illustrates the application of the TCAF core requirements. It should be noted that some of the numbers (particularly the future ex-post evaluation of each policy) are fictional.

Jurisdictional crediting at the margin. Example Amman, Jordan

In this example, we show how TCAF funding can be used to heighten ambition at the city level.

The Hashemite Kingdom of Jordan committed in its NDC to reduce its greenhouse gas emissions by 1.5% by the Country's own means compared to a business as usual scenario. Conditional on international assistance, it offered an emissions reduction by 2030 of 14% compared to a business as usual scenario level. The two targets to be achieved based on implementing at least 70+ projects (43 sectoral projects resulted from the mitigation scenario assessment articulated in the 2014 Third National Communication Report to UNFCCC and another around 27+ sectoral priority projects proposed concurrently or newly planned and not listed in the TNC Report.

The city of Amman is one of more than 70 cities worldwide that are aiming to become "carbon neutral" by 2050. Despite the economic shock imposed by the influx of Syrian refugees pushing the city's population from 3.7 million in 2017 to an estimated 6.4 million in 2025, it has a mitigation target much more aggressive than the national unconditional commitment, proposing to reduce its greenhouse gas emissions by 40 percent from BAU by 2030 through multiple projects principally in the electricity generation, private building energy, and transport sectors.

Amman's Green City Action Plan already has international partial funding support but would require additional support to achieve this target. It would need a dramatic scaling up of existing actions and an increase in penetration rates. Additionally, current programs do not adequately consider emissions saved from more complex multi-sector approaches, such as increasing density, improving transit-oriented development, and reducing urban sprawl.

Table 9 gives an indication (using some fictitious numbers) of their goal. With their high population growth, their baseline emissions are expected to increase from 7.4 million tons of CO2e in 2014 to 13.6 Mt CO2e in 2030. We assume that the Kingdom's NDC commits Amman to the same unconditional mitigation goal as offered at the national level (1.5% reduction compared to a business as usual scenario) since Amman is home to more than 42% of Jordan's total population. The international support that is considered in their current plans should generate additional mitigation of 2.0 Mt CO2e

The city can achieve this unconditional mitigation with its own resources and has obtained international support for 2.0 Mt CO2e in 2030. They are looking at using TCAF support to scale up many existing programs (in different sectors), accelerate introduction dates, and increase penetration rates. Many of these involve putting an implicit price on carbon.

As there are many programs involved, in different sectors, the crediting framework that is applicable is jurisdictional with crediting at the margin of the other efforts that are under way.

Table 9 - Expected Emissions in Amman with and without mitigation effort (includes some fictional numbers)

		Ex-ante *Emissions, All Sectors (MtCO2/year)*	2020	2025	2030
#	Calculation		*MtCO2/year*		
1	input	Baseline Emissions	8.40	11.00	13.60
2	input	Unconditional NDC	8.40	10.84	13.40
3	[2] - [1]	Change in emissions relative to Baseline	0.00	(0.16)	(0.20)
4	[3]/[1]	Change in emissions relative to Baseline (percent)	0.0%	(1.5%)	(1.5%)
5	input	Achievable change in emissions supported by unconditional own efforts		(0.16)	(0.20)
6	input	Achievable change in emissions, supported by international finance		(0.24)	(2.00)
7	[5] + [6]	**Achievable change in emissions with current program**	0.00	(0.40)	(2.20)
8	input	**Additional change in emissions with TCAF support**		(0.50)	(3.80)
9	[7] + [8]	Total achievable change in emissions		(0.90)	(6.00)

Given the diverse nature of the city-wide effort needed to reach this mitigation goal, the crediting approach for TCAF will be jurisdictional (city-wide) and at the margin, given that current programs with international support are expected to achieve some of the needed mitigation.

The numbers in Table 9 represent an initial rough ex-ante estimate of the basis for a crediting program.

TCAF offers to purchase verified emission reductions (ERs) resulting from the enhanced ambition of the city, at a rate high enough to compensate for any transitional or welfare losses due to the changes enacted. As TCAF is a hybrid instrument, around 50 percent of the VERs will be transferred to the TCAF donors under a carbon market transaction and will no longer be available to the Kingdom of Jordan towards its NDC. The remainder will be funded through results-based climate finance (RBCF) and the ERs will remain in Jordan for its compliance. This is because about half of TCAF donors are not interested in receiving offsets for their own NDC compliance and want to deliver RBCF to help host countries undertaking mitigation activities.

In addition to this, the Kingdom may decide not to sell all the emissions mitigation generated by this program, keeping a portion for its own use and to resolve future uncertainties.

Application of TCAF Guidelines

Transformational change:

TCAF criteria for transformational change are four-fold as listed below:

- ***Size****:* TCAF operations are expected to show their transformational quality in achieving a large volume of emission reductions, i.e., at least 5 million tons CO_2e over the crediting period of 5-7 years.

  The estimated emission reductions in this case-study are of over 500,000 tCO2e per year iin 2025, rising to 3.8 million tCO2e per year by 2030. (#8 in Table 10)

- ***Carbon pricing***: TCAF operations are expected to contribute directly or indirectly to the development and implementation of explicit or implicit domestic carbon pricing policies.

  Many of the programs in which ambition will be enhanced involve putting an implicit price on carbon

- ***Leverage:*** TCAF operations are expected to enable the country selling the ER to increase its domestic emissions-reduction ambition over time.

Amman's Green City Action Plan is much more ambitious than the country's NDC and involves significant private investment

- ***Sustainability***: emission reductions must be sustainable over time

  The mitigation being implemented across the whole jurisdiction is at a high enough level to motivate substantial increase in investment and resource utilization in the future..

Baseline-setting

The diversity of NDCs amongst countries means that TCAF requires a flexible approach to tailor the baseline for each TCAF operation. The baseline setting for TCAF operations will be defined by the selling-countries' unconditional NDC targets . Emission reductions forming part of these targets cannot be credited and need to be part of the baseline.

Additionally, the TCAF crediting threshold has to be stricter than baseline to ensure a high level of environmental integrity and compensate for uncertainties in the ER determination and calculation process since the Paris agreement anticipates that the NDCs will strengthen over time, and since ERs that have been sold through a carbon market transaction cannot be applied to tightening commitments,. This enhances the confidence level of the ERs that are put up for purchase. It is important to consider that if the purchaser of the ERs plans to use them to meet its own international commitments, then it needs to receive the assurance that the ERs for sale are of adequate quality. All other ERs that have been sold (for example, through CDM) are also discounted in this way.

In practical terms, this means that TCAF will credit against a crediting threshold or that is well below the BAU emissions trajectory and typically also well below the target emission trajectory (see Figure 23). Single year targets will conservatively be broken down to crediting periods (default is linear break down).

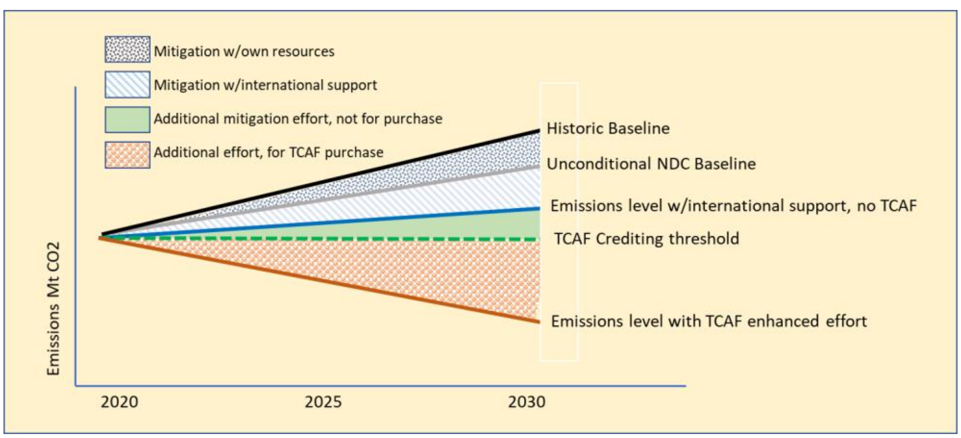


Figure 23 - Illustration of crediting framework

The Hashemite Kingdom of Jordan committed in their NDC to unconditionally reduce their emissions intensity by 1.5 % by 2030 compared to a business as usual scenario levels. With international assistance, they committed to an additional reduction of at least 12.5 % by 2030. We assume that Amman adopts the same unconditional mitigation goal as the national commitment since it is home to more than 42% of Jordan's total population.

This is shown in Table 10, where the unconditional NDC baseline is given in #10 and the TCAF crediting threshold in #13. Note how the historic baseline emissions, the unconditional NDC which is a percentage of these, and achieved mitigation (with and without international support) are all slightly different from the ex-ante estimations (given in Table 9). This is often experienced when economic and population growth, and policy enactment, in reality, are all different than that originally forecast.

