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Developing clean energy solutions in Latin America's major cities

An introduction for subnational energy policy decision-makers

PUBLICATION

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The Carbon Trust prepared this report based on an impartial analysis of primary and secondary sources. The Carbon Trust is an organisation of independent experts with the mission to accelerate the move to a sustainable, low carbon economy. We operate globally from London, Cardiff, Edinburgh, Washington DC, Beijing, Delhi, Johannesburg, Rio de Janeiro, and Mexico City.

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LIST OF ABBREVIATIONS

BEA: Sustainable Energy for All Building Efficiency Accelerator
BNDES: Brazilian Economic and Social Development Bank
BRT: Bus Rapid Transit
CCFLA: Cities Climate Finance Leadership Alliance
CEETI: City Energy Efficiency Transformation Initiative
CFF: C40 Cities Finance Facility
CHP: Combined Heat and Power
COP21: 21st Conference of the Parties to the United Nations Framework Convention on Climate Change
CTF: Clean Technology Fund
EnPC: Energy Performance Contracting
ESCI: IDB Emerging Sustainable Cities Initiative
ESCO: Energy Service Companies
ESMAP: Energy Sector Management Assistance Program
ETS: Emission Trading Schemes
FACC: Fondo Ambiental de Cambio Climático
FIDE: Mexico Electric Energy Savings Trust
GCF: Green Climate Fund
GEF: Global Environmental Facility
GHG: Greenhouse gas(es)
GPC: Global Protocol for Community-Scale GHG Inventories
HEAT: Hands-on Energy Adaptation Toolkit
IDB: Inter-American Development Bank
IRENA: International Renewable Energy Agency
LCCDP: Rio de Janeiro Low Carbon City Development Programme
MACC: Marginal Abatement Cost Curves
MIT: Massachusetts Institute of Technology
MRT: Mass Rapid Transit
MRV: Measurement, Reporting and Verification
NGOs: Non-Governmental Organisations
OECD: Organisation for Economic Co-operation and Development
PPP: Public Private Partnership
SET: Stakeholder Engagement Tool
TRACE: Tool for Rapid Assessment of City Energy
UNFCC: United Nations Framework Convention on Climate Change
WRI: World Resources Institute

Table of contents

TABLE OF FIGURES

TABLE OF TABLES

Executive Summary

"To transform our world, we must transform its cities"

Ban Ki-Moon

This publication is intended to help sub-national energy policy decision-makers of major Latin American cities as they look to develop and implement clean energy solutions. Our aim is to help local actors to understand, plan and execute initiatives successfully which, over time, will:

- **Save money, while increasing energy security**
- **Increase standards of living and the supply of more efficient and sustainable energy solutions**
- **Reduce the overall use of energy and greenhouse gas emissions**

While each city has its own individual circumstances, many common challenges are faced by major cities which can prevent the uptake of opportunities for improved energy management, energy efficiency and innovation in their energy systems. Due to the sheer size and complexity of large and megacities such challenges are typically exacerbated; yet the scale of the opportunities and related potential benefits are also much more significant. Clean energy solutions have delivered substantial benefits to millions of citizens and thousands of businesses and civic institutions, providing material positive social, economic and environmental impacts. It is for these reasons that this publication has its focus on large and megacities, which collectively we refer to as 'major cities'.

We first focus on the reasons why cities have become the primary focus of clean energy solutions, and then reference the key challenges to energy planning faced by major cities with respect to limited technical and financial capacity and complex governance contexts. We outline these and other key challenges and provide illustrative strategies to overcome these challenges. With the background context set, the subsequent sections cover **six building blocks to clean energy planning** in the context of major cities in Latin America, highlighting some of the ways in which Latin American cities are responding to these challenges. We set out key recommended actions that city governments can take to support the necessary expansion of investment into energy efficiency and renewable energy. These are accompanied by supporting case studies and an overview of the relevant initiatives and tools which can facilitate material progress.

The context of cities

Cities have a vital role to play in leading the clean energy transition: they consume over two-thirds of the world's energy, and are responsible for as much as 70 percent of man-made greenhouse gas (GHG) emissions.[1,2] Furthermore, the impact of cities will grow: global urban population is expected to rise by 1.63 percent per year between 2020 and 2025, increasing the proportion of energy use and wealth generation in urban areas.[3] As global demographics transform there is a related rise in the number of large and megacities, megacities being urban areas with over 10 million inhabitants, and large cities defined here as urban areas in the five to 10 million population range. Latin America is one of the world's most urbanised regions, with over 80 percent of its population living in cities. The region is currently home to five megacities (Buenos Aires, Lima, Mexico City, Rio de Janeiro and São Paolo). It is anticipated that by 2050 over 86 percent of Latin America's population will live in urban areas.[4]

The strain placed on major cities by increased urbanisation is immense and the implications are clear: **efforts are needed to support the further economic and social development of the region, while also reducing Latin America's use of carbon intensive energy**. To be consistent with the requirements of the Paris Agreement (negotiated at UN COP21), cities need to develop 1.5 degree compliant climate action plans. As is reflected in national and international climate programmes, clean energy use will be integral to these plans, depending primarily on the deployment of energy efficient technologies and behaviours and solutions for renewable energy generation. Sub-national decision makers in cities must provide the leadership necessary to empower this transformation.

Renewables are most productive when harvesting the resources where they are most richly available, yet are most cost effective when deployed close to the end user. This necessitates increasingly integrated energy systems able to cope with the geographical, political and commercial challenges of deploying renewable energy in and near to cities. Cities therefore need to drive demand for renewable energy generated outside the city boundary, while also pursuing opportunities for renewable energy generation within the city boundary.

Common challenges

Influenced by a combination of factors relating to geography, history, topography, climate, politics, governance structures and jurisdictions, finance, human and natural resources, each city is presented with its own particular set of opportunities and challenges. Nonetheless, there are challenges commonly faced by all of Latin America's major cities. These challenges can relate to:

- **Multitude of stakeholders:**
    - co-ordination of multiple urban municipalities and stakeholders, and different levels of government with jurisdiction over different matters.
- **Financial constraints:**
    - scale of finance needed to develop large and complex projects;
    - credit-worthiness and debt limits making it difficult to access affordable finance at scale;
    - the need to divert funds away from financing high carbon infrastructure to financing low carbon projects in developing cities; and
    - a lack of capacity and skills among sub-national officials and commercial banks to analyse and lead energy efficiency and renewable energy investments.
- **Time constraints:**
    - lengthy timeframes to carry out detailed techno-economic feasibility studies for large and often complex projects; and
    - overall project development timeframes which may exceed the lifespan of elected city administrations.
- **Project complexities:**
    - sourcing data from across the city;
    - complexity and transaction costs involved in implementing many multiple smaller projects;
    - lack of understanding of the benefits and co-benefits of action, such as air quality, health and cost savings, which could integrate energy planning with other strategic priorities; and
    - lack of city level clean energy plans and inventories consistent with a 1.5 degree target.
- **Cross-cutting challenges:**
    - projected population growth and economic development increasing demand for energy;
    - population growth and economic development putting further pressure on already strained infrastructure and services; and
    - urban sprawling and its associated informal and often illegal patterns of land use, typically characterised by poverty and a lack of infrastructure, public facilities and basic services.

Recommended areas for action

To address these issues major cities will have to take robust action to improve the effective management of energy consumption, to raise awareness, to increase capacity and to rapidly and materially increase the deployment of clean energy technologies. These key challenges and areas for action can be grouped into six building blocks:

1. **Policy - Aligning legal, policy and regulatory structures to foster sustainability.**
    - City governments should take a lead in developing and implementing policy to facilitate and nurture effective energy management, energy efficiency, and the adoption of renewable energy generation.
2. **Governance - Dealing with vertical coordination and multiple governance structures.**
    - City governments need to work within and beyond their own administrative boundaries, actively coordinating and collaborating between individual ministries and departments and also with neighbouring, regional, national and international actors.
3. **Project prioritisation - Identifying and prioritising projects to maximise energy savings.**
    - City governments need to tailor national level clean energy solutions to reflect the specific circumstances and opportunities for their city, based on objectively quantified project prioritisation.
4. **Stakeholder engagement - Engaging and managing a multitude of diverse stakeholders.**
    - Cities need to develop and implement effective stakeholder engagement strategies as a core part of any clean energy programme they undertake.
5. **Finance - Accessing finance and redirecting it to low carbon energy projects.**
    - Cities need to research and identify appropriate and sometimes novel sources of finance, prepare investment-ready projects and aggregate those projects to make them attractive to financiers.
6. **Resilience - Improving the resilience of the energy system.**
    - Cities need to increase the resilience of their energy systems, in particular the ability to maintain the city's electricity network and other energy infrastructure in the face of extreme weather events.

As Latin America continues to promote economic growth and social development within the reality of increased urbanisation, a city-led movement to transform the uptake of energy efficiency and implementation of renewable energy generation will be decisive in defining sustainable success across the region. Several overarching conclusions are clear:

- Cities, and notably major cities, must be the primary focus of clean energy solutions in Latin America.
- Using energy more efficiently presents an essential opportunity for cities to increase their energy security.
- Cities in Latin America are taking positive steps to advance clean energy planning. Focus on robust planning must be maintained, while recognising there are big hurdles to address in turning these plans into implemented policies and investments, in order collectively to meet the Paris Climate Agreement commitments.
- There are opportunities which lie within the reach of city governments to raise standards of living in cities while simultaneously leading the way in the implementation of clean energy solutions. Meeting these dual objectives will require increased technical support, financial and commercial capacity and expertise, robust stakeholder engagement, city to city collaboration, and highly focussed political will at all levels of government.

1. Introduction

This publication is intended as a guide to help sub-national energy policy decision-makers of major Latin American cities as they look to develop and implement sustainable solutions. Our aim is to help local actors to understand, plan and execute initiatives successfully which, over time, will:

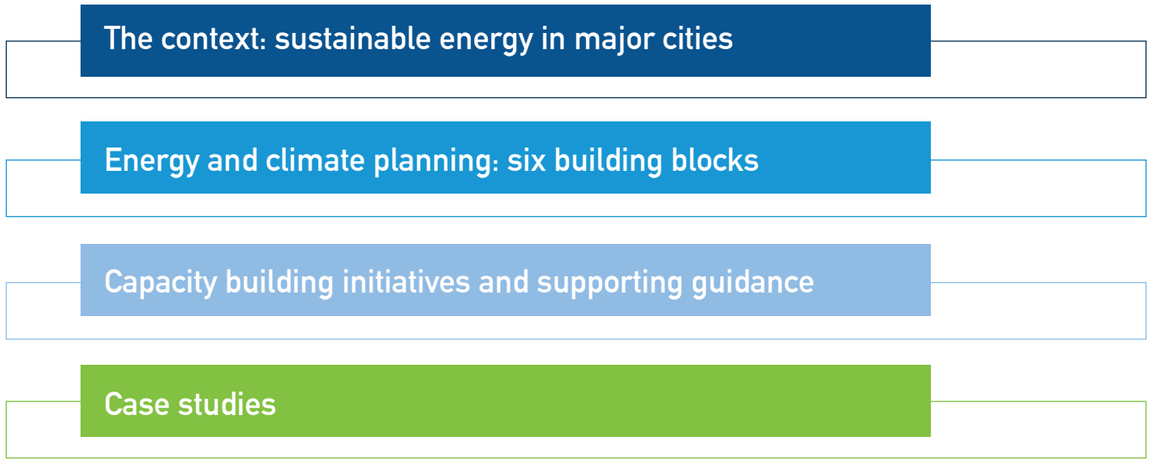
- **Save money, while increasing energy security**
- **Increase standards of living and the supply of more efficient and sustainable energy solutions**
- **Reduce the overall use of energy and greenhouse gas emissions.**

To support this transition, this publication provides examples of successful climate change mitigation and adaptation actions from all major areas of energy use, including transport, buildings, and public services.

This guide first focuses on the reasons why cities have become the primary focus of clean energy solutions, and then highlights some key challenges to energy planning that major cities face. With the background context set, the subsequent sections cover the six building blocks to clean energy planning in the context of major Latin American cities, and put forward solutions to overcome common challenges associated with these building blocks.

This publication has been developed from existing sources of knowledge and experience documented in national and international energy planning and climate change publications. This knowledge base has then been complemented by presenting a number of specific challenges and opportunities which are associated with the transition to clean and sustainable energy systems in major cities, with specific focus on Latin America.

Figure 1 – Structure of the report



Which cities is this guide aimed at?

This guide is primarily aimed at sub-national/local city energy policy decision-makers in major Latin American cities, i.e. large and megacities. Megacities are usually understood as a continuous metropolitan or urban area (this guide uses the latter) with a total population greater than 10 million.[i] Large cities defined here as urban areas in the 5-10 million range.

Megacities in the world have tripled in number since 1990[5], and some estimates say that two thirds of the world's population will be living in cities by 2030.[6] The global urban population is expected to grow approximately 1.63 percent per year between 2020 and 2025, this will be matched by growth in both prosperity and energy use, and, as a consequence, increased carbon emissions.[7] Population growth and energy consumption are arguably interlinked, and energy consumption in turn is linked to greenhouse gas emissions. It is estimated that cities globally with high levels of population growth account for more than 70 percent of growth in urban energy use.[8]

Individual cities differ from one another due to a number of factors including local differences in geography and topography, politics, governance structures and jurisdictions, finance, climate, natural resources, and more. Despite their individual differences, large and megacities share common challenges, as well as attributes and opportunities, which will be highlighted throughout this document.

Megacities and large cities are a particular focus for future energy planning because their continued growth, and associated expected increase in energy demand, presents significant challenges. Equally, this presents opportunities for improved energy management and innovation, which could result in satisfying the energy needs of the population in a cleaner and cost-effective, resource efficient way, taking advantage of economies of scale. The higher concentration of population in urban areas, if successfully planned and adequately managed, has the potential to deliver reductions in overall per capita demand for resources and services such as occupied land, transport and building energy, treated water, and the collection of solid and liquid waste.[9] Moreover, dense, mixed-use urban forms are uniquely positioned to reduce the unit cost of transport and energy infrastructure and enable the adoption of efficient transit systems and low carbon heating and cooling networks.[10]

That said, the rapid demographic and economic growth of major cities in Latin America (and elsewhere) has commonly led to urban sprawling. Sprawling can be seen as an undesired effect of expansion, leading to a landscape of informal and often illegal patterns of land use, typically characterised by poverty and a lack of infrastructure, public facilities and basic services. Sprawling presents particular challenges for successful urban planning, including the planning of sustainable energy systems.[ii] [11]

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i There are three distinct methods used to determine the size of cities based on population. These are often confused:

- The concept of municipal population – this is the population within the administrative boundary or political jurisdiction of a single municipal or city government. We do not use this definition here, as it often does not relate to the total size of a city as a social and economic unit. Many cities comprise multiple municipalities, and some municipalities include nearby rural areas.
- The concept of labour market area, also known as metropolitan area, which incorporates areas nearby to the main urban area that rely on the latter for jobs and services, and that are well connected by road and public transport. However, there is no commonly accepted definition of this dependence.
- The concept of urban area – this is a measure of the population of a continuous urban area or urban agglomeration. This is a more useful definition, giving a good indication of the size of the dense urban land area potentially suitable for large-scale building retrofit, mass transit or district energy projects.

ii Sprawling is most likely to be an ongoing problem where cities and their surrounding areas have (i) uncoordinated planning systems; (ii) ineffective enforcement regimes; (iii) overlaps of formal and informal systems; and (iv) fragmented urban governance. More compact cities with higher population density - with associated benefits for planning and delivering energy and other infrastructure and services - can emerge more easily where urban population growth is slower, and where planning and enforcement regimes are effective and operate within formal and strategic systems of governance, including the presence of distributive justice. A famous example where long-term positive outcomes have been achieved is Curitiba in Brazil, where strategic, integrated urban planning, focused on sustainability and adhered to over several decades, has delivered high density development concentrated along linear BRT corridors, with land use and transportation planning closely linked, and where zoning ordinances for urban development actively foster high density.

2. The context: Sustainable energy in major cities

A. PROMOTING SUSTAINABLE ENERGY IS KEY IN MAJOR CITIES IN LATIN AMERICA

Based on the definition of megacities as a continuous urban area with a total population greater than 10 million, five of the 28 megacities worldwide are located in Latin America: São Paulo (21.3m), Mexico City (20.1m), Buenos Aires (14.1m), Rio de Janeiro (12.7m) and Lima (10.8m).[12] In the coming years, it is expected that the 700 cities worldwide with population in the five to 10 million range will drive the majority of growth in energy use, with many growing into megacities. Latin America has several of these cities with 5-10 million population in their continuous urban area, such as Bogotá, Santiago (Chile), Caracas, Guayaquil (Ecuador), and several cities in Brazil.

Why are we addressing large and megacities?

Latin America, which is home to five megacities, is currently the most urbanised region on the planet with around 80 percent of the population living in cities. This figure is expected to rise to 86 percent by 2050.[13] With an expected yearly economic growth rate of 0.85 percent over the next 20 years, Latin America would be likely to see its energy needs increase correspondingly.[14]

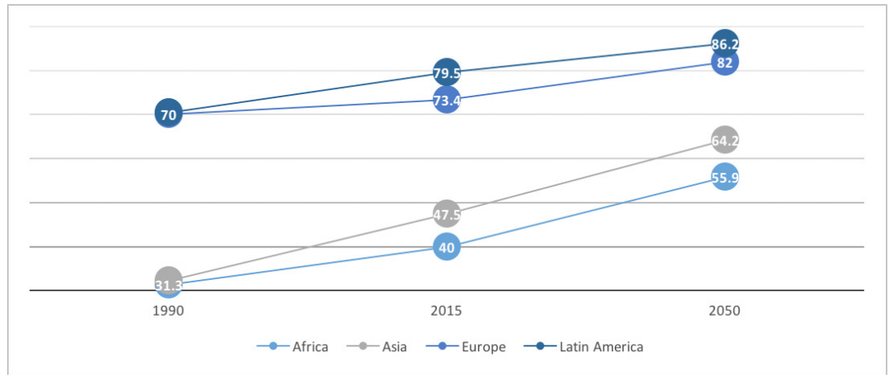
Table 1 – Annual percentage of population residing in urban areas in Latin America

Country	1990	2015	2050
Argentina	65.3	91.8	94.7
Brazil	36.2	85.7	91.0
Chile	58.4	89.5	93.1
Mexico	42.7	79.2	86.4

Source: UN DESA, Population Division (2014). World Urbanization Prospects: The 2014 Revision

With the continued trend of urban growth and the concentration of populations and of energy consumption in cities, it clearly must be a priority to promote and plan for the sustainable provision and use of energy in Latin America's major cities.

Figure 2 – Annual percentage of population residing in urban areas, 1990-2050



Source: UN DESA, Population Division (2014). World Urbanization Prospects: The 2014 Revision

B. SOME KEY CHALLENGES FACED BY MAJOR CITIES

Challenges to energy planning are exacerbated in major cities

Large-scale urban environments share common challenges that could prevent opportunities for improved energy management and innovation from being implemented. These relate, inter alia, to: (a) complex governance contexts, including multiple jurisdictions; (b) timing constraints associated with electoral cycles; (c) engaging with and managing a complex multitude of stakeholders (d) large-scale energy planning; and (e) accessing affordable finance at scale. These challenges - which as a function of scale are typically even more complex in the largest cities, particularly megacities - spread across the six building blocks of energy planning in major cities. These are covered in more detail in the next section of this document.

Cities in general face a number of challenges associated with clean energy planning, both from a demand and supply perspective. Cities often find it challenging to: engage with and coordinate across multiple stakeholders; provide long-term policy certainty to investors and developers; and also to manage complex legal and commercial issues. A large proportion of the challenges faced by cities is linked to the design and delivery of projects, in particular project prioritisation and the ability to achieve investable project scale. Controlling energy investment decisions, as with other infrastructure investment, is complicated yet necessary to make good investment decisions. Difficulties arise in measuring and capturing revenue streams and co-benefits, and more generally in providing adequate information on cash flows, risks and guarantees to project funders.

Due to the size of the projects being taken forward in large and megacities there are higher risks and additional challenges to be faced. The challenges faced by large and megacities can be grouped into the following categories, as shown in Figure 3: the multitude of stakeholders (and associated governance issues which require efficient vertical coordination), financial constraints, time constraints, the complexity of the projects to take forward, and the cross-cutting issue that also impacts and complicates all the other aspects: that of managing the rapid growth of the city.

Figure 3 – Challenges faced by major cities

Multitude of stakeholders	Financial constraints	Time constraints	Project complexities	Cross-cutting
Lack of effective governance structures	Rules of engagement	Election cycles	Capacity requirements	Managing rapid growth
Insufficient coordination	Project finance	Project timeframes	Data collection and information management	
Lack of vertical coordination	Risks of clean projects		Scaling project investments	
Transboundary projects	Credit requirements		Calculating savings	
	Capital requirements			
	Fossil fuel subsidies			

Source: The Carbon Trust

What are the challenges associated with a multitude of stakeholders?

The challenges associated with a multitude of stakeholders often revolve around vertical coordination, overlapping functions, transboundary projects and insufficient coordination and cooperation.

Vertical coordination is one of the biggest challenges faced by large and megacities, who face overlapping subnational jurisdictions, with whole-of-city government and planning structures sitting above individual municipalities. Overlapping competencies of national, regional and local levels increase the complexity of urban decision-making, with more actors having veto powers. Cities must work beyond their own administrative boundaries, collaborating with regional and national-level actors to ensure the national and international infrastructure that supplies them is also transformed to meet future targets at both city and national level. This point acknowledges the fact that most major cities are net consumers of energy, i.e. they must buy in energy from outside of city or municipal boundaries, which further implies high degrees of cooperation across boundaries of jurisdiction.

Projects usually span across a variety of sectors and activities such as transport, waste, district energy, and building retrofit, multiplying the number of decision makers involved as well as exacerbating issues of budgeting and constrained public funding. It is not uncommon that stakeholders have little incentives to cooperate. Local governments need to balance multiple priorities, including prosperity projects, access to electricity and water, health, education, and poverty reduction. Intervention from national level may become necessary to resolve conflicting views between stakeholders.

Another challenge of overlapping jurisdictions is that it is not always well defined who has control over assets at the subnational level. It has been estimated that cities might lack influence over budgets and ownership for around a third of their assets and functions. This creates additional challenges for the design and delivery of locally appropriate and effective solutions for energy systems and the delivery of action. Energy systems are most deliverable where cities hold considerable authority and influence over decision-making and have budgetary powers over their assets. For instance, it is key to ensure that cities have the ability to control key elements of their tax base and monetise efficiencies such as cheaper transport and energy savings. Section III-E on Financing and Delivery Models further highlights the role of tax revenues.

In developing their own clean energy strategies, large and megacities must manage the complexity of vertically integrating these strategies (and the resulting projects) with national energy and infrastructure strategies and plans (and indeed, national climate change strategies and plans aligned with international agreements such as the UN COP21 and G20 agreements). Large cities need to constantly engage and facilitate the transfer of information between stakeholders; sharing ideas and connecting strategies will ensure that city energy programmes and actions align across the city and with national concerns such as energy security and Nationally Determined Contributions (NDCs) to climate change action. Given the concentrated proportion of national energy consumption occurring within cities, subnational governments should, wherever possible, implement actions that support (or go beyond) national governments' climate, energy and growth strategies and commitments. This alignment and vertical coordination is key, yet it is especially challenging where national governments are of a different political party than the one in power at the city level, or when priorities between different local government entities or departments conflict.

To ensure efficient vertical coordination and transboundary project progression, large and megacities need to minimise duplications and manage overlapping functions effectively. Multiple layers of governments and municipalities, and multiple government departments themselves, need to maximise coordination. Examples include common procurement standards that ensure minimum energy efficiency standards, or shared waste collection and recycling facilities across neighbouring municipalities. One example that illustrates the potential complexity involved in energy planning at the city level - and the coordination issues that may arise - is the transport sector, where solutions involve a combination of urban density, city-wide planning and city-wide mass transit infrastructure, which will often require the involvement of different levels and entities of government (including where the transit network needs to serve urban areas which stretch across borders between multiple different municipal and/or state and/or regional government territories, as is the case for megacities such as Mexico City).

Box 1 - Mexico City: A megacity within a complex jurisdictional matrix

Greater Mexico City, officially called Mexico City Metropolitan Area (Zona Metropolitana del Valle de México) provides an example of the complexity and governance challenges that large and mega cities face. The city is composed of 76 municipalities across Mexico City, and the States of Mexico and Hidalgo, and hence combines many different legislations.

Considering that on average 82 percent of the income at state level comes from federal sources in Mexico and that competencies within the states are limited to matters such as transportation, water, urban land use, waste and buildings, the City has relied largely on federal guidance and resources to carry out urban development activities. Additionally, Mexican legislation forbids metropolitan government councils.

This lack of coordination between multiple authorities within Mexico City's metropolitan area has exacerbated governance issues. Lacking regional units of government able to address regional needs have therefore hindered prospects for effective city-wide policies.

Why is finding financing so important yet challenging for major cities?

Once energy efficiency and renewable energy projects have been identified, cities must be able to find and utilise affordable financing at sufficient scale to materialise these projects and ensure substantial change in the energy landscape of the city.

Actors at the subnational/city level often struggle to raise finance, though; rules of engagement for various sources of international finance often require money to flow via national governments, making it difficult for cities to access international sources directly, such as donor finance, international development banks and international pension funds. Moreover, many cities do not have a strong credit history and rating, and neither do companies specifically created for the purpose of implementing infrastructure projects (such as Bus Rapid Transit (BRT) or subway lines in Mexico City).

These obstacles lead to cities having to compete for investment with a vast array of diverging national priorities, both in financial and political terms. Competition is tightened by a general lack of suitable financing which is well aligned to and/or targeted at clean energy investment. This becomes a particular problem for cities which are trying to progress initiatives which involve innovative technologies. Such innovative projects are often complex and the technologies can be unproven at large scale, and hence are typically perceived as risky to investors and decision-makers. Scaling up projects to make them more investable is advisable. However local decision makers' limited experience in designing such projects, often coupled with insufficient project scale, can result in a poor definition of what should be investable projects in the first place. This picture may be further complicated by the ongoing presence of often sizeable (and sometimes complex) national subsidies for fossil fuels (including transport fuels and electricity generated from fossil fuels).

Creating an appropriate and robust business case is therefore key to ensure clean energy projects receive the correct assessment which is needed to progress them further and to attract and secure suitable financial backing. A weak business case often leads to poorly defined distribution of revenue and risk: stakeholders' perceptions will then be that they are not receiving the right incentives to encourage them to invest, leaving cities in a very weak position to raise finance. On the other hand, when cities do manage to raise finance, particularly from or via national government, there are emerging worries around subnational governments showing fiscal fatigue, meaning that they may levy fewer taxes locally as the transfers or royalties from central governments increase.

What are the challenges associated with time constraints?

Timing is a crucial factor in developing energy infrastructure, as well as in rolling out energy efficiency measures such as building retrofit. Whilst all cities and governments face time constraints, the lengthy timeframes for carrying out detailed techno-economic feasibility studies for large projects in major cities in particular can mean that overall project development timeframes exceed the lifespan of elected city governments. This is often problematic because mayors and city administrators usually work under the rigid (and often short) timescales that reflect fixed term election cycles (e.g. mayors in Mexico City are typically in power for three years and cannot be re-elected). If a project advocate is coming to the end of his or her term in office, the project itself could be at risk. To ensure that projects have the highest chance possible of advancing to full operational stage, decision makers in large and megacities need to focus on continuous stakeholder engagement to ensure constant buy-in from senior decision-makers. Section 3-D of this guidance focuses on Stakeholder Engagement and Management and further explains how continuous buy-in from key stakeholders can considerably increase the chances of project success.

What are the challenges associated with the complexity of projects?

The complexity and scale of projects that subnational governments in large and megacities need to carry out can present a number of additional challenges for city governments. Challenges arise around data collection, such as the difficulty in sourcing energy data (and other carbon inventory data) across multiple local governments and other stakeholders, and the difficulty of scaling project investments and accurately calculating savings when assessing larger schemes such as retrofit of multiple buildings across the city. One of the basic challenges facing cities is gathering enough data to enable a well-informed prioritisation of cost effective and practical clean energy solutions. Difficulties arise for any project which needs to engage with stakeholders including utilities and large industries and which requires the collection of data across multiple jurisdictions and municipalities. Estimating energy use can carry uncertainty due to the difficulty in obtaining data on activities in different economic sectors and carbon assessments may be complicated by uncertainty over the accuracy or applicability of available carbon emissions factors. When dealing with large and megacities, the challenges grow as the delimitation of activities' boundaries becomes more complex and capacity within subnational governments - such as the quantity and calibre of the human resources which have the required skills, expertise and bandwidth - is constrained.

C. OPPORTUNITIES TO SAVE ENERGY IN LATIN AMERICA'S MAJOR CITIES

What are the main energy saving opportunities in Latin American major cities?

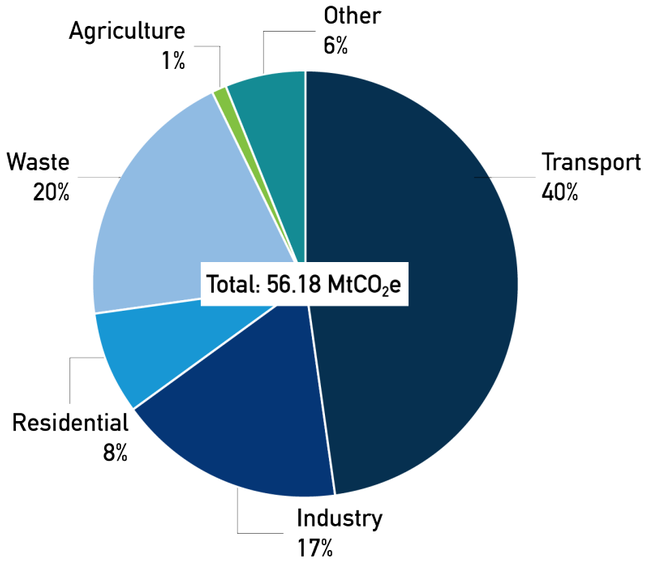
Major cities in Latin America have different energy mixes, which relate to their geography and the existing energy supply infrastructure in their locality and nationally. Gas and hydropower are the most prevalent sources for electricity generation, with fossil fuels also widely used for various purposes, including for transportation. As a whole, in the electric power sector across Latin America, 48 percent of generation capacity utilises renewable energy sources, the overwhelming majority of which being hydropower (accounting for around 44 percent of total generation capacity across Latin America).