Table 10 – Ex-post Emissions in Amman with and without mitigation effort (includes some fictional numbers)

		Ex-post *Emissions, All Sectors (MtCO2/year)*	2020	2025	2030
#	Calculation		*MtCO2/year*		
1	input	Baseline Emissions	8.40	10.70	13.30
2	input	Unconditional NDC percent change	0.0%	(1.5%)	(1.5%)
3	[1] * (1+ [2])	Unconditional NDC	8.40	10.54	13.10
4	[3] - [1]	Change in emissions relative to Baseline	0.00	(0.16)	(0.20)
5	input	Achieved change in emissions supported by unconditional own efforts		(0.16)	(0.20)
6	input	Achieved change in emissions, supported by international finance		(0.14)	(2.02)
7	[5] + [6]	**Achieved change in emissions with current program**	0.00	(0.30)	(2.22)
8	input	**Additional change in emissions with TCAF support**		(0.50)	(3.80)
9	[7] + [8]	Total achieved change in emissions		(0.80)	(6.02)
	Calculate TCAF crediting using Additionality Layer one (market mechanism)				
10	min([3],[1] + [5])	Baseline (Lowest of NDC, and Baseline less unconditional mitigation)	8.40	10.54	13.10
11	[6]	Emissions change, supported by international finance		(0.14)	(2.02)
12	input	Mitigation retained by host country for own use and to cover uncertainty		(0.10)	(0.70)
13	[11]+[12]+[13]	TCAF Crediting threshold	8.40	10.30	10.38
14	[1]+[9]	Emissions levels including TCAF effort		9.90	7.28
15	[14] - [13]	**TCAF emissions change to be credited (market mechanism)**		(0.40)	(3.10)
	Calculate TCAF crediting using Additionality Layer two (finance mechanism)				
16	[6] + [8]	Total change in emissions supported by internat finance (inc TCAF)		(0.64)	(5.82)
17	NPV[15]/NPV([6]+[15])	Proportion of NPV TCAF subsidy value to total international NPV subsidy value (see note)	65%		
18	[16] * [17]	change in emissions due to TCAF		(0.42)	(3.80)
19	[12]	Mitigation retained by host country for own use and to cover uncertainty		(0.10)	(0.70)
20	[18] - [19]	**TCAF emissions change to be credited (finance mechanism)**		(0.32)	(3.10)
	Calculate which is applicable Layer one or Layer wo				
21	[15] or [20]	Which is smaller: Total Layer two change or Total Layer one change?	Layer two is smaller		
22	[15] or [20]	Layer one and two: TCAF emissions change to be credited		(0.32)	(3.10)
23	input	Inventory weighted data quality discount (sectoral + overarching)	54%		
24	[22] * [23]	TCAF ERPA purchase volume		(0.17)	(1.67)
25	input	percent applicable for RBCF	50%		
26	[24] * [25]	Emissions reduction supported by RBCF		(0.09)	(0.84)
27	[24] * (1- [25])	Emissions reduction supported by Carbon Market Transaction		(0.09)	(0.84)
Note:	[17] should be calculated based on the net present value (NPV) of international finance contributions				
	[23] can be improved through good MRV design and implementation				

As this analysis is conducted ex-post, it is possible to directly measure through the MRV systems, the level of emissions with all the mitigation actions functioning. This is shown in item #14 of Table 10.

Additionality

Additionality is defined as the difference between the crediting threshold ("TCAF threshold") and the actual emissions (see Figure 23). TCAF uses a two-layer approach to additionality: (i) market mechanism; and (ii) finance mechanism. The volumes of layer one and layer two will be compared and the lower of these volumes will define the maximum TCAF ERPA purchase volume.

- **Layer one: market mechanism** takes into account that TCAF operations will follow a market mechanism logic as they are piloting potential new international market mechanisms under Article 6 of the Paris Agreement and seek recognition of the purchased verified emission reductions (VERs) under Article 6 as NDC compliance grade.

  Operationalization of layer one additionality is done through a systematic assessment of the crediting threshold. Instead of taking for granted that NDC targets will lead to emission reductions below BAU, TCAF establishes BAU trajectories on the level of TCAF operations and relates them to NDC targets. Furthermore, crediting parameters are defined in such a way that TCAF will only credit emission reductions relative to crediting thresholds, which are emission trajectories below the baseline. As target setting is not static under the Paris Agreement but dynamic – parties are expected to increase their NDC targets and coverage over time – increases in ambition will be reflected in baselines if they occur during TCAF crediting periods.

  Item #15 in Table 10 shows the crediting volume as calculated under the market mechanism.

- **Layer two: finance mechanism** follows a climate finance logic as TCAF operations are piloting Article 6 mechanisms through provision of results-based climate financing (RBCF). This suggests considering the underlying financial structure of TCAF operations within an attribution approach leading to a second layer approach to additionality.

  Layer two additionality follows an attribution approach to emission reductions achieved with TCAF operations. For that purpose, all international support that a TCAF operation receives will be mapped and for each of these international support components the grant equivalent ("subsidy value") will be determined. The subsidy value of the TCAF ERPA itself is the net present value of the ERPA payments.

  Next, the share of the TCAF subsidy value in the aggregated subsidy value across all instruments of international support used to support the TCAF operation will be determined. On that base, the emission reductions attributable to the TCAF operation will be derived. This will result in the "volume of layer two additional emission reductions" and ensure that no more emission reductions are attributed to TCAF than what TCAF relatively delivered in international support to make the operations happen.

  Item #20 in Table 10 shows the crediting volume as calculated under the finance mechanism. Note that the percentage shown in item #17 assumes that the net present value of the international support per ton of mitigation is constant when in reality the subsidy value across all instruments of international support may vary considerably.

- Finally, the volumes of layer one additional emission reductions and layer two additional emission reductions are compared, and the lower of these volumes will define the maximum. In all TCAF cases, both layer one and layer two calculations must be applied. In this case study, the volume from the finance mechanism is lower, as shown in item #22.

MRV

The Paris Agreement established a universal system of transparency for MRV, with built-in flexibility taking into account countries' different capacities. The Agreement requires countries to report and be reviewed on a biennial basis on:

- Progress with the implementation of NDCs;
- Progress with the provision/receipt of support; and
- Identification of capacity building needs.

A gradual strengthening of national MRV-systems should also be the framework for any TCAF MRV. To ensure legitimacy and support, TCAF's MRV must be aligned with national MRV systems (accounting methodology; computer systems; etc.). This way TCAF can also make a valuable contribution to building national level MRV capacity.

In Urban crediting, TCAF operations will typically be on a jurisdictional or sectoral level and the mitigation calculation will depend on measuring (and modeling) changes in inventory of emissions across the crediting period. Even in ex-post analysis calculating the baseline—the emissions in the jurisdiction that would have happened without the intervention--is often considered the most challenging aspect of calculating net GHG emissions.

Due to the fast-changing nature of many cities in developing countries, static baselines that do not change over the assessment period time frame cannot normally be used. Dynamic baselines require a more complex calculation in which emissions inventory measurements are modified using other indicators that reflect the changes and growth within the city so that they may be compared to the measured emissions performance of the city with the interventions in place.

There are three basic mechanisms for establishing this counterfactual emissions level:

- **An emissions inventory can be constructed for the jurisdiction that describes what would have occurred if no emission mitigating intervention had taken place**, including those that could have been incentivized by the crediting scheme. The inventory can be defined by using simple modelling approaches to project historical emission trends into the future and adjusting these to account for changes in the jurisdictions scope and complexity.
- **A baseline can be set based on performance standards**. This means that it represents a certain rate of emission reductions that is expected from particular activities or technologies.
- **A baseline can be set through the net mitigation method**, which means they are intentionally set below a BAU scenario to account for uncertainties in ensuring environmental integrity. This method requires a detailed bottom-up analysis of the city's mitigation costs and potential, as well as possible modelling of these.

Alternatively, they could also be based on apportioning a certain part of national targets to the city.

Treatment of uncertainty

Baseline development and emission measurement are often linked to a high level of uncertainty, particularly when the expected level of emissions mitigation is small. A discounting mechanism can be applied to compensate for these issues. Discounting is the process whereby the determined emissions reduction is multiplied with a discount factor that is between 0 and 1, based on the uncertainty of the data, to ensure that the buyer of the ER is not short-changed.

Uncertainlty can also be reduced by improving the MRV process and increasing the data that is collected. As discounting reduces the value of the ER to the seller, and improving the MRV process increases the cost of MRV to the seller, an optimal mix can be found (in which the MRV process is enhanced to what is economically practical) that maximizes the net benefit to the seller of generating each ER.

In the case of Amman, a comparison of Amman's 2014 and Actual versus Projected BAU 2016 Emissions resulted in an overall inventory-weighted discount of 56 percent (sectoral) and 54 percent when including overarching inventory data quality criteria[91] (see Table 11). The largest factor contributing to the score was the temporality of the data (the data was not consistent with the inventory year), followed by the use of national data scaled to the city. The sector with the lowest overall score was Stationary Energy, which then inflated the overall score of the sector, thereby contributing the most to overall emissions.

This analysis would need to be repeated to determine the overall discount to be applied to the TCAF crediting.

This discount factor is shown in Table 10, item #23, allowing calculation of the TCAF ERPA purchase volume in item #24. This is then divided amongst donors into two components, carbon finance transaction and RBCF (items #26 and #27).