Most energy demand is centred in urban areas. Section 3 of this guidance, on the six building blocks to energy and climate planning in large and megacities, gives an overview of the solutions that city officials can put in place to address energy use and energy supply for these sectors. It is important for planners and decision makers to consider that climate conditions, expected growth and population density will all influence the applicability of sustainable energy solutions for different cities.

As previously mentioned, cities may lack the technical expertise necessary to select the most cost-effective projects or to estimate policy impacts of their actions. By looking at the sectors consuming the most energy (and contributing the most to GHG emissions) in their city, local policy makers can gain a better understanding of the priority sectors to address in order to save energy and reduce carbon emissions. In this regard, Marginal Abatement Cost Curves (MACC), even if only at broader national level, can be good indicators of which sectors to target, as they compare the cost effectiveness of a number of mitigation measures, showing the potential for emission savings proportioned to the costs to implement each measure. MACCs can be insightful in selecting priority projects, though policy makers and city leaders will of course also consider other factors and metrics to inform decisions, including co-benefits of projects and opportunities to maximise synergies and benefits across multiple projects.

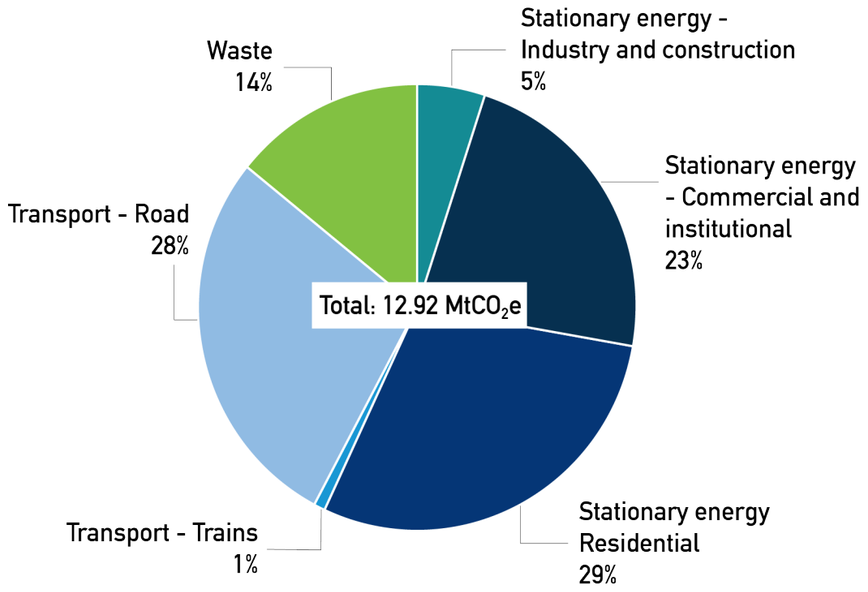
Figure 4 and Figure 5 below show examples of emissions inventories. Transport and building energy use are the largest contributors to energy consumption and carbon emissions in Latin American megacities, and are therefore two of the sectors on which we will be concentrating in later sections when making recommendations for good practice in energy planning for cities. More insights on inventory assessment and project prioritisation are provided in the next section.

Figure 4 – Greenhouse gas emissions inventory for Greater Mexico City, 2014



Source: Secretaría del Medio Ambiente del Gobierno de la Ciudad de México, 2016

Figure 5 – Greenhouse gas emissions inventory for Buenos Aires, 2014



Source: Gobierno de la Ciudad de Buenos Aires, 2015[15]

There is a significant range of low carbon energy options for high population density cities, especially in the transport and building sectors: district heating and cooling, on-site renewables, electric public transport, electric vehicle charging infrastructure for private electric vehicles, infrastructure to support active or 'soft' transportation modes (i.e. cycling and walking), electrification in buildings, building refits for energy efficiency, solar thermal for hot water etc.

Cities are setting their own climate change mitigation targets

Being at the forefront of climate change mitigation and adaptation strategies, cities are increasingly expected to set their own energy and carbon targets, both for the short and long term. Currently, 19 out of 20 countries in Latin America have set at least one type of renewable energy target at the national level.[16] As can be seen in the table below, transport and residential are two sectors which are being actively targeted by megacities.

Table 2 – Carbon targets in Latin American megacities

City	Baseline	Target	Target (-%)	GHG sources
Mexico City	2012	2020	3.9%	Transport.
Mexico City	2012	2020	6.4%	Residential: Emissions from electricity consumption and use of fossil fuel (LPG and natural gas) in different types of housing.
Rio de Janeiro	2005	2020	20%	Road Transportation, Railway, Residential, Commercial, Public Sector, fugitive emissions and other, Forest and land use, Urban Solid Waste, wastewater.
Buenos Aires	2008	2030	30%	The target applies for the energy, transport and waste sector, from both private and public areas.
Lima	2015	2016	10%	Transport sector within the Lima metropolitana boundary.

Source: CPD open data portal, https://data.cdp.net/

3. Energy and climate planning in major cities: six building blocks

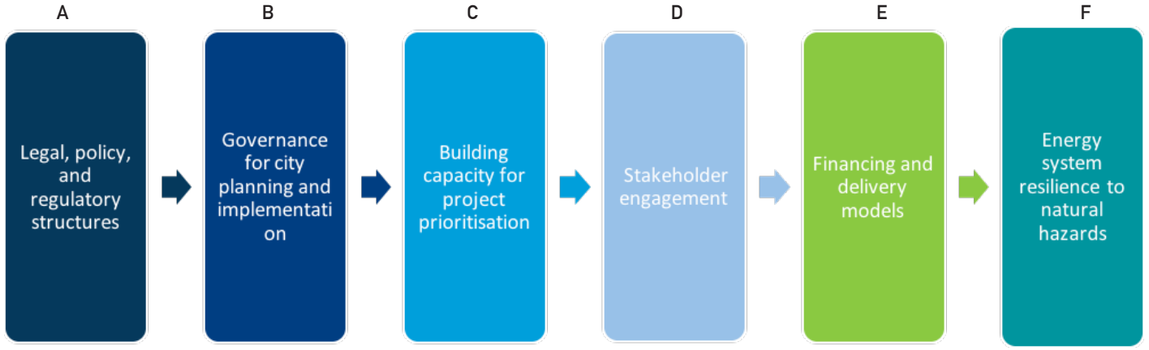
To advance the management of energy and the implementation of clean energy technologies at the city level, subnational energy decision makers need to create a long-term vision and roadmap for action. As part of this vision, there are five areas for mitigation action:

1. **Policy:** Aligning legal, policy and regulatory structures to foster sustainability;
2. **Governance:** Dealing with vertical coordination and multiple governance structures;
3. **Project Prioritisation:** Identifying and prioritising projects to maximise energy savings and increase energy security;
4. **Stakeholder Engagement:** Engaging and managing a multitude of diverse stakeholders; and
5. **Finance:** Accessing finance and redirecting it to low carbon energy projects.

In addition, on-going climate change will continue to create significant negative impacts for major cities; there is therefore a sixth area of focus in connection with cities' energy infrastructure which is also addressed below:

6. **Resilience:** Improving the resilience of the energy system, in particular the ability to maintain the city's electricity network (and other energy infrastructure) in the face of extreme weather events.

Figure 6 – Building blocks for energy planning in major cities



A. LEGAL, POLICY, AND REGULATORY STRUCTURES

Cities have limitations over their control of their assets and budgets. However, cities have a number of levers that they can pull to set or enforce policies and create a common vision, in the energy sector in particular.[17] This is key as cities have the potential to unlock energy efficiency through regulation, such as land-use planning and public housing programmes, building codes, technical standards, network connection rules, and more. City governments therefore have the potential to deliver high-impact policy actions simply by better utilising their own direct decision powers.

Cities should take a lead in using policy to facilitate energy efficiency and energy management, and should ensure they have clear visions and roadmaps in place to build consensus, which can help overcome challenges that relate to short election cycles. National governments and regional subnational authorities have a role to play in supporting these city-level policies. More specifically, national governments have the power to supplement cross-city initiatives and drive more ambitious city action. In addition to devolving powers and making public funds accessible, national governments should also ensure the long-term policy certainty required for private investment (see Section 3-E on Financing and Delivery Models).

Cross-city partnerships allow experience sharing and can lead to increased city-level action on efficient and sustainable energy solutions. The Covenant of Mayors, the C40 Cities Climate Leadership Group, 100 Resilient Cities (100RC) and ICLEI Local Governments for Sustainability are all good examples of cross-city partnerships. At a sub-city scale, municipalities are also encouraged to co-operate to drive a city wide approach. To achieve this, it is key to focus on co-benefits, which will align political support and lead to the adoption of low-carbon resilience policies and legislation.

Strong and ambitious policy support is essential to tap into cities' energy efficiency potential, but this may often involve non-energy policies. For example, local governments can include within their public tenders procurement policies which foster efficient and sustainable energy solutions. Procurement specifications could mandate the deployment of energy efficient solutions, for example in the construction of roads with low temperature asphalts and energy efficient street lighting; also in the requirement for electrical appliances, including lighting and IT equipment, purchased by the municipal government to be highly energy efficiency. By implementing such explicitly 'green' procurement policies and practices the municipal governments of major cities can leverage their significant purchasing power and play an important role in influencing the wider transformation in energy efficiency of electrical appliances and equipment.

B. GOVERNANCE FOR CITY-WIDE PLANNING AND IMPLEMENTATION

Governance challenges faced by large and megacities

Coordination between different levels of government is key in order to ensure long-lasting buy-in from stakeholders, mobilisation of resources at scale, and effective decision-making. Cities must work to achieve collaboration among different internal departments and beyond administrative boundaries, collaborating with actors at regional, national and even international level to understand and help to shape the regional, national and international regulatory frameworks that shape the local context, and to ensure that the energy infrastructure that supplies the city is also transformed to meet future targets. Evidence from the C40 Climate Leadership Group also suggests that cities that work in collaboration with partners (such as community groups and networks and the private sector) are able to deliver more actions across different sectors related to low carbon energy.[18]

Projects for cities are likely to span across a variety of sectors such as transport, waste, district energy, and building retrofit, multiplying the number of decision makers involved. City governments need to balance multiple priorities, including economic development, access to electricity and water, public health and health care, education, and poverty reduction and social mobility. Adjacent municipalities need to cooperate strongly on cross-border projects to advance city-wide programmes that benefit the whole urban area and its environs and increase appetite for investors by achieving economies of scale. Intervention and support from the national level may become necessary to resolve conflicting views of stakeholders, or where structures and resources within individual subnational governments are insufficient to achieve progress. With clean energy projects often spanning across sectors such as transport, waste, district energy, and building retrofit, it is important to understand the extent of powers accorded to mayors in the largest Latin American cities. For example, as can be seen in Figure 7 below on mayoral powers in Latin American megacities across a number of key sectors, powers are very limited with respect to energy supply in many cities.

Figure 7 – Mayoral powers in Latin American megacities, per sector

	Own & operate				Set and enforce policies				Budgetary and revenue control				Set vision			
	MC	BA	SP	RJ	MC	BA	SP	RJ	MC	BA	SP	RJ	MC	BA	SP	RJ
Private buildings																
Public buildings																
Energy supply																
Finance & economy																
Public transport																
City roads																
Urban Land use																
Waste																
Water																

KEY:

MC – Mexico City; BA – Buenos Aires; SP – São Paulo; RJ – Rio de Janeiro.

Not available | Not applicable | Limited powers | Partial powers | Strong powers

Source: Extracted from C40 Cities, http://www.c40.org/cities

Mayors and other subnational leaders will drive climate action globally, and have the potential to achieve 40 percent of the Paris Agreement goal; using cleaner energy, more efficiently, is the biggest win for these cities.[19] These goals are particularly challenging given the rate of urban growth in Latin America. Mayoral leadership will therefore have to be at the forefront of climate mitigation and adaptation.

Clean energy systems are most deliverable where city governments hold considerable authority and influence over decision-making, and have budgetary powers over assets. For instance, cities need to have the ability to control key elements of their tax base and monetise efficiencies, such as cheaper transport and savings from increased energy efficiency. Section 3 – E below on Financing and Delivery Models further highlights the role of tax revenues.

Building on this, energy planning in Latin America's megacities is also influenced by, and has to be analysed in light of, sprawling; approximately one quarter of the urban population resides in informal housing. Upgrading and relocation programmes have long been seen as the answer to combat sprawling. However, interventions are becoming increasingly proactive rather than reactive, aiming to lead urban development from the onset. The NYU Urban Expansion Initiative's 'Making Room' advocated the adoption of a four-step action programme to make room for urban expansion that starts with a realistic projection of urban land needs and ends with the identification of public open spaces to protect in the face of urban development. Where possible we will touch upon the challenges of informal housing and urban sprawl in the subsequent building blocks to energy planning.

What are the main strategies to overcome governance issues?

Devolution deals, which allow for the decentralisation of power closer to the citizens in order to account better for local factors in decision-making, enable cities to receive certain powers from the national government and are a response to the issue of vertical coordination. There are a variety of examples of different strategies employed by cities:

- In 2016, a federal political reform converted the previous Distrito Federal (Federal District) structure into Mexico City, giving the country's capital more authority under the status of an autonomous entity. Although the city will not become a state per se, it will have its own constitution and take on a level of autonomy with responsibilities and powers comparable to the 31 states of the country.[20]
- Colombia's government has been through a process of decentralisation over the past 30 years, which gave more powers to local administrations. Today approximately 50 percent of total public investment happens at subnational levels of government.[21]
- The UK central government has devolved powers to England's largest cities. This process is giving cities the ability to develop integrated energy planning schemes, such as the London Plan and the London Infrastructure Plan.

When cities acquire decision-making powers from central government, they need to promptly engage with stakeholders, such as neighbouring cities or suburbs, to ensure new clean energy projects such as urban transport projects are interconnected and dealt with as a whole. The creation of pan-city governments or setting up integrated, sector-specific authorities, such as integrated transport authorities, that are able to co-ordinate and join up different modes of transport across the urban area, could also help achieve this goal.

Examples of cross-municipal actions and city-level aggregation efforts

Cities need to share best practice in subnational and municipal energy planning and inventory assessment, focusing on strategies properly adapted to the local context, including local regulatory frameworks. Best practice shows that regional cooperation delivers, for example, synergies in developing inventories, through data sharing and improved data quality. In Mexico, through the establishment of a municipal programme for climate change in the northern region of the State of Jalisco, there are current plans to join more than six municipalities together in the efforts of compiling one single inventory and one resulting action plan. Mexico City has taken a variety of similar actions.

Box 2 – Mexico: supporting cooperation beyond the city boundary

Mexico City created a political coordination body called the Environmental Commission for the Megalopolis (Comisión Ambiental de la Megalópolis[22]) which seeks to design, coordinate and catalyse programmes and actions that contribute to the adaptation, mitigation and preservation of the ecological equilibrium of the central Megalopolis region, centred on Mexico City. By grouping all municipalities together, this Commission is an institutional example of good urban-regional sustainability practices. As highlighted in the previous section, Mexico City is also taking important steps to tackle and improve air pollution and reduce GHG emissions, particularly from urban transport. The city's ProAire programme, first launched in 1990, is now in its fourth round, covering the 2011-2020 timeframe. The programme aims, among other things, to reduce industrial and automobile emissions and contain urban sprawl.[23] ProAire IV covers actions across areas including energy consumption, greening of the municipal transport fleets, and land use and reforestation.[24]

We know that cities will need to lead green growth in the future, but it is important to align subnational actions with national and international actions in order to enable and maximise the effectiveness of these efforts if the Paris climate commitments are to be met. This could potentially be achieved through regional institutions for each city which could link local and national levels to address sustainability issues. There are also opportunities for international cooperation among cities. The mayors of Mexico City, São Paolo and Buenos Aires signed a Joint Declaration (the Environmental LAC G3) during the Rio +20 Summit. Their commitment was to exchange data, as well as to explore new mechanisms of action, such as a common fund to import, transfer and locally develop clean technologies.[25]

C. BUILDING CAPACITY FOR PROJECT PRIORITISATION

Tailoring solutions to the major city

With the rise of major cities as substantial units of economic scale, it is necessary to tailor national level clean energy solutions to each major city in order to reflect specific urban situations and ensure solutions are fit for purpose. Increasingly, the efficient and rational use of energy are national development priorities, but to achieve lasting success it is key for cities to develop full energy and carbon inventories.