Table 11 - Indicative Discounted Emission Volumes Eligible for Credit in Amman 2016 study (source: World Bank, 2020. Analytical report on Urban Crediting Methodology. Ministry of Environment of the Hashemite Kingdom of Jordan and Partnership for Market Readiness (PMR))

Sector	Inventory weighted discount
Residential Energy	0.63
Residential Electricity	0.45
Institutional & Commercial Energy	0.63
Institutional & Commercial electricity	0.45
Manufacturing Industries & Construction Energy	0.63
Manufacturing Industries & Construction Electricity	0.45
Road Transport	0.72
Solid waste	0.86
Wastewater	0.41
Overarching Inventory Quality Assurance Data Quality Discount	0.95
Discounted total (total inventory weighted score + overarching discount)	**0.54**

Definition of the inventory boundary and treatment of leakages

Defining an adequate inventory boundary is critical to successful carbon crediting by cities. For jurisdictional crediting, a geographic boundary that identifies the physical perimeter of the inventory's boundary, which can align with the administrative boundary of a local government, is usually used. For sectoral crediting, this is further limited functionally to include only the sector under consideration.

Many metropolitan areas lack an overarching framework for collaboration across municipal boundaries, which means that it can be difficult to adequately monitor the activities included in the metropolitan inventory. This has been an issue in Amman in relation to regional transport, potentially hampering improvements to public transport services.

[91] Source: World Bank, 2020. Analytical report on Urban Crediting Methodology. Ministry of Environment of the Hashemite Kingdom of Jordan and Partnership for Market Readiness (PMR).World Bank, Washington, DC.

Territorial accounting aggregates only the scope 1 emissions from cities within these geographic boundaries (see Table 12[92]). This is useful when aggregating results from different cities to avoid double-counting, but excludes the impact of city activity on other emissions. For example, scope 2 grid-supplied electricity that is generated outside the city boundaries, which can be important to include if the interventions involve energy efficiency measures that will reduce the consumption of electricity. A change in the use of electricity may modify the load factor and dispatch order of powerplants and hence the grid emissions factor.

Cases where it is important to include scope 3 emissions include, for example, waste management (when the landfill and waste treatment is outside the city's boundary) and out-of-boundary transportation (when the fleet fills tanks within the boundary, or commuters that travel within the boundary but fill-up outside.

Mitigation goals can apply to a city's overall emissions or to a subset of the GHGs, scopes, or emission sources set out in their GHG Protocol for Community-Scale GHG Emission Inventories (see [92]). **Keeping the boundary small is critical to reducing noise and improving the ERs that can be claimed** (it is easier to distinguish mitigation of a thousand tons CO_2 in an inventory of 50,000 tons than in an inventory of one million tons), and activity indicators can assist in detecting changes in the inventory. However, care must be taken to describe and reliably account for all leakage into or out of this boundary.

Table 12 – Scopes definitions for city inventories

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary.
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

Avoidance of double counting

Accounting of emission reductions is a complex task. In city-wide jurisdictional, sectoral and policy-based crediting, there is a real risk of double-counting against project level emissions reductions that may be claimed at the sectoral or national level. Great care must be taken to adequately and transparently record and document all stages in the process. Avoidance of such double-counting requires: (i) a commitment by the country selling the ER through an approval letter to apply record keeping to all international transfers of emission reductions (not just the transfers under TCAF operations) and to safeguard against double counting through appropriate diligence, (ii) a corresponding ERPA clause committing the TCAF operation implementing agency to the same principles, and (iii) including monitoring of compliance with the accounting rules in the due diligence of TCAF operations.

Sustainable development

All TCAF programs should ensure compliance of with the World Bank environmental and safeguard standards and consistency with UN Sustainable Development Goals. Going beyond a safeguarding approach, each individual TCAF program should define relevant indicators to evaluate progress and the nature of sustainable development benefits. Examples can include indicators related to health benefits due

[92] Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities; World Resources Institute, C40 Cities Climate Leadership Group, ICLEI - Local Governments for Sustainability

to reduced air pollution, positive impacts on disposable income from low income households through savings on energy bills, and reduced traffic accidents etc.

These indicators will become criteria for program selection as well as for performance monitoring and evaluation of program results over time.

Safeguarding against regrets

Overselling, i.e., missing the NDC target because of selling a too large volume of emission reductions is a risk, that needs to be mitigated both from a selling-country perspective and also from TCAF's perspective in order to avoid reputational risk.

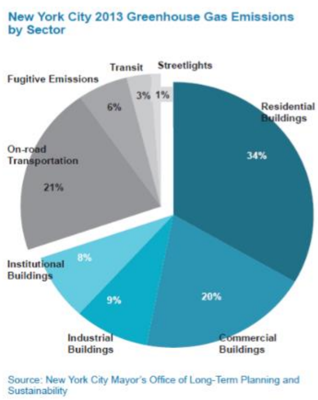
TCAF will require the country selling the ER to have a mitigation strategy that accounts for the TCAF operation. Such analytical work will require consideration of mitigation potential and mitigation strategy on the national level – depending on the nature of the NDC target potentially broken down to target sectors.

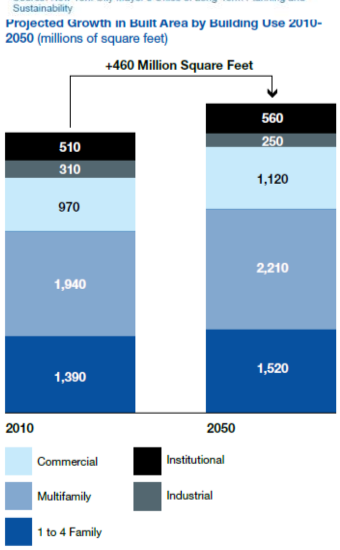
Annex 1: Detailed case studies from different cities/urban agglomerations.

Annex 1.1: Detailed Case Study of New York city

Reducing building emissions in New York City:

NYC 80x50[93], One NYC[94] and One City: Built to Last





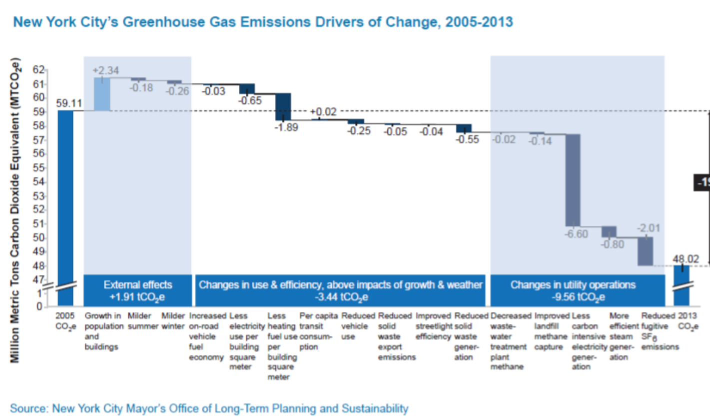
Country context: High income country

City context: Type 1 city (rapidly growing); Large city-size (8.6 million population) [95]

Project Background: New York City (NYC) is committed to achieving carbon neutrality by 2050. To achieve this, city will need to reduce its emissions as much as possible and offset its "irreducible emissions," — those that are not feasible to eliminate — with projects that create negative emissions outside NYC. In NYC, more than 68 percent of GHG emissions can be attributed to the energy used to power, heat, and cool buildings.

Drivers of GHG building emissions:

Existing buildings in NYC continue to be the largest contributor of GHG emissions, representing over 90 percent of the total built square footage and building-based emissions. New building growth is expected to increase these emissions by nine percent. By 2050, NYC's population growth is expected to result in nearly 100,000 new buildings, which equates to roughly 460 million sq.ft. of new built area. Therefore, increasing the energy efficiency of existing buildings by retrofitting them, in addition to ensuring efficiency of new construction, is the most important step to make deep reductions in carbon emissions.



Some of the key measures for Building emission reduction:

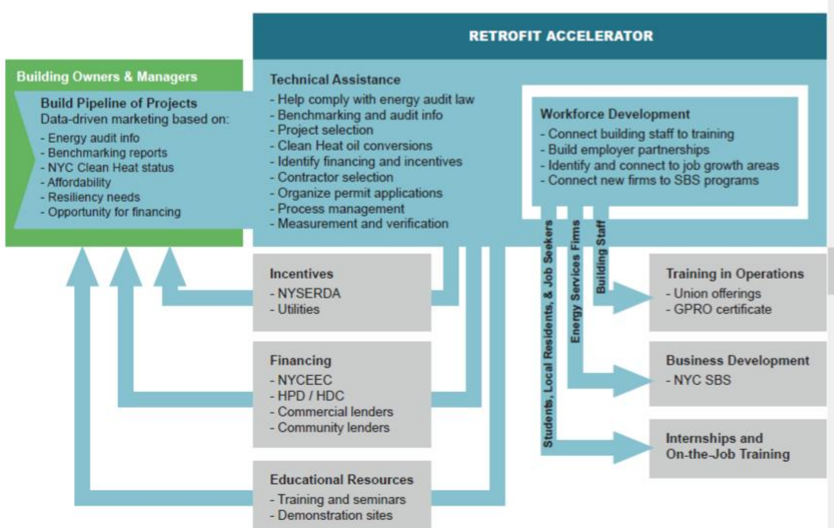
[93] City of New York (2016). New York City's Roadmap to 80 x 50. OneNYC.