To inform how projects are prioritised and taken forwards cities must understand their energy consumption and map energy hotspots which have potential for cost-effective interventions. Analysing energy hotspots gives decision-makers strategic guidance towards which sectors should be prioritised when developing energy saving and clean energy strategies. Robust carbon and energy inventories in Latin American cities are instrumental in helping to target the right sectors and technologies when developing clean energy plans. Inventories need to range across areas such as stationary sources (mainly buildings), transport, and industrial processes and product use. As previously mentioned, however, gathering data remains a substantial challenge for many cities and is rarely effectively resourced.

Within the city, it is important to operate across buildings and neighbourhoods. For example, by going beyond a building-by-building or measure-by-measure approach and assessing the entirety of the public building stock, it is possible to accelerate infrastructure investment. This is because a holistic approach to clean energy in buildings, with project aggregation rather than a singular intervention approach, has the potential to attract more finance because transaction and project feasibility costs form a lower percentage of the total spending, spreading risk across multiple projects. However, a challenge to this approach can be the lack of robust data held by city governments on the number and characteristics of the buildings which they own/occupy and the related collaboration required across jurisdictions.

It is also useful to look at best practice examples. Objectively quantified project prioritisation is key in a context in which we need to tailor national level clean energy solutions to large and megacities to reflect specific urban situations. We need to ensure solutions are fit for purpose and learning from other cities can be key.

Initiatives to help cities identify and prioritise clean energy projects

Approximately 80 percent of the world's 150 largest cities lack the basic tools required for low-carbon energy planning.[26] This makes the need for capacity building evident. Cities can procure external expertise to fill skills gaps, though energy planning is a long-term priority that calls for municipalities to develop and retain skills in-house to ensure continuity and reduce costs. Although training and tools for carbon and energy planning are available, only a limited amount focuses specifically on energy planning in cities and megacities. Initiatives such as the World Bank's City Climate Planner Certificate, the Energy Sector Management Assistance Program (ESMAP), Tool for Rapid Assessment of City Energy (TRACE), and networks such as C40 Cities, aim to address and overcome this.

As many city governments currently lack skills and resources to collect and analyse data and create robust, investable business cases, tools and capacity building platforms offered by international institutions are indispensable. Notable examples include carbon reporting guidance such as the Global Protocol for Community-Scale GHG Inventories (GPC) and the Sustainable Energy for All Building Efficiency Accelerator (BEA), a network led by the World Resource Institute (WRI) providing guidance and support on technical capabilities for sub-national governments who commit to implement and report on energy efficiency measures for buildings in their cities.[27]

Cities in Latin America are taking advantage of these platforms; Mexico City is the first city globally to report a city-wide emissions inventory to the Compact of Mayors using GPC Basic+[28], and was one of the first cities (in partnership with the federal government of Mexico) to commit to the BEA. To provide a full picture, we present a list of tools and capacity building initiatives in Annex 1 (including an assessment of their applicability/suitability for major Latin American cities).

Urban land use and masterplanning

An increasing amount of work is emerging in relation to simultaneously driving low carbon urban density and liveability. There is a need for limiting outward growth of cities while boosting population density to manage urban areas efficiently and ensure sustainable development. Compact, connected, and coordinated cities can lead to energy savings (from the transport sector, for instance) and reduce the 'lock-in effects' of carbon emissions from inefficient infrastructure. Urban sprawl increases both per capita land consumption (by 60 to 80 percent) and motor vehicle travel (by 20 to 60 percent) when compared to more dense developments.[29] Compact, walkable, bicycle-friendly, transit-oriented cities use land more efficiently and are able to take advantage of more efficient transportation options.

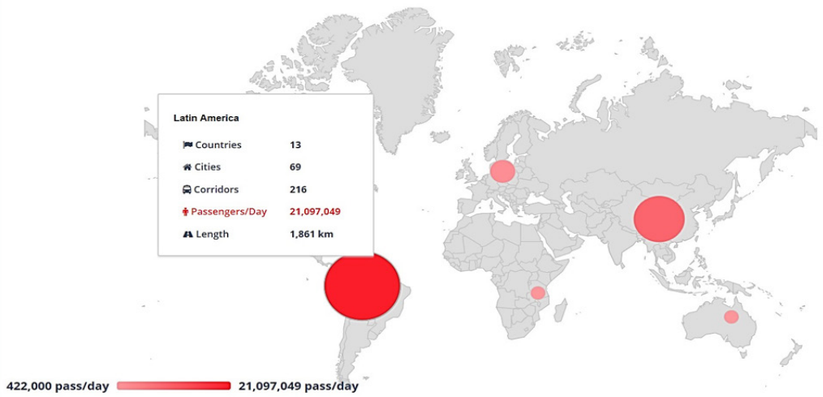
Singapore's land use plan is a compelling example of a strategic city-level land use planning framework: by 2030, eight out of ten homes will be within a ten-minute walk of a Mass Rapid Transit (MRT) station.[30] In Curitiba, Brazil, a strict zoning code enforces growth along transit corridors and integrates land use to public transport and street networks, and zoning ordinances based on floor area ratio (FAR) requirements foster high density development.[31] At present, 18 percent of existing actions taken by C40 cities are in the transit sector, and this share is expected to continue to rise and reach 28 percent by 2020. Currently, Latin America is the region with the highest demand in terms of passengers per day[32] and a high potential for sustainable transportation; in this context, bus rapid transport systems have proved an important tool (see Box 3).

Public transportation

Box 3 – Bus rapid transport systems and other transport innovations delivering benefits in major cities

BRT can be a cost effective way of creating mass transit options in developing cities. Mexico City, Rio de Janeiro and Lima have all implemented BRTs, whilst Bogotá is introducing car-free days and cycling superhighways interconnected with BRT routes, "Transmilenio". Buenos Aires and New York are achieving both sizeable energy savings and improvements in air quality by changing road systems and removing urban highways, and redistributing street space in favour of dedicated cycling lanes, bus lanes, pedestrian space as well as green/recreational spaces. In Santiago, Chile, the Metro should be powered 42 percent by solar and 18 percent by wind energy by 2018.[33]

Figure 8 – BRT panorama per region, Latin America



Source: BRTdata (2015)[34]

Buildings

In the buildings sector, subnational governments have the ability to use policy structures in the planning sphere to foster sustainability. Major cities have the economic and capital scale and, typically, the legislative powers to set their own building codes for energy efficiency. Mexico City for instance is promoting its Green Plan and incorporating sustainability criteria into city building regulations.[35] Additionally, the city also developed a green mortgage programme in partnership with the federal government called Hipoteca Verde that offers a line of credit for social housing fitted out with green technologies.[36] In Sao Paulo, Brazil, under the Solar Ordinance new residential, commercial and industrial buildings are required to install solar water heating to cover 40 percent or more of energy used for heating water.[37] Considering that buildings are usually responsible for about 30% of energy consumption, cities should also put great emphasis on energy efficiency and resilience in retrofitting existing buildings and the sustainable construction of new buildings. More action and city-wide investments is needed, however, especially in the energy efficiency of buildings. Cities need to seize the many cost effective opportunities available to retrofit schools, housing, hospitals, offices and other commercial buildings with energy efficiency and renewable energy technologies, and they need to strengthen and enforce building codes for new and existing buildings. This will result in buildings that cost less to run and provide a better internal environment for building users.

D. STAKEHOLDER ENGAGEMENT

Why is stakeholder engagement important?

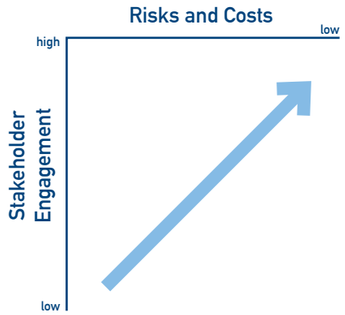
The Organisation for Economic Co-operation and Development (OECD) defines stakeholder engagement as a "means to prevent conflicts, manage trade-offs, raise awareness and build inter-sectoral complementarities at the right scale".[38] Not only is stakeholder engagement a necessary factor in project development, it is also a crucial decision-making tool and a key factor in achieving principles of good governance such as transparency and accountability. Good stakeholder engagement allows a city to:

- Generate the necessary broad-based support to drive forward change;
- Plan and develop successful projects;
- Deliver positive outcomes for their citizens; and
- Empower local populations.

The way in which energy is delivered and consumed impacts on everyone's day-to-day lives; effective stakeholder engagement is therefore absolutely critical to the successful planning and delivery of clean energy projects. Stakeholder engagement is a governance instrument: effective frameworks help to understand the multifaceted stakeholder dynamics around energy planning at the subnational level.

If a city tries to impose a solution that does not work for citizens then the results could be catastrophic, both politically and economically. Successful stakeholder engagement allows administrations to 'listen to the city', ensuring the solutions proposed are equitable and work for citizens. Effective communication leads to collaboration, which can help to overcome limitations on city government policy influence. Stakeholder engagement is therefore one of the most important factors in reducing the risk of project failure or unpopular policy initiatives, and in improving outcomes and ensuring that public money is well spent.

Figure 9 – The effect of stakeholder engagement on policy and project risk and costs



The more you engage with your stakeholders, the lower your project risks and costs. Where stakeholders don't have much say and the project goes ahead, risks around buy-in of the outcome arise.

The ongoing clean energy conversation between stakeholders and public authorities is hence crucial to a socially, economically and environmentally thriving city. If cities want to move to a cleaner, greener energy future they will need the support of their businesses and their communities. Stakeholder engagement is an issue for any city, but the sheer scale of a major city, with a population of five to ten million people, brings an amplification these challenges. Major cities are likely to face greater diversity in terms of geography, project scale, and the type and number of stakeholder groups. Especially relevant to major cities in Latin America is the informal nature of significant parts of the urban environment, with many non-legalised settlements and slums that can make stakeholder engagement even more complicated and risky.

Why do we need to understand stakeholders' perspectives and collect stakeholder data?

Local governments and city authorities need to develop and implement stakeholder engagement strategies as part of any clean energy project they undertake. The success of projects depends upon understanding stakeholder views and securing commitment from a range of stakeholders to the switch from the status quo

to something considered as new.[39] Local and municipal authorities can play a powerful advocacy role. In order to add rigour to this process, the Carbon Trust utilises a specific approach when supporting cities including a five-step approach to stakeholder engagement in energy infrastructure projects (see Box 4). This approach, which is based on the prevailing literature on the topic, ensures that stakeholder engagement is an integral part of project development. It provides a framework to guide project promoters and helps them avoid common problems such as inconsistent or partial engagement. Following this approach has delivered better project outcomes for both project developers and stakeholder groups.

Box 4 - Carbon Trust 5-step approach to city stakeholder engagement

Step 1. Identification: identify all stakeholders, including individuals, groups and organisations. Cities should consider as wide a range of internal and external stakeholders as possible.

Step 2. Mapping: Map and analyse named individuals to understand the nature of their interests, barriers and motivators. Build up a profile for each stakeholder to inform and strengthen the engagement strategy. Categorise and classify stakeholders according to an agreed list of groups (e.g. private/public sector customers, infrastructure providers, investors, etc.). Always try to refine this step as engagement progresses.

Step 3. Prioritisation: Rank stakeholder importance to inform the engagement strategy further. An Influence-Interest Grid can be used to present stakeholders' importance visually, according to the likely 'interest' the stakeholders show in the project and the 'influence' they can exert on its success. Cities should prioritise stakeholders and refine this activity throughout the engagement programme. Initial assessments may be incorrect, and ongoing engagement activities may affect the ranking.

Step 4. Planning: Define and plan an engagement strategy, differentiating communication channels and resources across stakeholder groups according to their priority level. Referring to the overall strategic objectives helps cities to develop key messages and communicate the project effectively. Develop an engagement plan which assigns key tasks to team members over a defined timeline.

Step 5. Engagement: By use of engagement activities such as workshops, ensure that all stakeholders understand the purpose of the engagement, as well as the background and strategic vision for the project. Continued engagement allows cities to demonstrate continuity and secure trust.

To support the implementation of this 5-step framework for stakeholder engagement, the Carbon Trust uses a customised Stakeholder Engagement Tool to enable city project teams to plan, track and report on stakeholder interactions and outcomes, and calculate stakeholder risk. This tool is particularly effective in supporting data collection and projects with a large number of key stakeholders who can directly affect the project. Currently, the Carbon Trust is using this tool to support Colombia in developing a roadmap for a potential Emissions Trading System (ETS), as part of the World Bank´s Partnership for Market Readiness.

Data collection at scale, from a variety of sources across the city, is a significant challenge for infrastructure projects in major cities. For example, the data required to create city-wide energy maps and carbon inventories will need to be sourced from multiple stakeholders, and good stakeholder engagement is vital to facilitate this. From the Carbon Trust's experience in delivering such support at the state level in Mexico, it was effective stakeholder engagement which enabled successful data collection for the state and city's carbon inventory; without this the inventory would have been neither sufficiently accurate or credible, and therefore flawed as an effective roadmap to reduce the state and city's carbon emissions.

Other organisations have also developed toolkits to help with carrying out stakeholder engagement activities. The Hands-on Energy Adaptation Toolkit (HEAT) aims at performing stakeholder-based risk assessments of climate vulnerabilities and adaptation options for energy supply chains.[40] UN-Habitat has also identified mechanisms that cities could use to engage with their main stakeholders, such as businesses, householders and schools. These mechanisms range across three categories: consultation, participation, and coordination mechanisms.[41] As an example of the participation mechanism, Peru has created an ecological park (Parque Ecológico Voces por el Clima[42]) which is composed of five pavilions: sustainable cities, energy, oceans, mountains and water, and forests. Through scientifically designed interactive learning modules these pavilions cover themes of strategic importance to Peru in relation to the impacts of climate change. The Ministry of Environment finds this a good way of engaging citizens and stakeholders about climate change and clean energy.

What are the critical success factors for best-practice stakeholder engagement?

In order to overcome the challenges associated with engaging a large number of stakeholder groups in progressing clean energy projects we have developed a list of critical success:

- **Clarity of purpose** – cities should understand why they are engaging with stakeholders and what is needed from each stakeholder. Is it information? Approval? Funding? If collecting information from stakeholders, can cities provide templates to facilitate the collection of this information?
- **Planning –** much of the most important stakeholder management occurs behind the scenes and before the actual engagement begins. Meticulous research and planning informs why, when and how to engage with stakeholders to give better results.
- **Timing –** it is key to engage with stakeholders at the right moment. For example, do they have enough information at a particular point in time to allow them to answer a question? It is important to recognise that it is possible to engage too early as well as too late.
- **Momentum –** stakeholder fatigue is a known challenge in infrastructure projects, which take a long time to mature. Check the engagement history, avoid over-frequent or disjointed engagement, beware of over-promising, and always communicate the outcomes of any engagement.
- **Two-way communications and feedback –** stakeholder engagement is not a one-way process. Municipalities should listen to stakeholders and complete the feedback loop.
- **Compromise –** authentic stakeholder engagement takes on board the views of all parties and seeks to reach a compromise that genuinely addresses everyone's needs. Cities should be prepared to adapt policies or projects; stakeholder engagement is more than a sales pitch.