[94] City of New York (2015). OneNYC 2050- Building a strong and fair city. A livable climate (Volume 7 of 9). NYC.GOV/OneNYC

[95] Decennial Census, ACS 5-Year 2017, NYMTC 2050 borough population projections.

- In 2010, the City began benchmarking public buildings for energy performance in 2010 and included all buildings greater than 10,000 square feet in floor area. The City has also conducted energy assessments for nearly 300 public buildings, performed retro-commissioning studies on 250 buildings, and implemented energy efficiency upgrades and renewable energy projects in more than 200 buildings.
- In 2013, NYC launched the Accelerated Conservation & Efficiency (ACE) program to deliver quick, cost-effective, energy-saving projects that target the individual needs of City agencies. The program leverages agencies' energy expertise and existing contract capacity to deliver quick and creative energy savings and building improvements.
- With more than 4,000 buildings in the City's portfolio—including public schools, libraries, courthouses, wastewater treatment facilities, firehouses, and offices—NYC is currently leading by example by retrofitting every city-owned building to reduce energy consumption and installing 100 MW of solar energy on these properties. To maximize city investments and reduce GHG emissions, the City will expand two key initiatives that improve operations and maintenance in City-owned buildings.
- The New York City Housing Authority (NYCHA)—which houses more than 400,000 New Yorkers in 334 public housing—has made a concerted effort to reduce its energy and water consumption through upgrading building systems and improving regular operations and maintenance.
- NYC has installed roughly 0.7 Megawatts (MW) of solar power on City-owned rooftops and has another 1.9 MW underway at buildings including schools, a garage, and a wastewater treatment plant.

Accelerator Program Technical Assistance and Outreach Process



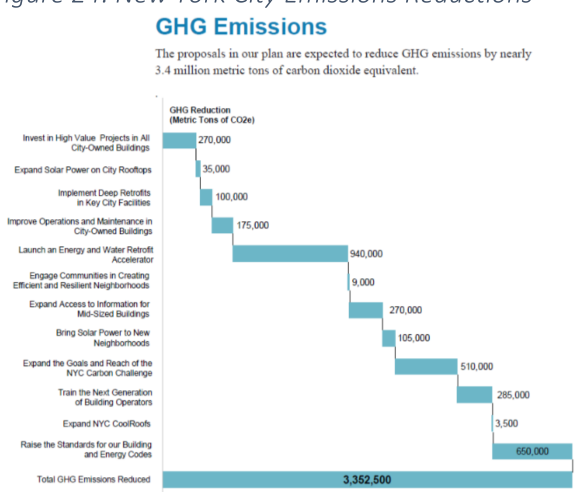
Source: New York City Mayor's Office of Long-Term Planning and Sustainability

- ***The Retrofit Accelerator:*** The City launched a coordinated outreach and assistance program to help private building owners and decision-makers accelerate efficiency retrofits and clean energy investments. The Retrofit Accelerator is expected to stimulate energy and water efficiency retrofits and clean energy investments in more than 20,000 buildings (7,500 properties) over the course of ten years. It include a team of customer service and building experts who will provide technical assistance to help remove the complexities of undertaking projects, using the recommendations from buildings' Local Law 84 (LL84) benchmarking, Local Law 87 (LL87) energy assessments, and other data sources. It will seek to complement, as opposed to replicate, existing financing, incentive, and assistance programs available in New York City. Roughly half of the properties assisted through the platform of the Retrofit Accelerator are expected to be government-assisted affordable properties or at least 50 percent rent-regulated or rent-stabilized.

- In 2017, the City proposed mandatory energy use limits for existing buildings (including affordable housing units) under local law 97 - which requires buildings larger than 25,000 square feet to meet strict greenhouse gas emissions limits starting in 2024. This applies to 50,000 buildings across NYC and is expected to reduce cumulative emissions from large buildings at least 40% citywide by 2030 through building retrofits. The city also introduced Property Assessed Clean Energy (PACE) program to enable retrofits through long-term financing and it has a requirement to install solar PV and green roofs on new buildings and major renovations. Together PACE and local law 97 is expected to eliminate 6 million tons of greenhouse gas emissions by 2030, the equivalent of taking 1.3 million cars off the road every year.
- In 2017, under Local Law 32, city introduced performance-based stretch energy codes that require new construction be built to the latest energy efficiency standards.
- City introduced Green Housing and Preservation Program, which provides low- or no-interest loans to finance energy efficiency improvements. Moreover, the city also intends to work with City Council and local financial institutions to enable property owners to access PACE financing, a low-cost mechanism for making energy-efficiency upgrades that is available in states and cities across the country.

NEW YORK CITY MAYOR'S OFFICE	
Current Emissions	
NYC Gross Building Floor Area (2012)	5.75 Billion SF
2005 NYC Emissions	59.2 MtCO2e
2012 NYC Emissions	47.9 MtCO2e
2012 NYC Buildings Emissions	33.9 MtCO2e
2012 Emissions per SF of Building	0.0000000059 MtCO2e
Projected Emissions Reductions	
2012 - 2050	MtCO2e
New Buildings	0.88
Type 1 & 2 Renovations	-11.77
Building Sales	-25.36
TOTAL	-36.24
TOTAL @ 85% Compliance	-30.81

Figure 24: New York City Emissions Reductions



Results:

- The City has already achieved a 30 percent reduction from 2005 levels across the building portfolio and will achieve a 50 percent reduction from City-owned buildings and operations by 2030 on the path to carbon neutral buildings.
- The initiatives taken by the city is expected to reduce 3.4 million metric tons of carbon dioxide equivalent.

    Hidden benefits: The retrofits on public and private buildings will generate an estimated $750 million in construction spending every year over the next ten years, generating an estimated 3,500 construction-related jobs and hundreds of additional administrative and programmatic jobs. The efficiency improvements resulting from this plan are expected to generate $1.4 billion in cost-savings for New Yorkers annually, and nearly $8.5 billion in cumulative cost-savings over the course of ten years.

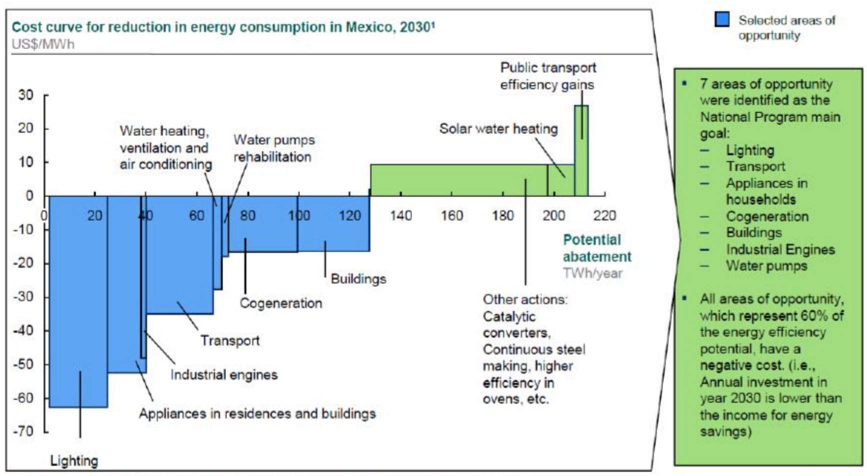
Conclusion: It should be noted that such a transformational change to reduce emissions from buildings in urban space involved multiple stakeholders from city authorities to local communities, took a long set of measures both at public and private sector level, and involved thinking through and overcoming implementation challenges from financing to policy environment, over several years.

Annex 1.2: Detailed Case Study from Mexico city

CTF–IDB" ECOCASA" PROGRAM ECOCASA Program[96]

Mexico Energy Efficiency Program Part II

Urban expansion in Mexico in past decades averages to 50 hectares daily for urban areas. Housing represents 60% of this growth. This expansion of Mexican cities over the past years has significantly increased their carbon footprint. There has been dramatic increase of direct and indirect GHG contributions from residential sector in Mexico in past decades due to inadequate architectural designs, use of energy and GHG emission intensive building materials and technologies, inefficient water use and locations with poor accessibility etc.



1 Considering the cost curve for the reduction in Green House Effect Emissions for main fuels.

Source: McKinsey GHG abatement cost curve V 2.0. CONUEE's review

Figure 25: Cost curve for reduction in energy consumption in Mexico in 2030

An average house in Mexico consumes approximately 71kWh/m². A poorly designed house in a hot climate may use an additional 1,000 kWh per year, representing about 600 kg of CO_2 unnecessarily released into the atmosphere. [97]

CTF–IDB "ECOCASA" PROGRAM (~50million) aims to provide financing and the incentives that will lower the costs of both developing and acquiring energy efficient houses. There is a menu approach to the measures such as: insulation in roof and walls, reflective paint, efficient gas boiler, efficient refrigerator, solar water heater, energy saving windows, among others. Project components include:

Component 1. Loans for developers: To provide bridge loans to developers and is geared towards low- and middle-income housing (income between 5 and 12 times the minimum wage). Sociedad Hipotecaria Federal (Federal Mortgage Society) (SHF) will select an initial pipeline of projects that deliver at least 12 kg CO_2e per m² and year or 20% reduction in the expected GHG emissions associated with energy consumption of the houses relative to the baseline, whichever is lower.