Figure 10 – The winning formula for best-practice stakeholder engagement

E. FINANCING AND DELIVERY MODELS

Cities need to redirect finance from high carbon to low carbon infrastructure energy projects

At COP21 in Paris, developed countries agreed to commit US$100 billion per year to 2020 for climate change mitigation and adaptation.[43] Targeting the buildings and transit sectors to reduce energy demands will be the main focus of this spending at city level; wider urban energy programmes are likely to make up the vast majority of actions even post-2020.

Cost-effective and energy-efficient investments in buildings and transport systems have the potential to reduce urban energy use, and generate financial savings in the range of 1.7 to 9.5 percent of annual city-scale GDP.[44] Energy intensive infrastructure such as poor quality buildings and fossil fuel based road transport are increasingly becoming obsolete, short term solutions due to the rising cost of carbon, and there is a real risk of stranded assets - investments that cities can no longer effectively used. Additionally, energy intensive infrastructures increase the risk of locking-in inefficient, costly and polluting development paths, reinforcing that cities must act now to move consistently towards a clean energy path. However, in the past decades Latin American cities have focused their energy agenda mostly on energy reform, overlooking energy efficiency programmes. Now there is a need for city-level infrastructure finance to shift from fossil fuel generation, roads, and investments which may have lower upfront cost but higher lifetime operational costs, to low carbon buildings, low carbon public transport, and renewable energy generation projects compatible with denser urban developments. To create climate-resilient infrastructures, we need a shift in the business as usual scenario of urban investments. A welcome step in the right direction is the October 2016 announcement from the Brazilian Economic and Social Development Bank (BNDES), Latin America's largest development bank, which reduced credit to high-carbon energy investments and increases credit to renewables and energy efficient investments. According to BNDES, this promising solution aims to "increase alternative energy sources in the Brazilian power mix, directing investments to projects with high social and environmental returns".[45]

Cities need to become more attractive for private sector investment

Cities need to be equipped with the right skillset to assess investment options and to use public financing efficiently. One of the main challenges is then to match finance with investable projects. In order to match their projects successfully with sources of finance, municipalities need to manage and reduce project risks. This can be done by:

- performing a full risk analysis;
- using performance guarantees;
- grouping of high risk assets to reduce the overall risk (securitisation);
- blending of public and private sources of finance to de-risk the investment;
- applying project and stakeholder management strategies; and
- providing investors with an exit (e.g. development of a secondary market to sell green bond shares).

If municipalities want to unlock the full potential of green finance they will need to become more attractive to private investors. This can be challenging, and to do so local governments need, as a minimum, to take the following steps:

- design economically rational financing structures;
- carry out full discounted cash flow analyses on identified and prioritised projects;
- bundling projects to generate scale for project investment;
- reduce bureaucracy and procurement administration costs as percentage of capital;
- ensure outcomes are measurably delivering additionality; and
- build post-implementation measurement, reporting and verification (MRV) into each project.

Leveraging private financing has the potential to allow cities to make better use of scarce public funds.[46] Bringing together scale, knowledge, and aggregating investments is a smart strategy for municipalities to attract the private sector.

Once municipalities become more attractive to private investors, they can leverage hybrid-financing systems such as Public Private Partnerships (PPPs) which combine the public finance aspect that helps monetise global and local benefits with the private appetite for a return on investments. One issue to bear in mind, though, is that some governments in Latin America do not yet have the legal frameworks in place to support entering into such contracts. Moreover, entering into long term contracts is not always seen as desirable at the local level because it can be associated with a substantial acquisition of debt and hence a source of financial risk.

Subnational governments need to provide private investors with a clear understanding of the essential but non-monetary impacts green investments, including valuing air quality and increased energy resilience, amongst others. The Carbon Trust and others have developed templates to help local governments to quality assure financial and other metrics from project-specific investment appraisals, and cities are being trained on project preparation software such as SOURCE to maximise public sector users' financing options – including PPPs (see Appendix 1).

Sourcing clean energy finance - assistance programmes for cities

To respond to the financing challenges faced by cities, a number of external and internal players are putting in place initiatives to encourage low carbon investments at the city level. We divide these initiatives according the leading promoters: international finance Institutions and international climate funds, subnational governments, and cross-city initiatives.

International and national finance	Subnational government	Cross-city initiatives
• City creditworthiness • International resources • Grants and loans	• Tax revenues • Pension funds • Crowdfunding • Green bonds • Carbon markets • Energy Performance Contracts • Public-Private Partnerships	• C40 Cities Finance Facility • C40 Financing Sustainable Cities Initiative • Cities Climate Finance Leadership Alliance

Figure 11 – Examples of assistance programmes and climate finance mechanisms available to cities

International finance institutions and international climate funds

Renewable energy and energy efficiency options are key candidates for the change to clean energy policy and investments. Estimates show that at least 14 countries in Latin America have established public funds or facilities to finance renewable energy projects in the electricity, transport, heat and energy access sectors[47], yet it is important that cities too have access to options to raise their own finance. This section outlines current initiatives that are supporting cities to gain the capacity required to take advantage of financing opportunities, using the Mexican experience to date as an example.

International climate funds are providing grants and loans to cities, and also focus on capacity building for adaptation and mitigation. Sources of international climate financing include the Clean Technology Fund (CTF), the Pilot Program for Climate Resilience (PPCR), the Least Developed Country Fund (LDCF) and the

Special Climate Change Fund (SCCF), as well as the Global Environmental Facility (GEF) and the Green Climate Fund (GCF). One of the GCF's five investment priorities is climate-compatible cities, and the GCF is currently financing a six-year project in Latin America aimed at demand-side energy efficiency projects. The project is being piloted in Mexico and estimates indicate that it has the potential to avoid emissions of 2.6 million tCO_2e.[48] GCF has also recently launched a US$500 million request for proposals to support private sector projects

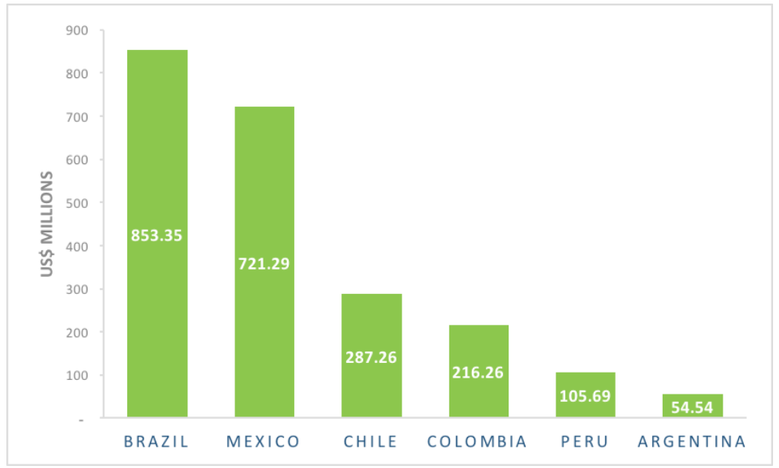
that help combat climate change in developing countries. This is the first time the GCF has directly invited the private sector to apply for funding.

The IDB is developing economic tools and financing systems that serve to pool international resources, and also provides significant financial support to improve access for cities to long term capital in Latin America.[49] In addition, the IDB is helping cities to strengthen their fiscal sustainability and governance and improve their credit rating by helping cities prepare projects which are attractive to the financial market.[50] Estimates exist that for every US$1 spent on improving creditworthiness in a city, US$100 of private sector finance are attracted.[51]

The World Bank is behind other similar programmes such as its City Creditworthiness Initiative, as well as its City Energy Efficiency Transformation Initiative (CEETI), a technical assistance programme focused on capacity building and knowledge dissemination. CEETI, led by ESMAP, matches cities with sources of financing and helps their governments develop prospectuses of promising energy efficiency investments. Following on from the success of this, CEETI will be constituted of two complementary pillars: the Energy Efficient Services Project Preparation Facility and the Efficient and Sustainable Buildings Program. ESMAP's work includes support towards city energy diagnostics (via TRACE – see Appendix I), as well as technical assistance to cities via detailed energy audits. In Mexico ESMAP is supporting detailed energy audits in six municipalities, covering street lighting, energy use in municipal buildings, and water and wastewater.[52] These audits formed critical technical assistance support towards the World Bank's US $100 million loan for a Municipal Energy Efficiency programme in Mexico. This programme, known as PRESEM, is being led by the Ministry of Energy (SENER) in Mexico's federal government and underpins Mexico's first national programme targeting energy efficiency at the municipal level.[53]

To date climate and energy finance in Latin America has been concentrated on two of the largest countries: between 2003 and 2016, Brazil received more than US$ 800 million and Mexico more than US$ 700 million.[54] Between 2010 and 2014, dedicated climate funds for explicitly urban projects have provided approximately US$ 850 million, of which US$ 250 million were given to Mexico for mitigation purposes.[55]

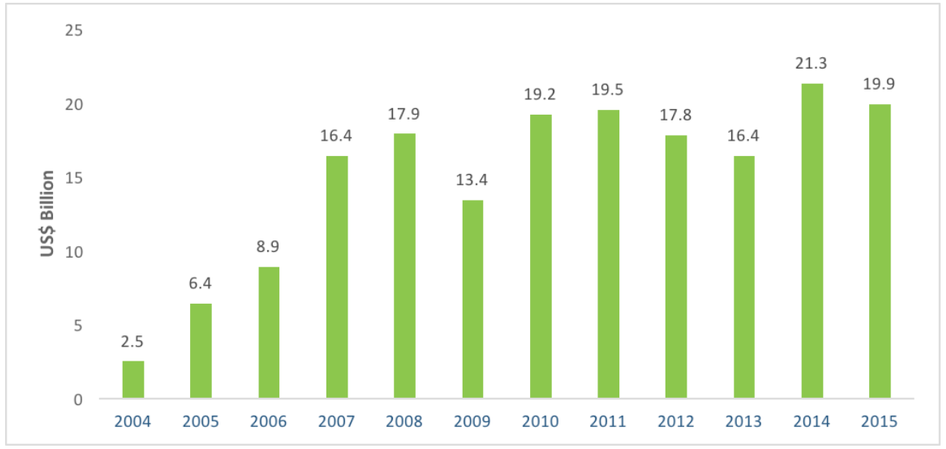
Figure 12 – Climate funding approved in selected Latin American countries, 2003-2016



Source: Climate Funds Updates 2016, http://www.climatefundsupdate.org/regions/latin-america

In addition to climate funding, Latin American cities are also benefiting from non-climate specific sources of funding from the IDB, the World Bank, CAF, and other international financial institutions (IFIs) financing energy efficiency and renewable energy. Entities such as the IDB are increasingly working with green investment specialists and also using software tools to assess and optimise the potential environmental benefits during the diligence and execution phases of projects in which they invest.

Figure 13 – New investments in renewable energy 2004-2015, Americas (exc. US)



Source: Global Trends in Renewable Energy Investment 2017, http://fs-unep-centre.org/publications

Mobilizing more resources at the subnational level

The Cities Climate Finance Leadership Alliance (CCFLA) calls for governments to create enabling frameworks for cities to invest in low carbon projects. A recent IDB report encourages subnational governments in Latin America to generate more own-source revenue and augment budgetary resources to allocate to local development issues.[56] Mexico City for instance has established an environmental fund for climate change, the Fondo Ambiental de Cambio Climático (FACC). FACC aims to finance actions and projects related to the conservation and protection of natural resources; inventory and mitigation of emissions; educational programmes, studies and information sharing; and the implementation of the city's climate action plan. Programmes and actions financed by this fund relate to both mitigation and adaptation.[57]

Internationally, actors are increasingly advocating a decentralisation of revenues to local governments to enable them to manage their tax base better. These tax revenues can represent both a source of clean energy finance for cities and a driver of low carbon behaviour. For instance, cities could use their tax systems to charge residents for energy efficiency measures (e.g. levies on residents to generate funds to be used to finance city-wide energy efficiency measures, or direct charging of residents to install energy efficiency measures at their homes), which as a co-benefit reduce their bills. Tax revenues can also capture a percentage of land value uplift from public transport projects provided by the city government, such as mass transit.[58] It should be noted, however, that past studies have found that the share of local government revenue that Latin American cities derive from taxes varies considerably; in Mexico and Chile the national government is the main authority, while in Brazil and Colombia tax structures are less centralised. This results in cites having more limited powers of taxation in the first two countries.[59]

Recent studies suggest that emissions trading schemes (ETS) are increasingly attracting interest from subnational governments as a potential way to leverage finance.[60] Some 21 sub-national jurisdictions are said to have implemented or are planning to implement carbon-pricing instruments such as ETS and taxes.[61] Tokyo, for example, deployed the first urban carbon-trading programme, focused on urban industries and enforced by its metropolitan government.[62] At present, Colombia, Mexico, Chile and Brazil are all investigating the potential for carbon markets. These will initially be implemented at the national level (as occurred in Colombia and Chile). However, there is also the potential to follow the Japanese example and deploy subnational schemes where cities have (or adopt) the appropriate powers for policy making and legislation in this area, and have the capacity to progress and implement such policies.

Fast growing local pension funds are increasingly investing in clean energy finance as they respond to citizens' growing desire to see their money used for sustainable and responsible investments. These are promising

sources of finance, and bring co-benefits to support the local economy if made in local currencies. Crowdfunding and green bonds are other examples of finance sources used by cities. To date, São Paulo has raised around US$2 billion through the sale of bonds for infrastructure projects, and New York and Johannesburg have issued green bonds for public transportation, with the latter oversubscribing by 1.5 times.[63] A more in-depth analysis of this topic can be found in the 2016 Climate Policy Initiative report: Green Bonds for Cities: A strategic Guide for City-level Policymakers in developing countries.[64]

Finally, Energy Performance Contracting (EnPC) can help cities monetise resource savings: in this model energy service companies (ESCOs) implement low carbon energy projects and use the energy cost savings to refund the costs of the investment.[65] To date, there is no evidence of a local government in Latin American entering into a contract with an ESCO (this seems to be for a variety of reasons, including legal and regulatory barriers; the relatively early stage of maturity of the supply side of the ESCO market; issues with creditworthiness of some local governments in the region), although there are some federal and municipal programmes that in effect work as an ESCO, such as those offered by the Electric Energy Savings Trust (FIDE) in Mexico.[66]

Cross-city initiatives

Cross-city initiatives have a high potential in terms of sharing knowledge and best practice. For example, the C40 Cities Finance Facility (CFF) with partners in the German Government, GIZ, USAID, and IDB, focuses on demonstration projects with replicable financing models, and provides funds for technical assistance to upskill cities and help them access and manage financial markets and mechanisms. CFF is currently committed to support Bogota's cycling super-highway project, as well as supporting Mexico City with the development of a green transportation corridor with a fleet of clean electric buses.[67] Additionally C40's Financing Sustainable Cities Initiative, develops peer-to-peer learning communities, provides technical assistance, and delivers an online engagement platform to pioneer a common language between cities and investors.[68]

Other examples of city initiatives are in Colombia, where the government signed an agreement, Protocolo Verde, with public and private domestic banks to align their strategies to national environmental policies[69]; and in Brazil, where state governments transfer a share of their sales tax revenues to municipalities through a fiscal mechanism, ICMS-Ecológico, compensating subnational governments for land-use restrictions.[70] Also in Brazil, the National Urban Mobility Law fosters the transfer of funds from the national government to cities to support sustainable transport measures.