[96] CTF–IDB "ECOCASA" PROGRAM ECOCASA Program. Mexico Energy Efficiency Program Part II. Proposal for Submission to the CTF Trust-Fund Committee.

[97] Specific Program for Sustainable Housing Development to combat Climate Change. CONAVI (2008). Mexico City. P10. See Link http://bit.ly/PEDHSCC.

Component 2. Loans for Local Financial Institutions (LFI): SHF will facilitate to eligible LFIs the financing of mortgages for the purchasing of houses that meet the CONAVI criteria for Hipoteca Verde.

Expected Results:

- Program is expected to produce around 27,600 houses built and another 1,700 financed, in the first seven years.
- CTF/KfW funds are expected to deliver the construction of additional houses 13,800 houses in second phase, totalizing 43,100 houses built and purchased.
- Expected to deliver energy savings of around 2.4 million MWh and emissions reductions of **1.6 million metric tons of CO2e**, accumulated over 40 years.

Annex 1.3: Detailed Case Study from Bogota

TransMilenio (TM)- Bus Rapid Transit (BRT) system in Bogota, Columbia

Country context: Upper middle-income country (GNI of USD 6,510 per capita)[98]

City Context: Type 1 (Rapidly growing city) and Type 5 (Host city); Mega city-size (current population of 10.97million)[99] and the city generates 25% of country's GDP.

Project background: In 1998, as part of urban renewal strategy of the city, Mayor Penalosa proposed an integrated mobility strategy consisting of a package of measures such as placing restrictions on private automobiles, promoting non-motorized transportation, improving public transit with respect to efficiency, safety, speed, convenience, and comfort ensuring high ridership, and enhancing public spaces. BRT system that is the centerpiece of mobility strategy, is designed to transport 5 million people per day, divert 80% of city travel to the BRT system, and is scalable over time to meet the needs of the growing city. [100] The city also plans to phase out diesel buses from its streets and replace them with hybrid and full electric models by 2024.[101]

Total Investment: BRT masterplan for 241 miles is estimated to cost US$3.3 billion.[102]

Emission reduction: Estimated reductions of CO2 equivalent emissions are estimated to be 15-25 million metric tons for the first 30 years of operation.

Carbon credits: The project is expected to earn US$25 million in carbon credits by 2012. TransMilenio BRT has become a model for similar transport related CDM initiatives in the pipeline worldwide.

Challenges	Measures to overcome barriers
1. *Opposition from private sector:* Before 1998, Bogota‟s public bus transportation system suffered from underuse, with low quality service and efficiency. Without price regulations, private bus operators were free to hike up prices and charge far more than public bus operators. Therefore, when BRT proposal came forward, small bus owners and drivers fought against it by coordinating worker strikes in an	1a. The project encouraged the participation of small operators and provided them incentives to play an effective role in the public-private partnership for bus operations and fare collection with rights and responsibilities defined by the concession contracts. For example, it provided the incentives for private operators to compete for specific route in terms of per-kilometer basis as opposed to a per-passenger basis. This policy has enhanced operating efficiency, facilitated healthy competition "for the market" as opposed to an unhealthy competition "in the market" while also reducing the fiscal risk imposed on Bogotá"s city government.

[98] World Bank (2019). https://data.worldbank.org/country/colombia?view=chart
[99] United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision, Online Edition.
[100] World Bank (2016). *Bogota, Colombia – Bus Rapid Transit for Urban Transport.* ESMAP EECI Good Practices in Cities. Energy efficient cities Initiative.
[101] Asian Development Bank (2016). *Case study: Efficient City Transport for Those Who Do Not Own Cars*. https://development.asia/case-study/efficient-city-transport-those-who-do-not-own-cars
[102] Applicability of Bogota‟s TransMilenio BRT System to the United States, (2006). Federal Transit Administration, USA.

effort to block its ratification, as they feared loss of income.	1b. The municipality created Transmilenio S.A., a public-private partnership (PPP). Under the PPP, the new public sector agency, plans the system, takes responsibility for funding its infrastructure, and supervises daily operations. Private sector participation has been promoted and the existing bus operators who have won competitive contracts are responsible for fare collection and operations (including vehicle costs). The private sector earns 33% profit with obligation under the contract to maintain the quality of services provided.
2. Limited financial resources and technical capacity at municipal level.	2a. The local government mobilized resources by raising gasoline taxes, launching against tax evasion, increasing its property tax base, and reducing capital investments in the City‟s Telecommunication Company. 2b. *Leverage existing infrastructure, financing sources and partnerships:* The capital cost of the infrastructure for Phase I was financed through local fuel taxes (46%), national government grants (20%), a World Bank loan (6%) and other local funds (28%).Phase II was financed by the national government (66%) and local fuel surcharges (34%). 2c. *Opting for most cost-effective and appropriate option:* The original proposal of a public transit system that featured both heavy rail (Metro) and a network of buses was abandoned because it cost four times more than the proposed BRT system which required US$1-10 million/km to implement. 2d. In 2002, the Colombian government developed a national urban transportation policy in an effort to improve public passenger transportation service in the country. It provided institutional support, training and assistance in traffic and transit planning, management and control.
3. High capital and operational cost to introduce new mass transit system: Mass transit options till	3a. TM is designed to recover 100% of its costs through passenger fares. The private operator can earn profits when demand for ridership increases and incurs cost in the case that the demand

1999, were limited to privately owned public bus service, suffered from the oversupply of bus route permits, inadequate institutional capacity, and a fractured owner/driver relationship, which resulted in fleet oversupply, low quality services and high social cost due to slow travel, high pollution, high accidents rates, and operating inefficiency.	for ridership declines. The national and city governments only cover capital costs. The municipal budget's allocation for operating costs declined from 50 to 20 percent of its total budget after 1999. 3b. In order for TransMilenio to be successful, it was imperative that fares should fully cover the cost of its operations. The project required that the fare should move up to US$0.40 in order to cover all costs of operations. Wary of the possibility for public resistance to a bus fare hike from US$0.30 to US$0.40, the city of Bogota approved the new rate a year before the TransMilenio BRT system opened.
4. *Unaffordable, mismanaged and inefficient transit system:* The bus owners and operators, often affiliated with trade unions and cooperatives, made profits by reducing or eliminating vehicle maintenance and by forcing bus drivers to work long hours, as they did not have incentives to improve quality as they earned additional profits as demand increased.	4a. Successful implementation of a concession-based contract that aimed at regulating service operations and eliminating rents to avoid fare-hikes. This contract system allowed bus operators to undertake the demand risk associated with running a public transit system. 4b. The BRT uses a variety of design features, such as the use of high capacity buses, exclusive running ways, level boarding, offboard fare payment, and high service frequencies that permit headways as low as 13 seconds on busy sections of the system etc., to accommodate high volumes of passengers that makes the BRT affordable. The exponential growth in passengers using mass transit system since its operation in December 2000 testifies to that.

5. Lack of Political will and institutional fragmentation	5a. Strong leadership on the part of the City Mayor, who mobilized a team to bring about municipal reforms for effective service delivery by promoting cost efficient schemes. 5b. Collaboration between the national and local government was crucial to the success of mass transit system development in Colombia, specifically the relationship regarding the 70/30 financing rule. This established a system where the national government helped with planning and orientation plus financing, and the local government responded with interest and commitment to develop the project, along with their share of financing.
6. Lack of awareness and support from communities:	6a. Cultura Ciudadana (Citizen Culture) campaign, which encouraged civic behavior and strived to create a sense of belonging for the inhabitants of the city, included curriculum on traffic etiquette. This led to changed attitudes about the relationship between motor vehicles and pedestrians, and set the stage for increased investment in public transit and non-motorized infrastructure.[103] 6b. A balancing act was required for the TransMilenio project that ensured fares were high enough to cover costs without precluding low-income passengers.

Hidden benefits and results:

- With the implementation of the BRT system, there has been a 32% reduction in overall travel time, 40% reduction in emissions into the air because of scrapping of over 2100 old public service buses, 92% reduction in accident rates in the BRT corridors, and recorded fuel savings of 47% post implementation while increasing the throughput by 60%. [104]
- The TransMilenio project has been able to generate significant carbon revenue through the sale of both Voluntary Emission Reductions (VERs) and Certified Emission Reductions (CERs). The project generated 277,044 Certified Emission Reduction credits under the Kyoto Protocol's CDM for 2006-

[103] Turner et. al. (2012). Case Study: Colombia's Bus Rapid Transit (BRT) Development And Expansion - An Analysis of barriers and critical enablers of Colombia's BRT systems. Center for Clean Air Policy. CCAP's Mitigation Action Implementation Network (MAIN).
[104] World Bank (2016). *Bogota, Colombia – Bus Rapid Transit for Urban Transport.* ESMAP EECI Good Practices in Cities. Energy efficient cities Initiative.

2009, which were sold to provide additional funding for bus purchases. The expected additional income from the sale of CER credits is US $25 million by 2012 (assuming a total estimated reduction of 1,725,940 tCO2eq is achieved in the first crediting period 2006-2012 and price of US $14.5/tCO2). [105]

- About 1.5 million passengers travel on the system every day with the completion of its first two phases. [106] The residents and visitors of Bogota are thus enjoying reduced travel time, cleaner air, and reduced accidents.
- Increase in real-estate values and densification around the mass transit: *A* study by the Urban Land Institute in 2008 found that property values around TransMilenio stations have a 15 to 20% price premium over other areas in the city.
- Raising gasoline taxes mostly affects private vehicle owners who form less than 1/5th of the city‟s population. This resulted in the redistribution of resources in favor of the poorer city residents who constitute the majority of the city‟s public transportation users.

Figure 26: Before and after photograph of Bogota with BRT system (on right).

[105] Turner et. al. (2012). Case Study: Colombia's Bus Rapid Transit (BRT) Development And Expansion - An Analysis of barriers and critical enablers of Colombia's BRT systems. Center for Clean Air Policy. CCAP's Mitigation Action Implementation Network (MAIN).

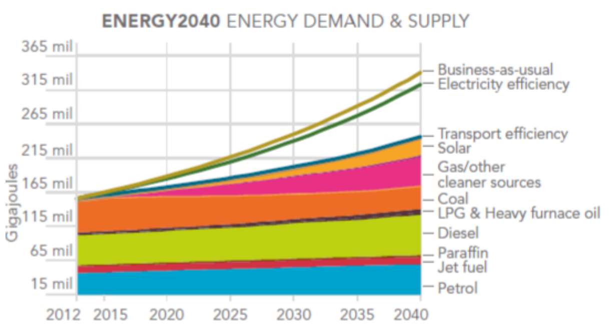
[106] World Bank (2016). *Bogota, Colombia – Bus Rapid Transit for Urban Transport.* ESMAP EECI Good Practices in Cities. Energy efficient cities Initiative.

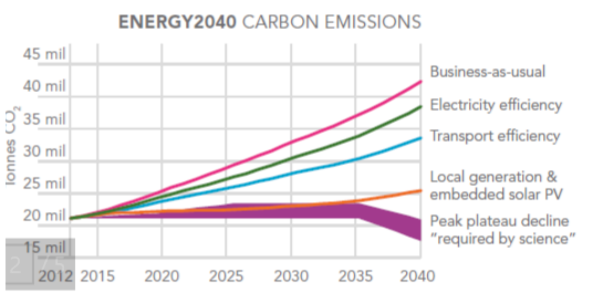
Annex 1.4: Detailed Case Study from Cape Town

Cape Town city plans for reducing emissions from energy[107] and waste sector.

City Context: Type 2 (Slow growing city); medium city-size (current population of 3.8 million) generating 11% of national GDP and a Carbon footprint of 5,6 tCO2e/capita.

Energy sector context:





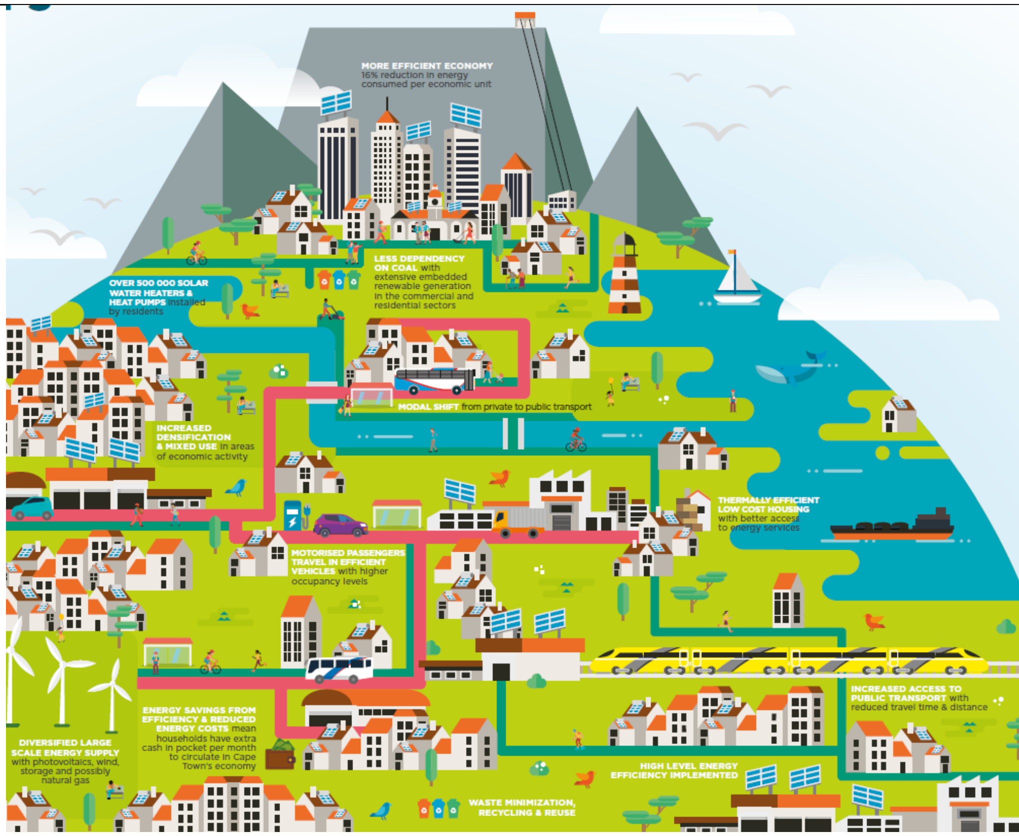
CARBON EMISSIONS TARGETS*	2020	2030	2040
Electricity efficiency	-3,7%	-7,7%	-9,3%
Transport efficiency	-3,2%	-7,2%	-11,2%
Cleaner electricity supply	-6,2%	-13,9%	-15,9%
Total carbon reduction off business-as-usual	-13%	-29%	-37%
Tonnes of CO_2/USD million GDP	820	600	490
Tonnes of CO_2/capita	5,4	5,3	-

**The energy and carbon emissions targets are conditional on the Energy2040 modelling assumptions remaining constant.*

Measures for reducing energy emissions: The City has made institutional and strategy changes to reduce its high carbon footprint by 2040, which includes mix of soft and hard measures. For example:

- City is collaborating with Western Cape Government on an Energy Game Changer programme to drive energy efficiency and a rapid diversification of the energy supply mix.
- Introduce Electricity Savings Campaign for commercial and residential sectors.
- City supports Small scale embedded generation and has a feed-in tariff.
- City is retrofitting streetlights, traffic lights and buildings with energy efficient lighting, and by installing rooftop photovoltaic systems, along with energy management training for facilities staff, smart driver training for fleet, and behavior change programmes for building users.
- Introduce transport and spatial planning programmes on public transport, transit-oriented development, maintenance of the urban edge, non-motorised transport and transport demand management.
- Introduce Smart Living and Working programme that targets learners, teachers, office workers, households, municipal staff and councillors in resource efficiency across energy, water and waste.

[107] City of Cape Town (2015). CAPE TOWN ENERGY2040 - Towards a more resilient, low carbon and resource efficient future for Cape Town



Waste sector country context[108]**:**

Solid Waste (SW) sector in South Africa is responsible for 19 million tons of CO2e per year[109], mainly from methane generation from decomposition of organic waste at landfill sites. Organic waste[110] represents the dominant fraction of waste generated (~56% of total waste) in the country, but only 1% of total organic waste is recovered[111] , and remaining unseparated organic waste is either landfilled or dumped, thereby contaminating the recyclables, and over burdening the already limited landfill space. The Waste sector emissions have increased from 10.8 MtCO2e in 2000 to 19.5 MtCO2e in 2015 (or 3.6% of South Africa's gross GHG emissions). The largest source is the Solid waste disposal which contributed 85.5% (16.7 Mt CO2e) towards the total sector emissions.[112]

Waste sector city context:

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[108] Sachdeva et.al (2019). GPURL team notes from Solid waste management scoping mission meeting in July 2019.

[109] Data on waste composition in South Africa varies considerably and is limited. Most of the data that is accessible comes from a small number of municipalities and covers only certain years. There is no data dating back to the 1950s showing how waste composition has changed annually nor how this relates to urban income disparities and population densities. In the 2000 inventory, only greenhouse gases generated from managed landfills are included for two main reasons: Firstly, data on waste dumped in unmanaged and uncategorised disposal sites have not been documented. Secondly, most of the unmanaged and uncategorized disposal sites are scattered throughout rural and semi-urban areas across South Africa and are generally shallow (i.e. less than 5 metres in depth). In such shallow sites a large fraction of the organic waste decomposes aerobically which means methane emissions are insignificant compared to those from managed landfill sites.

[110] Organic waste (in figure above) comprise waste mainly biomass from sugar mills, sawmills, and P&P industry; and also includes the organic fraction of MSW. Municipal waste (in the figure above) excludes organics; C&D waste, and recyclables fractions of MSW; as well as commercial and industrial waste.