F. RESILIENCE TO NATURAL HAZARDS AND CITY ENERGY SYSTEMS

How do natural hazards affect the energy system in major cities?

It is now broadly recognised that existing weather events have been intensified by climate change causing material economic and social impacts. Extreme weather events such as heatwaves have led to sharply increased demand for electricity while other extreme weather events (hurricanes and other severe storms, flooding, landslides) have caused infrastructure damage and power cuts. Major weather-related natural hazards affecting energy systems that have recently occurred in large and megacities in Latin America include heatwaves, droughts, El Niño Southern Oscillation, flooding and landslides.

Box 5 - What constitutes the electricity system?

The electricity system is broadly composed of three components: generators, networks (sometimes called 'grids') for transmission and for distribution, and consumer demand. Generators produce electricity at power stations or from renewable sources that are often located far away from the centres of population. The transmission network (or grid) then carries the produced electricity from the generating centres to the load centres. This transmission occurs at high voltages to help minimise losses. Finally, the distribution networks feed the power received from the transmission network to consumers, at lower voltages.[71] Much of this system is outside of the direct control of subnational governments.

Table 3 below shows a list of the most common climate hazards in Latin American major cities and their associated perceived level of impact on the power network and the population needs.

Table 3 – Climate hazards and impacts in Latin American megacities

Notes: S= serious; ES= extremely serious

City	Climate Hazards
Mexico City	Forest fires (S); Heat waves (S); Vector-borne disease (ES); Flash/ surface flood (S)
Rio de Janeiro	Extreme hot days (S); Heat waves (ES); Rain storm (ES); Flash/ surface flood (S); Severe wind (S); Drought (ES)
Sao Paulo	Flash/surface flood (S); Heat wave (S); Drought (ES); Vector-borne disease (S)
Buenos Aires	Heat wave (ES); Extreme hot days (S); Rain storm (S); River flood (ES); Coastal flood (S); Vector-borne disease (ES); Severe wind (S)
Lima	Coastal flood (S); Drought (S); Heat wave (S); Landslide (S); Heavy snow (S); Storm surge (S)

Source: CDP open data portal, https://data.cdp.net/ .

Buenos Aires saw its most intense heat waves on record in December 2013 and January 2014, which prompted a series of power outages, leaving hundreds of thousands of Argentines without power, lighting and running water.72 Heavy rains have an immense impact on dense urban areas and cause landslides and surface water flooding, leading to infrastructure damage.

The past 30 years have seen two very strong El Niño events (1997-98 and 2015-16) which contributed to torrential rain, flooding, landslides, and drought throughout the region. Further extreme weather-related events have also been experienced in the region in the first few months of 2017, notably flooding and landslides in Peru and Colombia, and meteorologists have indicated that there is a 50 to 60 percent chance of an El Niño event forming in middle to late 2017.73 In Peru, registered economic losses from the deadly flooding and mudslides during the 1997-98 El Niño were about US$3.5 billion, equivalent to about 4.5 percent of the country's GDP at

the time, primarily due to the impact on primary production sectors and destruction of infrastructure.[74] In cities throughout Latin America, we can expect flooding to increase in its severity due to intense rainfall on impervious urban surfaces such as roads.

Lima, a city highly dependent on hydropower, experiences frequent droughts, and this creates vulnerability in its electricity generation. Water scarcity has already become an issue due to the rapidly growing population, compounded with the lack of coverage of water-related services and leakage in the water supply network. For the electricity supply network to be more resilient, policy makers need to draw relationships between climate change and the existing economic and social challenges. For Lima, more severe and frequent droughts will exacerbate existing water scarcity issues. Integrated water resource management will therefore play an increasingly important role in optimising water use in the energy sector.

How can we build resilience into the energy system for major Latin American cities?

When considering the resilience of the energy system of cities, the primary climate risks and impacts are likely to be for the electricity system. Understanding each city's electricity system and mapping potential shocks or chronic stressors will be the first step when planning to increase resilience in the electricity system. Although the availability of resources, information, and incentives is key to fostering adaptation, subnational energy planners need to consider the institutional context in which their cities are rooted, and in particular address those barriers associated with multi-level governance and participation.[75]

Box 6 - What is resilience?

The definition of resilience used in this guide is "the ability of assets, networks and systems to anticipate, absorb, adapt to and/ or rapidly recover from a disruptive event."[76]

The UK Government's Cabinet Office identified four components that contribute to making infrastructure resilience: resistance, reliability, redundancy, and response and recovery.

- Resistance focuses on providing protection to resist the hazard or its primary impact;
- Reliability ensures the design and operation of infrastructure components under a range of conditions;
- Redundancy enables operations through backup installations or spare capacity in the event of disruptions; and
- Response and Recovery provides a fast and effective response to and recovery from events.

Therefore, two characteristics provide resilient infrastructure: (a) good design of network and systems to ensure the necessary resistance, reliability and redundancy and (b) the organisational governance of risk and resilience to respond to, and recover from, disruptive events.

A survey developed by Massachusetts Institute of Technology (MIT) showed that 95 percent of Latin American cities responding to the survey were, in 2012, already planning for climate change, with the region displaying the highest rates of engagement in adaptation planning.[77] Local officials are working with scientists that help them conduct assessments and examine new measures to best prepare cities for the future resilience threats. One reason why Latin American cities demonstrated high engagement with adaptation planning appears to be that they see strong links between climate adaptation and other strategic topics such as economic development, housing, migration, and public health.[78] Resilience planning thus represents an opportunity for local governments to integrate adaptation efforts with existing departmental responsibilities and strategies at city level.

The UK approach

The UK Government's Cabinet Office developed a guidance document for infrastructure resilience that stresses the importance of information sharing at the heart of building infrastructure resilience.[79] The Resilience Cycle introduces a framework for building resilience in relation to infrastructure by following four steps:

(a) Identify risks from natural hazards;

(b) Assess risks by developing resilience standard;

(c) Build resilience by setting an organisational resilience strategy; and

(d) Evaluate resilience through sector resilience plans.

Developing and issuing guidance documents along the lines of those produced by the UK government will help support infrastructure owners and operators, emergency responders, industry groups, regulators and government departments to work together to improve resilience in the electricity systems in major cities in Latin America.

Box 7 – Transmission and distribution network in the UK

In the United Kingdom, the transmission network tends to be resilient to severe weather events, with the impact of the latter usually restricted geographically thanks to diversified plant base management of major transmission lines, and high levels of attention given to the operational resilience of the meshed transmission network.[80] Distribution systems are less resilient to such weather events and localised damage can result in groups of consumers being off supply for some days, particularly in rural areas.[81] Distribution companies have taken steps to increase resilience to severe weather events, using insulated overhead line conductors, rebuilding lines to conform to a heavier construction specification, increasing capability to withstand lightning surges, and using automated switching to isolate faults and restore supplies.[82]

Achieving resilience through decentralised energy systems

Leading cities and their citizens are moving away from playing merely a demand-side consumer role, and are taking steps in becoming producers of their own energy. Distributed generation, especially when implemented at scale, can bring regulatory complexities (e.g. connection fees) as well as practical and commercial challenges for the network and the existing utility providers. The use of shared infrastructure needs to be planned, managed, and fairly compensated. Nonetheless, where possible and appropriate distributed electricity generation (i.e. power generation at or close to the point of consumption) and micro-networks will positively influence the reliability of supply under eventualities such as storms, floods, and major fires, amongst others.[83,84] The benefits of decentralised elements to the energy system can be coupled with those arising from demand side energy efficiency measures and with the development of a "smart" electricity network.

Cuba is at present the second country globally in terms of the scale of its distributed energy generation, with around 40 percent of energy production in the country being distributed.[85] The shift from a centralised to a decentralised model has mainly been the consequence of damage caused by natural hazards such as hurricanes. Studies show that Cuba's reliability of supply and efficiency have both increased by the decentralisation of its electricity generation. In addition to having security of supply and efficiency benefits, such a decentralised network is also now better suited to meet the future deployment of renewables.

4. CONCLUSIONS AND A LOOK AHEAD

In considering the promotion of further economic growth and social development in Latin America while using energy more efficiently and implementing carbon emissions reduction efforts at scale, several overarching conclusions emerge:

- Major cities will be the primary focus of clean energy solutions in Latin America.
- Using energy more efficiently presents an opportunity for cities to increase their energy security.
- Cities in Latin America are taking positive steps to advance clean energy planning. Nonetheless, focus on robust planning needs to be accelerated, while recognising that there are big hurdles to address in turning plans in to implemented policies and investments, in order to collectively meet the Paris Climate Agreement pledges.
- There are opportunities within the reach of the governments of major cities to raise standards of living in cities while simultaneously reducing energy use and combatting global climate change; these opportunities involve the application of energy efficiency measures and renewable power generation. Meeting these dual objectives will require not only increased technical & financial capacity, but also focussed political will.

To help subnational energy policy decision-makers establish more holistic clean energy programmes, international organisations are developing various initiatives and tools. These include reporting and planning tools such as GPC and CURB, the World Bank's Climate Action for Urban Sustainability planning tool, and capacity building initiatives such as the IDB's Emerging Sustainable Cities Initiative (ESCI) and the C40 Cities network (set out in Appendix I.) Understanding how these tools and initiatives have been applied in actual city contexts provides important lessons, both in terms of the challenges and conditions for success.

Based on an analysis of the Latin American context and other global experience, as well as existing initiatives and tools, there are several key recommendations to guide action in six key areas:

1. **Policy**
   City governments should take a lead in developing and implementing policy to facilitate energy efficiency, energy management and the adoption of renewable energy sources. They should:
   - take a proactive leadership role, ensuring that they have a clear long-term vision and roadmap in place to build consensus and cross-city partnerships, and set targets for city-wide action;
   - be proactive in engaging with partners, including private sector actors, financiers and NGOs, in order to drive and facilitate investment in clean energy infrastructure;
   - seek to limit the city's outward growth and sprawling, with renewed focus on managing urban development to achieve concentrations of higher population density which are more conducive for efficient and sustainable development;
   - develop and implement policy structures in the planning sphere that foster sustainability, with emphasis on building energy efficiency standards, holistic energy efficiency retrofit, and compact, walkable, transport orientated urban environments; and
   - seek to leverage energy efficiency potential through non-energy policies such as green procurement and helping to influence industrial transformation.

2. **Governance**
   City governments need to work within and beyond their own administrative boundaries, actively coordinating and collaborating between individual ministries and departments and also with neighbouring, regional and national-level (even international) actors. They should strive to:
   - achieve coordination and collaboration horizontally among different internal departments of the city government; reach beyond administrative boundaries to seek vertical coordination with higher levels of government to ensure that planning for regional and national infrastructure is as supportive as possible of city objectives;
   - ensure that related challenges such as land use, public transportation, and waste management are considered within a coherent framework which supports the development of clean energy;
   - balance multiple priorities, including economic development, access to electricity and water, public health and health care, education, poverty reduction and social mobility;
   - seek devolution deals where these can provide greater powers for planning and delivering clean energy programmes;
   - engage promptly with stakeholders to ensure clean energy projects are interconnected and considered as a whole across the entire urban area; and
   - network with other cities to share best practice in order to accelerate impactful progress in relation to energy planning and inventory assessment.

3. **Project prioritisation**
   City governments need to tailor national level clean energy solutions to reflect specific urban situations in their city. Objectively quantified project prioritisation is key in this context. To support this city governments need to:
   - develop and retain capacity and skills in-house;
   - take advantage of existing learning platforms and capacity building initiatives, as provided and supported by a number of major international organisations;
   - build a programme of actions, utilising the rich set of existing tools (provided and supported by major international organisations) to manage data and quantify and prioritise projects;
   - engage with international cities networks such as ICLEI and C40, which facilitate cities learning from others' experience; and
   - identify and analyse case studies from other cities which highlight what actions and interventions have and have not proven to be effective elsewhere.

4. **Stakeholder engagement**
   City governments need to develop and implement effective stakeholder engagement strategies as part of any clean energy programme and any individual project they undertake. City governments should:
   - follow a robust five-step approach to stakeholder engagement: identification, mapping, prioritisation, planning, and engagement;
   - recognise key success factors for best-practice stakeholder engagement, including clarity of purpose, timing, and compromise; and
   - leverage business and community support by sustaining ongoing dialogue with stakeholders and continually reiterating the many inter-connected benefits of clean energy in buildings, transport and industry.

5. **Finance**
City governments need to re-direct finance away from high carbon infrastructure to low carbon projects. City governments must:

- leverage their capability to convene and coordinate, bringing together stakeholders for a full range of viable and investable projects;
- focus on becoming more attractive to private sector financiers by aggregating investments through the bundling of projects to generate scale and by ensuring that outcomes will be measurable and delivering additionality; and
- take advantage of existing initiatives from international finance institutions, climate funds and national governments which encourage low carbon investments.

6. **Resilience**
Cities need to increase the resilience of their energy systems. In order to take a leadership position city governments must:

- fully understand the electricity systems which serve the city; and
- map potential stress points, linking to climate risks and other factors such as economic development, housing, migration, and public health.

Appendix 1 – Existing tools

This appendix serves as a reference section covering a range of existing tools and guidance documents for city planning for clean energy and carbon reduction. In addition to presenting a list of existing tools and capacity-building platforms that address sustainability issues at local government level, we also assess the applicability of such platforms to Latin American major cities. Our aim is to comment here on how well these tools can assist Latin American megacities in planning for sustainable energy actions, and for compiling a robust carbon emissions inventory.

CAPACITY BUILDING INITIATIVES AND SUPPORTING GUIDANCE FOR MAJOR CITIES

Our high-level assessment considers whether Latin American cities have already implemented or could implement the tool or initiative, and whether these tools are available in a language other than English. We also consider the capacity of these tools to deal with the complexity of multiple layers of local governments and multiple stakeholders in megacities. Although reasonable steps have been taken to consider the most known tools and initiatives, this list should not be taken to be exhaustive.

Table 4 – International reporting tools and methodologies for Latin American cities

Reporting platforms, tools and methodologies	Assessment
GPC: The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: global reporting standard that accounts consistently for emissions across sub-sectors from stationary to other scope 3 emissions. It is becoming the default international GHG accounting and reporting framework for cities and subnational governments. It enables cities and communities to measure and report GHG emissions consistently and develop climate action plans and low-emission urban development strategies.	Latin American cities are already using the tool, and other programmes and initiatives such as the Compact of Mayors and ESCI, which have a Latin American representation, are using it too. Buenos Aires, Mexico City and Rio de Janeiro were amongst the 24 pilot cities of the GPC.
The carbonn® Climate Registry (cCR): an alternative reporting platform to the GPC, designated as the central repository of the Compact of Mayors. Enables local governments to report climate actions such as emissions inventories and climate adaptation actions. It is the world's largest reporting platform on climate actions and commitments and the global response of local and subnational governments towards measurable, reportable and verifiable climate action.	São Paulo, Rio de Janeiro, Mexico City, Bogotá and Lima are amongst the Latin American cities already reporting to the cCR. Guides are also available in Spanish and Portuguese.
CURB: the Climate Action for Urban Sustainability planning tool uses local city data to provide tailored analyses that will help cities evaluate low carbon actions. The World Bank, C40 Cities, the Compact of Mayors, and other partners launched this planning tool to help city officials more easily identify, prioritise, and plan cost-effective and efficient ways to reduce carbon emissions.	The CURB tool is now embraced by the Compact of Mayors, which includes hundreds of cities, including in Latin America. The tool is designed specifically for use by cities. The World Bank's user guide for CURB is also available in Spanish.

TRACE: The World Bank's Tool for Rapid Assessment of City Energy is a decision-support tool designed to help cities quickly identify under-performing sectors, evaluate improvement and cost-saving potential, and prioritize sectors and actions for energy efficiency interventions. It covers six municipal sectors: passenger transport, municipal buildings, water and wastewater, public lighting, solid waste, and power and heat. The tool is composed of an energy-benchmarking module, a sector prioritisation model and an intervention selection that matches city capability to the capabilities required to implement each recommendation. City officials can then select from the set of ranked recommendations. Version 2.0 of TRACE is now freely available from ESMAP website.	Recommendations from TRACE are always tailored to the city's needs. It has already been deployed across Latin America in cities such as Rio de Janeiro, Bogotá and Medellin (Colombia), and Puebla and Leon (Mexico).
SOURCE: global standard, reliable, secured, and user-friendly project preparation software to maximise public sector users' financing options – including PPPs – by providing well-prepared projects in a consistent and transparent way to the international community of contractors, investors and lenders.	The users of SOURCE are governments and public institutions, and multilateral development banks such as the IADB sit on the advisory committee. Latin American countries are already being trained on and have projects on Source.
HEAT+: ICLEI's Harmonised Emissions Analysis Tool is a multilingual online GHG emissions inventory tool, compliant with GPC. HEAT+ is intended to help local governments to make informed climate action decisions and identify the most effective measures in emissions and pollutant abatement.	The initial HEAT software was developed for four countries, including Brazil. The new HEAT+ tool is multinational and multilingual, being available in Spanish and Portuguese.
Carbon Trust Carbon Inventory Tool and Project Register: model that was developed in line with the GPC and with the international FAST Standard for financial modelling (FAST = Flexible, Appropriate, Structured and Transparent).	This tool has been used by subnational governments in Mexico, and is available in Spanish. However, it is not specifically aimed at megacities.
NASA Megacities Carbon Project: NASA's project is developing, testing, and improving robust methods for assessing carbon emissions and monitoring the atmospheric trends of carbon attributed to the world's largest cities.	Los Angeles and Paris are the two current pilot cities, though discussions are underway regarding inclusion of a third sister city in Sao Paulo, Brazil. If this goes ahead, the resulting baseline estimates would potentially be applicable to other Latin American megacities. The estimates are specifically for large cities.

Table 5 – International capacity building initiatives for Latin American cities

Capacity building initiatives	Assessment
ESCI (Emerging Sustainable Cities Initiative): IDB's non-reimbursable technical assistance program provides direct support to national and subnational governments in the development and execution of City Action Plans. It employs a multidisciplinary approach to identify, organise and prioritise urban interventions to tackle the main roadblocks that prevent sustainable growth.	ESCI focuses on emerging cities in Latin America and the Caribbean. Although addressed at emerging cities, the ESCI methodology could potentially be applied to large and megacities.
Compact of States and Regions: initiative designed to catalyse climate change mitigation through inventory development, target setting and strategy development at regional and state level.	It has become the global go-to platform for states, provinces and regions to measure and manage their GHG emissions and among the governments leading the way are: Sao Paulo, Rio de Janeiro, and in Mexico the State Governments of Hidalgo, Jalisco and Yucatán. Some Latin American large and megacities are hence already actively engaged in this initiative.
Global Covenant of Mayors for Climate and Energy Initiatives: largest global coalition of cities committed to climate leadership. Formally brings together the Compact of Mayors and the Covenant of Mayors and provides a central platform that brings together relevant data on cities' energy and climate actions. It captures these actions through standardised measurement of emissions and climate risk, and consistent public reporting of their efforts.	Among the cities committed are Mexico City, Rio de Janeiro, Santiago, Lima and Bogotá. Some Latin American large and megacities are hence actively involved in this initiative, and should benefit from the reporting of collective actions.
C40 Cities networks: convenes 17 networks that provide a range of services in support of cities' climate change efforts. Networks cover mitigation, adaptation and sustainability topics and facilitate dialogue amongst city officials. This builds trusted relationships, which in turn ensures that ideas, solutions, lessons, questions, and even friendly competition can flow freely and responsively to cities' needs.	C40 networks focus mainly on larger cities, and the networks have several Latin American city members. Many case studies and best practice examples are in Spanish so these networks can have a great influence on Latin American cities. There is also a specific C40 city network on clean energy, which had its inaugural meeting in Buenos Aires in July 2017.
City Credit Worthiness Initiative: this World Bank program provides local authorities with comprehensive, hands-on, and long-term support and helps them achieve higher creditworthiness and improve both the demand and supply sides of financing.	The associated City Creditworthiness Academies provide a set of training modules ranging from revenue management to climate smart capital investment planning, from debt financing options to the enabling environment for sub-national finance. The latest of these initiatives took place in Bogotá, suggesting that there could be high potential for transferability to other Latin American large and megacities.
Urban-LEDS (Urban Low Emissions Development Strategy): EU funded project, implemented by UN-Habitat and ICLEI, with the objective of enhancing the transition to low emission urban development in emerging economy countries, offering tailor-made training to local governments to integrate low-carbon strategies into all sectors of urban planning and development.	Urban-LEDS focused on the local community level and from 2012-16 provided selected local governments in four specific countries (Brazil, Indonesia, India and South Africa) with a methodological framework. It is therefore relevant to urban environments in Brazil. Other countries in Latin America could replicate this type of training.

Solutions Gateway: an online resource platform developed and tested under the Urban-LEDS project (see above), aimed at local governments. Offers clean energy solutions and guidance based on proven technologies and practices, drafted and peer-reviewed by experts.	Initially, it focused on LEDS priorities identified by the Urban-LEDS model and satellite cities. As seen above, Brazil is one of the four Urban-LEDS countries. Additionally, the platform presents a number of Latin American case studies, in Chile and Mexico for example, so this platform is becoming increasingly useful for other Latin American cities as its content is expanded.
Under 2 MOU: a global climate leadership Memorandum of Understanding (MOU) signed by subnational governments that commits the signatories to adopt emission reduction targets in line with the best available science, thereby helping to raise the international level of ambition to tackle climate change.	24 subnational governments in Latin America are already part of this coalition, including Sao Paulo, Mexico City and Santiago, Chile. These local governments can now set plans that highlight current or future actions and commitments to achieve emissions reduction targets through to 2030. The impact for Latin American large and megacities will be greater the more these cities become signatories.
Megacities Alliance for Water and Climate: the initiative aims to enhance capacity building between megacities so that they can adapt better to climate change. It includes a worldwide cooperation platform to improve the dialogue on adapting to or mitigating the effects of climate change related to water in megacities.	Ten megacities are involved the initiative, amongst which are Buenos Aires and Mexico City. This alliance can enhance capacity in Latin America. However, it focusses largely on water rather than energy use.
Carbon Neutral Cities Alliance: a new implementation and technical dialogue initiative, which ensures collaboration between international cities committed to achieving aggressive long-term carbon reduction goals.	This initiative aims for international cities to work together to meet their respective goals more efficiently and effectively. The applicability for Latin America is medium as Rio de Janeiro, one of the newest member cities, being the only Latin American city to join the Alliance so far (all other members being in developed economies in North America, Europe, Australia and Japan).
ICLEI 100% RES Cities & Regions Network: this brings together leading cities, towns and regions that are driving the transition towards 100% renewable energy, in a global community of practice to facilitate peer learning and accelerate progress through the creation of cooperation opportunities.	To join the network, a city, town or region needs to have approved a 100% renewable energy target in at least one sector or have interest in exploring the feasibility of a 100% target for their territory, To date, no Latin American city is a participant in this initiative.
URBACT: European Territorial Cooperation programme acting as an exchange and learning programme promoting sustainable urban development. It enables cities to work together to develop solutions to major urban challenges, reaffirming the role they play in facing increasingly complex societal changes.	This programme promotes common themes faced by European cities; we expect the target sectors to differ in Latin American cities.
ESMAP Renewable Energy Resource Mapping Initiative: initiative that supports countries in undertaking renewable energy resource assessment and mapping studies. It supports renewable energy resource assessment and mapping for biomass, small hydro, solar and wind.	The initiative focuses on country projects in low to middle-income countries, such as Ethiopia, Indonesia, Vietnam and Nepal. There is no evidence that this initiative will extend to Latin American countries and their cities, so we assess its applicability as Low.

Appendix 2 – Case studies

This section highlights a number of successful sustainable energy programmes and projects to promote clean energy at city level. It covers examples of work done by the Carbon Trust as well as additional implementation examples of cities' sustainable energy and carbon reduction projects in Latin America.

THE CARBON TRUST LOW CARBON CITIES PROGRAMME

The Carbon Trust has developed a Low Carbon Cities Programme that supports cities and regions in developing area-wide sustainability and carbon reduction strategies. The programme helps cities through the process of gathering data and creating a roadmap to promote low carbon growth and achieve efficiency savings. The end goal is collaborative area-wide carbon reduction strategies led by local or city governments, championed by the public sector, actively supported by the private sector and owned by the entire community. We hereafter present examples from our work in Mexico, Malaysia and the United Kingdom.

Mexico

The Carbon Trust's Low Carbon States Mexico Programme, funded by the UK Government's Prosperity Fund, works with state governments to create energy strategies which contain an investment-ready pipeline of energy efficiency and renewable energy projects for future implementation. The programme has successfully developed and applied a framework, emissions inventory database and tools, training and advice, providing direct support to five of Mexico's 32 state governments to develop a robust carbon reduction strategy and implementation plan. In particular, the programme has enabled state governments to lead by example in managing their large estates of buildings, vehicle fleets, water pumping and other operational activities.

The Carbon Trust initially in 2014/15 provided change management and technical training and assistance to facilitate two state governments, Jalisco and Tabasco, to guide them in identifying, quantifying, prioritising and planning for implementation of energy efficiency and other low carbon measures over the subsequent 3-5 years. Further dedicated support to Jalisco and Tabasco followed in 2016/17 to drive the implementation of their plans, along with a new programme of support (based on the original Jalisco/Tabasco pilot programme) for three additional state governments: Baja California, Morelos, and Yucatán.

The programmes key steps are:

1. Engaging senior stakeholders, including to Governor and State Cabinet Minister level, to ensure state government commitment to leadership by example, ultimately demonstrated by the state government publishing a strategic Carbon Management Plan, including carbon inventory, targets and project pipeline for the state government's buildings and operations.
2. Guiding and supporting each state government in stakeholder mapping and the design and establishment of communications strategies and governance structures to ensure a consistent approach to energy efficiency and renewable energy solutions.
3. Establishing an energy and carbon toolset for the state governments, including an Excel-based carbon inventory baseline tool and a carbon mitigation/energy efficiency project register tool, supported by a programme of workshop training and one-to-one advisory support.
4. A detailed, objective energy and carbon emissions inventory and mitigation targets (GPC compliant) for each of the participating state governments.
5. A project roadmap consisting of a number of potential and existing initiatives. These include lighting retrofit in buildings (to LEDs), air conditioning upgrades, building fabric improvements, on-site renewable energy opportunities (solar PV, solar hot water, wind), co-generation of electricity, heat and cooling, savings opportunities through energy management and service/maintenance disciplines, transport initiatives (substitution to low emissions vehicles: LPG/gas/electric; fleet and mileage planning).
6. Technical training on key technologies for energy efficiency, energy management and carbon reduction in public/administration buildings.
7. Advice on accessing financing for projects, including innovative financing models.
8. Launch of the Carbon Management Plans for each state, with Governor/Ministerial endorsement and publicity, and promotion to other state governments and wider stakeholders in Mexico to encourage wider uptake of these principles and processes.

Project outcomes include:

- 5-year carbon management strategies and action plans delivered for the State Government of Jalisco and for the State Government of Tabasco, for the government estate and operations, targeting total annual savings of over 70,000 tonnes CO_2e and projected MX$132 million in energy costs avoided. Baja California, Morelos and Yucatán state governments are on track to complete and publish similar Carbon Management Plans by June 2017.
- Credible pathways for each state government to achieve its carbon emissions reduction and energy savings targets through identified and quantified behavioural and technical projects to implement cost-effectively.
- Outline financial business cases to support key projects, unlocking funding from finance departments and investors.
- Commitment from State Governors and Cabinet Ministers to energy efficiency as a priority to enable the state government to lead their wider regions by example.
- Dissemination of project outcomes in stakeholder events in Mexico City and elsewhere.
- Implementation support programme for Jalisco and Tabasco, covering technical specification and solution identification, financial modelling, procurement advice, and savings verification.

Malaysia

The Carbon Trust's Low Carbon Cities Malaysia Programme is a framework and set of tools designed to help municipalities in Malaysia develop a climate mitigation strategy, primarily through focussing on clean energy solutions. The Carbon Trust provided technical assistance to facilitate Malaysian local and city governments in strategically implementing energy efficiency and low carbon measures across their wider city regions, in partnership with key private and public sector bodies such as the UK Foreign & Commonwealth Office, Green Tech Malaysia, and PEMANDU (the Malaysian Government's economic transformation agency). This programme has great potential to help Malaysian local governments become low carbon leaders in Asia, at the same time as transferring expertise between the UK and Malaysia.

Following extended application processes in 2014, 2015 and 2016 where all municipalities within Greater Kuala Lumpur (KL) could express their interest in participating in the programme, the Carbon Trust selected Kuala Lumpur City Hall (DBKL), Petaling Jaya City Council (MBPJ) and Ampang Jaya City Council (MPAJ). The programme focuses on helping city governments to lead by example through efficient management of their own estate and operations, as well as on city-wide energy planning.

Some of the project outcomes include:

- A carbon management strategy and action plan for the DBKL, MBPJ and MPAJ local government estates and operations, with net positive cash savings.
- A GPC-compliant climate mitigation and energy plan for the wider municipal area and city of Petaling Jaya (c. 650,000 people) and Ampang Jaya (c. 600,000) within Greater KL. The plan identifies annual savings upwards of 9 million tonnes of CO_2e and RM 8.7 billion through projects including transport planning, industrial process efficiency, LED lighting retrofit, electric vehicles and renewable energy.
- Financial business cases and a MAC curve for projects identified both in the municipal buildings and across the wider city.
- Commitment to climate change mitigation from key stakeholders including the city Mayor and national government bodies.
- A high level climate risk assessment for the city and region covering impacts such as flooding and heat.
- A low carbon and clean energy platform for Malaysian cities and municipalities, comprising a website, skills and capacity building via workshop training, project management framework and set of tools facilitating the building of city carbon inventories and project registers.
- Technical implementation support for new and existing projects including verifying savings, independent advice and training on tender documentation, sources of finance and market engagement to guide projects through procurement.

"Since the year 2000, MBPJ has been working closely with various stakeholders from diverse backgrounds and sectors on programmes to develop Petaling Jaya as a leading, dynamic and sustainable city. It is a privilege and honour for MBPJ to be the pioneer local authority in this sustainability initiative."