[111] 2011 DEA report

[112] SOUTH AFRICA'S 3RD BIENNIAL UPDATE, March 2019 (p59, p87)

Waste collection is core municipal function, city provides services to formal HHs and informal areas. However, there 'backyarders' are not included (grey area) (properties within the city's rental stock or private land). Approx. 43,000 backyard housing in the city who aren't covered in waste collection services, lead to informal dumping. More than 2700 illegal dumping spots have been identified, and it costs about R112m per year to clean (232,000 tonnes) i.e. 10% of annual cleaning operating budget. City is starting to roll out LFG capture and flaring.

Ongoing measures for reducing waste emissions at city-level: The City has made few regulatory, institutional changes as well introduced innovative programs to reduce emissions from waste in next decade.

- Western Cape provincial governments has made a decision to ban green waste to landfill by 2027
- Food waste is accounted as a special waste in Cape town and has a special tariff starting in 2019. This could encourage composting or other waste to energy initiatives to divert food waste going to landfill.
- City plans to pilot SWOP services in 5 areas, for encouraging segregating waste before it reaches landfill – lack of sorting facilities and operational funding is identified as biggest barrier to sort waste at source. Ward councilors will partner with the city to workshop this idea.
- City plans to pilot foot patrol to guide residents to drop-off sites for separating organic waste.
- City is planning to launch 'Think-twice!" campaign for recycling and waste minimization awareness among communities.

Annex 2: Useful tools for urban application

There are many tools available to the city or municipal authority to evaluate its emissions inventory, identify areas of concern where GHG emissions can be expected to increase over the coming years, and identify measures that can mitigate this increase in GHG emissions.

A limited selection of frequently used resources for urban application is shown in **Error! Reference source not found.** In addition, the World Bank's Climate Change Knowledge Portal[113] is a fabulous online tool for access to comprehensive global, regional, country, and local-level data related to historical and future climate change and development.

Table 13 - Non-inclusive selection of useful tools for urban application

Tool	Link
EPIC	
EDGE	https://www.edgebuildings.com/
Long Range Energy Alternatives Planning System (LEAP) Tool	https://www.sei.org/projects-and-tools/tools/leap-long-range-energy-alternatives-planning-system/
Energy Forecasting Framework and Emissions Consensus (EFFECT) Tool	www.esmap.org/esmap/EFFECT
Energy Efficient Cities Case Studies Database	http://www.esmap.org/node/231
Options and Guidance for the Development of Baselines	https://www.thepmr.org/system/files/documents/PMR%20Technical%20Note%205.pdf
RETScreen Clean Energy Management Software	https://www.nrcan.gc.ca/maps-tools-publications/tools/data-analysis-software-modelling/retscreen/7465
Stock Taking Tool	https://www.transparency-partnership.net/documents-tools/stock-taking-tool
Tool for rapid assessment of city energy (TRACE 2.0)	https://esmap.org/TRACE
ClearPath	https://icleiusa.org/clearpath/
carbonn Cities Climate Registry (cCCR)	https://sustainabledevelopment.un.org/partnership/?p=220
EMEP/EEA Emission Factor Database	https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/emission-factors-database
Citiesact.org – Air Quality, Climate, Transport and Energy Portal	https://www.cleanairinitiative.org/portal/node/2348/
EPA Energy Star Portfolio Manager	https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager
EPA_Using WARM Emission Factors for Materials and Pathways Not in WARM	https://www.epa.gov/sites/production/files/2016-03/documents/using_warm_efs_for_materials_and_pathways.pdf
Harmonized Emissions Analysis Tool plus (HEAT+)	http://heat.iclei.org/heatplusv5/indexnew.aspx

[113] https://climateknowledgeportal.worldbank.org/

Tool	Link
Integrated Enviornmental Assessment (IEA) Platform	https://www.unenvironment.org/integrated-environmental-assessment
Practical Evaluation Tools for Urban Sustainability (PETUS)	http://www.petus.eu.com/
Street Lighting Evaluation Tool	https://superefficient.org/tools/street-lighting-tool
Tool Finder for Local Government Clean Energy Initiatives	https://www.epa.gov/statelocalenergy/tool-finder-local-government-clean-energy-initiatives
US Local Government Operations Protocol	https://www.theclimateregistry.org/tools-resources/reporting-protocols/local-goverment-operations-protocol/
US Recycling and Composting Emissions Protocol	https://icleiusa.org/publications/recycling-composting-emissions-protocol/
Waste Reduction Model [WARM]	https://www.epa.gov/warm
MEASUREMENT, REPORTING AND VERIFICATION	https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf

Annex 3: List of measures used to reduce energy demand

Multiple measures can be implemented by the local authorities to achieve emissions reductions, and based on their unique challenges, needs, and capacity, the local stakeholders and decision-makers can choose the most appropriate measure for themselves.Figure below highlights 55 example measures that have been successfully implemented by different municipal and city authorities.

These 55 listed measures not only satisfy the needs of local context but have also positively contributed to a reduction in GHG emissions. The measures in the table are grouped into the following eight focus areas –

(i) planning and development;
(ii) Buildings (municipal, commercial and residential);
(iii) District heating;
(iv) Power;
(v) Lighting;
(vi) Transport (municipal, public and private);
(vii) Waste (solid waste and wastewater); and
(viii) Water.

Table 14 - 55 Successful Measures

Focus	Measure	Example
Planning and Development	Create an energy efficiency or green growth Municipal Task Force	Barcelona Energy Agency, Spain
Planning and Development	Create an Energy Efficiency Strategy and Action Plan	Integrated resource planning and management, Stockholm, Sweden
Planning and Development	Create a Capital Investment Plan	Toronto Atmospheric Fund, Canada
Planning and Development	Update Procurement policies (Purchasing and Service Contracts)	Municipal procurement, Vienna, Austria
Power	Energy Performance Contracting	Performance Contracting, in Akola, India
Transport	Municipal Vehicle Fleet Efficiency Program	NYPD hybrid vehicle program, New York, USA
Commercial Buildings	Rooftop Solar for Commercial Buildings	Tiffany and Company, Whippany and Parsippany, New Jersey
District Heating	District Cogeneration Thermal network	District heating network, Bishkek, Kyrgyzstan
District Heating	District Heating Network Maintenance and Upgrade Program	District heating network pipe maintenance, Seoul, Korea
District Heating	Solar District Heating	Seasonal Storage Solar District Heating, Rio Vena, Burgos, Spain
Water	Pumps and Motor Drives	Water Treatment Plant, San Juan, Puerto Rico
Power	Explore Renewables	Community Based Micro Hydropwoer, Long Lawen, Sarawak, Malaysia
Lighting	City-Wide Integrated Public Lighting Assessment Program	Energy Efficiency Public Lighting Project, Vietnam
Lighting	Street Lights Audit and Updating Program	ESCO street light retrofit, Akola, India
Lighting	Traffic Signals Audit and Retrofit Program	LED traffic lights retrofit, Hong Kong, People's Republic of China
Lighting	Public Spaces Lighting Audit and Retrofit Program	Park and waterfront lights retrofit, Melbourne, Australia
Lighting	Lighting Timing Program	Motorway intelligent lights retrofit, Kuala Lumpur, Malaysia
Lighting	Lighting Infrastructure	Municipal Energy Efficient Publi Street Lighting, Rio de Janeiro, Brazil
Planning and Development	Municipal Buildings Energy Efficiency Task Force	Ekurhuleni Metropolitan Municipality (EMM) Energy Efficiency Strategy, South Africa
Municipal Buildings	Buildings Benchmarking Program	Energy Management Systems in Public Building, Lviv, Ukraine
Municipal Buildings	Municipal Schools Audit & Retrofit Program	Energy Agency of Podravje, Slovenia
Municipal Buildings	Municipal Residential (Public Housing) Audit & Retrofit Program	'"Warm and comfortable living" Campaign, Amersfoot, The Netherlands
Municipal Buildings	Municipal Hospitals Audit & Retrofit Program	Bhubaneswar Municipal Hospital, India
Water	Solar Hot Water Program	Energy Efficiency Strategy, Ekurhuleni, South Africa
Residential Buildings	Mandatory Building Energy Efficiency Codes for New Buildings	Energy Efficiency Codes in Residential Buildings, Tianjin, China
Residential Buildings	Green Building Guidelines for New Buildings	Green Building Guidelines, Cape Town, South Africa
Residential Buildings	Installing Cool Roofs	NYC Cool Roofs, New York, NY
Transport	Public Transportation Vehicles	Vehicle scrapping and replacement program, Cairo, Egypt
Transport	Public Transportation Development	Land Use and Public Transport Planning, Curitiba, Brazil
Transport	Development of Bike Sharing System	Hangzhou Public Bicycle Sharing System, China
Commercial Buildings	Establish Mix Use Developments	Redevelopment of Hammarby Sjöstad, Sweden
Transport	Transportation Congestion Management	Congestion Pricing in London, UK
Transport	Road Diet	Road Diet Reconfiguration in Portland, Oregon, US
Power	Create a Solar Map to Promote Renewables Generation in the City	San Francisco Energy Map and GoSolarSF Program
Transport	2-Stroke Engine Replacement or Retrofit	CNG baby taxis program, Dhaka, Bangladesh
Transport	Parking Restraint Measures	Parking fees, Aspen, US
Transport	Traffic Restraint Measures	Motorcycle ban, Guangzhou, China
Transport	Congestion Pricing	Congestion Charge, Stockholm
Transport	Non-Motorized Transport Modes	Dedicated cycle network, Bogota, Colombia
Transport	Deployment of Electric Vehicle Charging Infrastructure	New Home EV Charging Infrastructure in Koto City, Japan
Water	Prioritizing Energy Efficient Water Resources	Gravity-fed Schemes, Moyamba Township, Sierra Leone
Water	Water Meter Program	Kagiso Project, Mogale City, South Africa
Water	Improve Performance of System Networks	System optimization to improve energy efficiency in water supply, Monclova, Mexico
Water	Promote Water Demand Restrictions	Bonus Program, Sao Paulo, Brazil
Waste	Waste Vehicle Fleet Maintenance Audit and Retrofit Program	Energy Study on Oeiras' Municipal Fleet, Oeiras, Portugal
Waste	Waste Composting Program	Solid Waste Composting, Lahore, Pakistan
Waste	Waste Infrastructure Planning	Solid Waste Management Project, Dhaka, Bangladesh
Waste	Landfill Gas Capture Program	Sanitary Landfill Gas CDM Project, Ho Chi Minh City, Vietnam
Waste	Intermediate Transfer Stations	Kuala Lumpur Waste Structure Plan 2020, Kuala Lumpur, Malaysia
Waste	EE Sorting and Transfer Facilities	Community Materials Recovery Scheme, Naga City, Philippines
Waste	Waste to Energy Program	Abidjan Municipal Solid Waste-To-Energy Project, Abidjan, Ivory Coast
Water	Improve Efficiency of Pumps and Motors	No- and low-cost Energy Efficiency Measures, Pune, India
Water	Active Leak Detection and Pressure Management Program	Pilot Leak Detection and Abatement Program, Iasi, Romania
Waste	Sludge Beneficial Reuse Program	Sofia Energy Centre, Greece
Water	Improve Performance of System Networks	System optimization to improve energy efficiency in water supply, Monclova,