Datin Paduka Alinah Ahmad, Mayor of Petaling Jaya

UK

Bristol City Council is a unitary authority responsible for all local government functions in England's sixth largest city. Bristol City Council has committed to becoming a low carbon city and home for green industries, and was the European Green Capital in 2015. Bristol City Council managed to reduce its own carbon footprint by 28 percent between 2003/04 and 2011/12. The Council also has a wider goal of reducing emissions from the city as a whole by 40 percent by 2020 compared to a 2005 baseline.

The Carbon Trust has been working with Bristol City Council since 2003 to help them lead on clean energy and climate mitigation. The city first implemented a plan to reduce emissions from the municipal estate, and then in 2008 created a city-wide energy strategy for the first time.

A key priority for Bristol is to take forward a number of heat network opportunities in and around the city, reducing energy losses from waste heat. In order to do this, Bristol City Council successfully applied for ELENA technical assistance funding from the European Investment Bank. This funding has allowed the Council to bring in external expertise from the Carbon Trust and others to support and advise them in the project development process.

The first two schemes – the Temple and Redcliffe scheme (biomass boiler system serving an enterprise zone) and the City Centre scheme (gas combined heat and power (CHP) system serving a university, hospital and social housing) – are now being implemented. These schemes aim to deliver carbon reduction, reduced energy costs and greater energy security, as well as paving the way for future development.

Some of the project outcomes include:

- A stakeholder management and customer engagement programme with major local heat users to help them understand the benefits and practical implications of connecting to the scheme and to secure commitment and buy in.
- An amended city planning policy support, to support the growth of clean decentralised energy solutions.
- A bespoke financial model for the City Centre heat network. The Carbon Trust worked alongside the Council's finance department for 6 months, upskilling and embedding the model in local Council practices. These efforts ensured a £5 million budget contribution through the Council Cabinet report, in the wake of the Bristol mayoral elections.

The result has been the accelerated development of clean energy opportunities through feasibility and commercial discussions, reduced transaction costs for the Council, and increased ownership of the projects at city government level.

"With energy prices rising sharply over the past few years and general strain on public finances, cutting bills and fuel poverty are two pretty major concerns for us at the moment. Decentralised energy schemes are a big part of our commitment to investing in making Bristol the most sustainable city in the UK, with a high quality of life."

Paul Barker, Energy Management Officer, Bristol City Council

OTHER CASE STUDIES

Rio de Janeiro

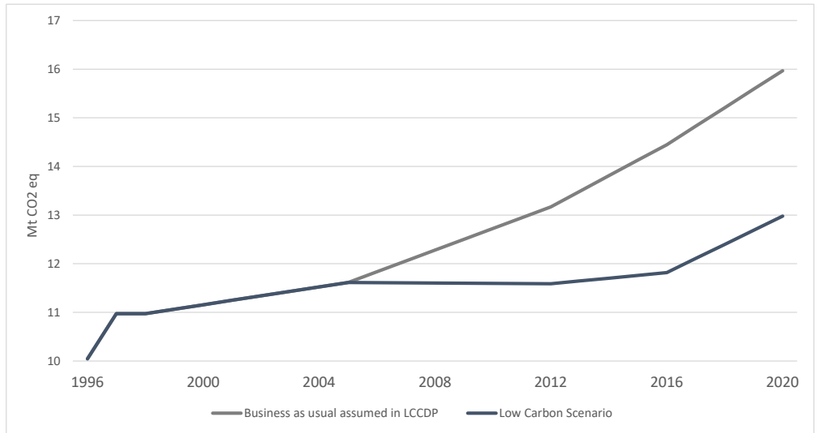
Rio de Janeiro Low Carbon City Development Programme (the Rio LCCDP) was launched in June 2012 at the Rio+20 conference as a systems approach to low carbon development. It sets out an ISO-certified framework and a set of comprehensive requirements to help the city transparently and credibly plan, implement, monitor and account for low carbon investments and climate change mitigation actions. Jointly developed by the City of Rio de Janeiro and the World Bank, the Rio LCCDP is seen as a prototype business model for other cities to replicate for green and climate-friendly growth.

GHG reduction targets for 2012, 2016 and 2020, and progress to date

The basis of Rio's LCCDP are voluntary GHG reduction targets defined by the Municipal Law on Climate Change and Sustainable Development, law No. 5,248, enacted in 2011. This law sets GHG reduction targets at 8%, 16% and 20% of 2005 emission levels (11,613 ktCO2e) for the years 2012, 2016 and 2020, respectively, as shown by the orange and yellow curves in Figure 15 below.[4]

Rio's targets include emitting 12,240 ktCO2e/year in 2012; 12,590 ktCO2e in 2016; and 13,645 ktCO2e in 2020, well below the estimated business as usual pathway.

Figure 14 – GHG reduction targets for Rio de Janeiro



4 The baseline emissions of Rio in 2005 were first reported as 11,252 ktCO2e in Rio's LCCDP, when the plan was launched in 2011. In the updated city GHG inventory launched in 2013 (link below) the 2005 emissions were revised to 11,613 ktCO2e. This report calculated the LCCDP's target figures based on this update of the city's 2005 total emissions figure.

What Rio witnessed since the definition of its LCCDP was in fact very different to its planned GHG emission trajectory. Rio's most recent city-wide GHG inventory[86], launched in late 2013, revealed emissions in 2012 were almost twice as high as targeted, summing to ~22,760 $ktCO_2e$.

Despite progress in the implementation of large-scale GHG mitigation measures (in particular: a new landfill site with capacity to sort, recycle or recover a significant share of the city's solid waste[87]; additional metro stations connecting the city's south and west sides – referred to as line 4[88]; and a new BRT System, with 125km of exclusive corridors and 440 vehicles connecting the city's extreme west side to the metro system[89]) several factors have conspired against the city's low carbon trajectory. In fact, the trajectory was based on a business as usual scenario which already diverged from reality in the year of the LCCDP's launch.

Key factors behind the sharp rise in Rio's GHG emissions were:

- An increase in economic activity and GDP driven by Brazil's FIFA World Cup in 2014 and Rio's Olympic Games in 2016, including significant infrastructure additions, leading to a GDP rise of 45% between 2005 and 2012.
- Commencement of operations of a large-scale steel mill in the city's extreme west, in late 2011, known as TKCSA90, adding approximately 6.3 $MtCO_2e$ to the city's emissions in 2012 alone.
- Brazilian federal energy policies which led to a significant increase in the use of thermoelectric power plants in compensation for the reduced output of Brazil's hydro power plants, especially between 2012 and 2015 - a significant share of Brazil's thermoelectric capacity is in the municipality of Rio, including a significant generation capacity in TKCSA.
- Reduced production of bio-ethanol, leading to an increased use of gasoline in the city's vehicle fleet.

Adapting the plan to a changing reality

Despite the mismatch between the original LCCDP plans and the city's actual emissions pathway, the city administration still made some progress. As the chair of C40 Cities between 2013 and 2016, Rio's Mayor, Eduardo Paes, led a review of the original LCCDP. The review concludes that actions taken by the end of 2012 cut emissions by 378 $ktCO_2e$, well below the 929 $ktCO_2e$ target in the municipal law. Nonetheless, the administration remained optimistic, estimating that the series of actions envisaged between then and 2016 could allow the city to end 2016 with a year-long mitigation impact of 1,832 $ktCO_2e$, very close to the target of 1,858 $ktCO_2e$ for that year.

Table 6 below summarises Rio's realized and foreseen GHG mitigation actions and their estimated impact in milestone years, according to the city's LCCDP review within the 2012 GHG inventory. Estimates for AFOLU are not available in the review for the year 2020 and are marked "n/a".

Table 6 - Estimated GHG mitigation from LCCDP interventions in Municipality of Rio de Janeiro ($ktCO_2e$)

Interventions (realised and foreseen)	2012	2016	2020
LED street lighting	0.64	0.64	0.64
1,000 units of social housing	0.05	0.1	0.1
Retrofit of gas distribution network	5.7	17	11.4
BRT lines	7.7	211	215.8
BRS Copacabana	17.6	17.6	17.6
Metro expansion	51	290	290
Bike lane expansion (300km)	3.2	6.4	6.4
Agriculture Forestry and Other Land Use	36.3	49.7	n/a
Biogas capture and use in Gramacho landfill	235	329	n/a
Biogas capture and use in Seropédica landfill	8.7	911	n/a
Liquid effluent treatment	12	n/a	n/a
TOTAL estimated emissions mitigated	**378**	**1,832**	**542**
LCCDP target	**929**	**1,858**	**2,323**

Source: Adapted from: (Centro Clima, COPPE UFRJ, and Rio Prefeitura, 2013)

Critical review of targets and interventions

The table above reveals that Rio relies heavily on its BRT lines, metro line expansion and landfill biogas capture to accomplish 2016 climate and energy goals. The energy and climate mitigation impact of these measures face some controversy though, with the LCCDP's revision itself pointing to a series of limitations such as budgetary constraints, political uncertainties and uncertainties with regards to mitigation potentials.

Examples of such controversy include biogas capture and flaring in the Gramacho landfill, which has been operating since 2009, before the launch of the LCCDP, casting doubt on its additionality in relation to a business as usual scenario; and Rio's bicycle hire programme and cycle lane expansion - target of some criticism due to the poor condition of the infrastructure.

Looking forward – points for improvement

Although it has a good framework in place, Rio is yet to implement it effectively. This is partly because the city's emissions are influenced by factors beyond the control of the city government, such as those led by federal-level policies (e.g. base load energy generation trends or bio-ethanol vs. gasoline prices). However, Rio has not yet assessed and transparently presented an array of future investment options with regards to their potential to mitigate emissions and generate value to the city. As a result, opportunities such as cross-sector energy efficiency and distributed generation remain largely untapped, despite their capacity to mitigate emissions and generate value to businesses and people.

A clear example is Rio's LCCDP ambition to become a hub for low carbon development and for low-carbon goods and services. Whilst issues beyond the municipality's control could work against Rio when shaping the city's attractiveness for investors, such as Brazil's daunting national economic situation, unfavourable taxation policies, and exchange rate issues, the city could benefit from a set of holistic measures to attract investments to the right sectors. Enhancing the City's creditworthiness[91] for example, could support the city in securing private investments to additional 'climate smart' interventions. Identifying market opportunities for energy efficiency, developing aggregate portfolios with significantly large scale, and building a robust programme delivery structure could enable the city to attract significant climate finance for urban energy efficiency and climate-resilient infrastructure investments, leading to further mobilization of private financing.

Finally, like many Brazilian cities, Rio has just been through a change in administration in early 2017, and the new administration's commitment to the LCCDP is unproven.

Buenos Aires

The City of Buenos Aires has more than 13 million inhabitants and is one of the five megacities in Latin America, as well as being the financial, industrial, commercial and cultural hub of Argentina. To strengthen the development of its climate change adaptation strategy, the city has had a Climate Change Action Plan in place since 2009 and approved an Adaptation and Mitigation Climate Change Law in September 2011. Buenos Aires also has a GHG emission reduction target of 30 percent by 2030.

Buenos Aires concentrates on awareness raising and training campaigns, and sustainable mobiliity

Between the adoption of the Climate Change Action Plan in 2009 and the first target year of 2015, the city government focused its actions on awareness and training campaigns to promote the use of renewable sources and encourage a reduction in energy consumption.[92] For example, Buenos Aires launched a Green Schools Program in 2010, aimed at promoting sustainable development through environmental education on topics such as energy efficiency, renewable energy, waste management and environmental health.[93] According to C40 Cities, "public engagement through active opinion polling, awareness campaigns and the launch of a dedicated educational website remain a key focus for the city".[94]

Actions to tackle mobility started in 2011, when the City of Buenos Aires developed the Plan for Sustainable Mobility, creating the first BRT system in Argentina. In 2014, the city became the ninth winner of the annual Sustainable Transport Award[95] for improvements to urban mobility and CO_2 emission savings as well as improvements to safety and access for cyclists and pedestrians. The city is increasingly pedestrianizing areas of the centre and adding new corridors to their BRT system. A BRT corridor has transformed the world's widest avenue, 9 de Julio, cutting travel time in half for more than 200,000 commuters per day.[96]

Buenos Aires won the C40 Cities & Siemens City Climate Leadership Award in 2014 for the Solid Waste Management category. Moreover, the city was the first in Latin America to test the World Bank's new Climate Action for Urban Sustainability planning tool (CURB).

Bogotá

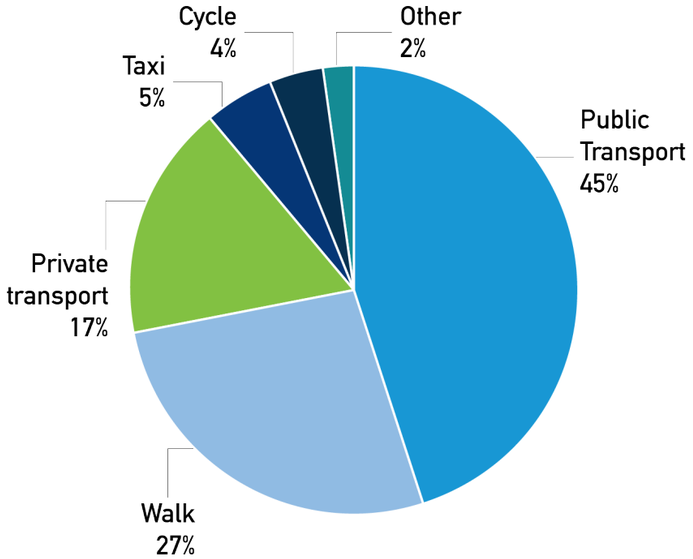
With an estimated population of 9.8 million people, Bogotá is the largest and most populous city in Colombia, one of Latin America's most important metropolitan areas and amongst the 30 largest cities in the world.[97] Since early 2000, Bogotá has implemented numerous policies and initiatives to transform its urban transport to respond to record levels of transportation demand.

TransMilenio Bus Rapid Transit System

One example of the city's efforts to promote public transport and alleviate congestion is the establishment of the TransMilenio BRT system, helping the city to cover the transport needs of the vast majority of citizens.[98] Although the transportation infrastructure formerly favoured the use of private vehicles, Figure 16 below demonstrates that now only 17 percent of passenger trips occur through private transport, with over 65 percent of passenger trips in Bogotá occuring either via public transport or walking.

As a result of the implementation of the BRT system, which has been designed and built in a very short time, users are now saving an average of 223 hours annually, which roughly equates to a 32 percent reduction in travel times.[99]

Figure 15 - Modal share of transport (in passenger trips) in Bogotá, 2013



Source: Extracted from UNEP (2015). Zero Carbon Latin America[100]

"Bogotá How Are We Doing?"

In order to debate and reflect on the most salient issues related to the quality of life of the city and evaluate changes that are taking place, a project called "Bogotá, how are we doing?" was established. This independent and diverse alliance promotes citizen participation with the capacity to influence public policy. This initiative was the object of a workshop as part of the IDB Emerging Sustainable Cities Initiative (ESCI), which aimed to use the experience of Bogotá as a foundation for future cities initiatives.[109]

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ABOUT THE CARBON TRUST

The Carbon Trust is an independent company with a mission to accelerate the move to a sustainable, low carbon economy. The Carbon Trust:

- advises businesses, governments and the public sector on opportunities in a sustainable, low carbon world;
- measures and certifies the environmental footprint of organisations, products and services;
- helps develop and deploy low carbon technologies and solutions, from energy efficiency to renewable power.

The company has approximately 180 staff with over 30 nationalities, based in the UK, China, India, Brazil, Mexico, South Africa and the USA. The Carbon Trust's experts come from a diverse range of professional backgrounds, including engineering, policy, academia, and business management.

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