The policymaker has many ways of achieving these energy, and emissions reductions.

The following presents a description of each type of measure that can be employed:

Prescriptive Measures

Minimum efficiency performance standards (MEPS),
MEPS are most commonly applied to municipal procurement. MEPS most directly affects equipment manufacturers and importers—preventing them from selling inefficient equipment.
MEPS can be particularly useful in buildings and appliances that are widely used, are high energy consumers, or are in-use for long periods. Vehicles, traffic lights, lighting, refrigerators, transformers, and electric motors are prime examples. There are various ways to improve the efficiency profile of product that are procured, including:

- encouraging the purchase of higher efficiency products,
- discouraging the purchase of low-efficiency products, and
- encouraging the continual improvement of efficiency standards.

Support from climate finance could allow the jurisdiction to introduce tighter standards than those mandated at a national level, support the necessary infrastructure for their accelerated introduction, such as charging stations for electric vehicles, accelerating the market transition towards more efficient appliances.

Negotiated agreements
Negotiated agreements involve contracts used primarily between local governments and commercial and industrial enterprises, which outline energy use or CO_2 emissions targets and schedules, and provide compensatory support and concessions from the government. These can be grouped into six types (Tanaka 2011):

- <u>Completely voluntary agreements</u>
  This type has no tangible 'stick' or 'carrot' incentives, and usually, there is uncertainty about their effectiveness.
- <u>Agreements with penalties/rewards</u>
  This type includes penalties or rewards and promotions. In China, the top 1000 enterprise scheme affects promotion and salary.
- <u>Agreements with annulments/exemptions from existing measures</u>
  This type awards preferential treatment (for example, tax exemption) for signing the agreement and achieving its targets and rescinds it if the objectives are not met. Because of the ties to other policies, they are usually introduced as part of a policy mix.
- <u>Agreements with the threat of future regulation</u>
  This type is tied to preferential treatment concerning future policy, perhaps a costly regulation or tax. Uncertainty can be high if the details of the future policy are not known or there is a doubt on the government's long-term ability to follow through on the agreement.
- <u>Agreements with government support for actions the targets</u>
  This type includes support from the government in the form of recognition, awards, and financial support for energy management, capacity building, identification of opportunities, technical information, and site visits by experts.
- <u>Agreements with publicity recognition of compliance or non-compliance</u>
  This type involves public disclosure of sectors' or companies' compliance or non-compliance with the targets.

Where the agreements can lead to an acceleration of the introduction of energy efficiency measures or enhanced efficiency standards, climate finance could be applicable to facilitate the process.

Energy management requirements

Energy management requirements are another policy approach to encourage the city itself and firms to employ energy management processes by regulations, such as the requirement of an energy manager or reporting of audit results; and setting standards for energy management.

Funding from climate finance could support the establishment of such agreements.

Economic Measures

Economic policies used to promote energy saving can take the form of incentives (for example, favorable tax treatment and subsidies) or disincentives (taxation and cap-and-trade schemes).

Most companies are sensitive to costs, but those in some sectors are more sensitive to energy and CO_2 taxes and emissions pricing than others. For example, the cement industry is susceptible to energy costs while in the paper, and pulp industry energy cost is not seen to have a significant impact on gross investment. In the paper and pulp industry 1) energy expenditures are a small proportion of the total production cost, (2) cost of equipment installation is much higher than the energy savings gained and (3) Industry generally requires a maximum of three year payback period on energy-saving equipment, therefore paper and pulp industry is less responsive to economic measures.

Funding from climate finance can make a difference here by leveraging access to lower-cost capital, demonstrating international support for the energy efficiency proposal, and supporting the MRV process needed to demonstrate emissions mitigation impact of economic measures.

Energy or carbon taxes

An energy or carbon tax is a surcharge on fossil fuel consumption. As the tax applies to CO_2 emissions from these fuels, it further disincentivizes the higher emitting fuels (coal) as opposed to lower emitters (natural gas). Its purpose is to give energy consumers an incentive to use alternative energy sources and improves the cost-benefit analysis of using these when compared to fossil fuels. The tax income that it generates is often used to offset other taxes[114] and to raise revenue for the government to help finance public spending on clean and sustainable energy solutions. Some economies combine this concept with prescriptive measures into a "cap and trade" program (see below). An initial consideration in applying a carbon tax is how to phase-out fossil fuel subsidies, which were implemented by many countries to incentivize national production but provide a perverse incentive limiting the adoption of alternative low emission energy sources. Currently, Some 40 countries and more than 20 cities, states, and provinces have implemented carbon pricing mechanisms, which cover about half their emissions, and translates to about 13 percent of annual global greenhouse gas emissions[115].

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[114] An example of this is Canada. Provinces and territories are allowed to create their own system of carbon pricing but In the absence of a provincial system, the 2018 federal Greenhouse Gas Pollution Pricing Act (GHGPPA) implements a regulatory fee in which 90% of the revenues are returned to tax-payers.

[115] Source: World Bank Pricing Carbon. https://www.worldbank.org/en/programs/pricing-carbon

Directed tax reductions, other financial incentives, and non-tax, financial incentives, such as subsidies, preferential loans, and R&D funds

These can be applied to encourage energy efficiency investment by lowering the financial risk and reducing barriers when companies invest in new or additional technology. These can reduce the risk to the investor and lower the cost of capital, especially important when the energy efficiency project has payback times longer than standard. Subsidies are popular measures in many countries. Preferential loans or loan guarantee schemes for energy efficiency investment are used in fewer countries.

Capital Cost Allowance systems

Capital Cost Allowance systems can encourage investment in energy-efficient equipment by accelerated depreciation. These take the form of an annual tax deduction that can be claimed on depreciable assets[116] as a percentage of the asset's cost for several years.

Supportive policies

Supportive policies consist of informational, analytical, and institutional development measures, which help to establish a favorable environment to implement energy efficiency actions. They help companies and end-users see and act on their energy efficiency interests as defined by the market and also by other policies. They may be a preliminary step leading to regulations, negotiated agreements, and taxes, or they may be supplementary to these other policies—enhancing and verifying their effects.

These can take the form of:

- identification of opportunities for energy saving/conservation;
- capacity building through advice, training, information sharing, and education;
- public disclosure of energy efficiency efforts and achievements of Industry; and
- supportive measures in which the government works together with the energy consumer to promote their efforts for energy saving and increase their capacity to do so.

Supportive measures are usually low cost (in comparison with other measures). They are only somewhat effective as stand-alone programs in reducing energy use or CO_2 emissions. Still, their crucial contribution is increasing the cost-effectiveness of the various other prescriptive and economic measures. Companies need these supportive resources to translate market and policy incentives into cost-efficient technical actions; governments need these resources better to understand the opportunities and barriers to improved energy efficiency and to design policies and measures accordingly. (Tanaka 2011)

Climate finance is ideally suited to support such measures where its inclusion in a proposal leverages the effectiveness of other regulatory or economic measures.

Direct Investment

Direct government investment in energy-efficient equipment and processes is typical for City-and municipal expenditures and tends to be project-specific. Grants, from international funding agencies and NGOs, are often applicable to pilot operations, but usually, less-so to full-scale production or roll-out.

Where grant funding is used as part of a blended finance package to generate preferential loans, this would be considered above in "Economic measures."

[116] such as buildings, plant and equipment, or machinery, as well as additions and improvements to such assets