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Economics, Finance, and the Private Sector

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Financing Climate Change Solutions in Cities

Since cities are the locus of large and rapid socioeconomic development around the world, economic factors will continue to shape urban responses to climate change. To exploit response opportunities, promote synergies among actions, and reduce conflicts, socioeconomic development must be integrated with climate change planning and policies.

Public-sector finance can facilitate action, and public resources can be used to generate investment by the private sector. But private-sector contributions to mitigation and adaptation should extend beyond financial investment. The private sector should also provide process and product innovation, capacity building, and institutional leadership.

Major Findings

- Implementing climate change mitigation and adaptation actions in cities can help solve other city-level development challenges, such as major infrastructure deficits. Assessments show that meeting increasing demand will require more than a doubling of annual capital investment in physical infrastructure to more than US$20 trillion by 2025, mostly in emerging economies. Estimates of global economic costs from urban flooding due to climate change are approximately US$1 trillion a year.

- Cities cannot fund climate change responses on their own. Multiple funding sources are needed to deliver the large infrastructure financing that is essential to low-carbon development and climate risk management in cities. Estimates of the annual cost of climate change adaptation range between US$80 billion and US$100 billion, of which about 80% will be borne in urbanized areas.

- Public–private partnerships are necessary for effective action. Partnerships should be tailored to the local conditions in order to create institutional and market catalysts for participation.

- Regulatory frameworks should be integrated across city, regional, national, and international levels to provide incentives for the private sector to participate in making cities less carbon-intensive and more climate-resilient. The frameworks need to incorporate mandates for local public action along with incentives for private participation and investment in reducing business contributions to emissions.

- Enhancing credit worthiness and building the financial capacity of cities are essential to tapping the full spectrum of resources and raising funds for climate action.

Key Messages

Financial policies must enable local governments to initiate actions that will minimize the costs of climate impacts. For example, the cost of inaction will be very high for cities located along coastlines and inland waterways due to rising sea levels and increasing risks of flooding.

Climate-related policies should also provide cities with local economic benefits as cities shift to new infrastructure systems associated with low-carbon development.

Networks of cities play a crucial role in accelerating the diffusion of good ideas and best practices to other cities, both domestically and internationally. Cities that initiate actions that lead to domestic and international implementation of nationwide climate change programs should be rewarded.

7.1 Introduction

This chapter provides an overview of the economic factors shaping urban responses to climate change. In four parts, it moves from a description of how climate change shapes urban economic options to an examination of the ways in which public-sector finance can facilitate action, including the use of public monies to generate private-sector investment. It then examines the many roles the private sector can play and ends with conclusions and policy recommendations.

7.1.1 Economic Challenges and Opportunities for Cities

Cities are where the biggest and fastest socioeconomic changes take place. Global climate risk is accumulated in urban areas because people, private and public assets, and economic activities become more concentrated there (Mehrotra et al., 2009; Revi et al., 2014). With rapidly expanding populations, the influence of cities will only grow in the 21st century. This dynamic, coupled with the increasing threat of climate change, puts cities at risk of major social and economic disruption in the absence of sound plans for climate change mitigation and adaptation.

Mitigation and adaptation are closely related tasks at the city level in terms of synergies and conflicts. They can be complementary (as with energy efficiency measures) or in conflict (as when climate adaptation relies on air conditioning). At the same time, measures to improve carbon sequestration in urban green spaces must be coherently connected with the goals of biodiversity and urban development. To exploit synergies and reduce conflicts, we must integrate socioeconomic development with climate change policies. The Urban Climate Change Research Network (UCCRN) conceives this as a joint effort: one without the other would be insufficient. More detailed analysis of the interrelationships (synergies and conflicts) of mitigation and adaptation can be found in Chapter 4 (Mitigation and Adaptation) of this volume.

In most countries, national or federal Ministries of Environment are recognized as responsible for climate change, whereas in reality such activities are far more distributed across multiple levels of public-sector jurisdictions (see Chapter 16, Governance and Policy). It is not clear how national-level climate change budgets – if any – will finance city initiatives. Thus, we emphasize the importance of citywide approaches to economic decision-making and finance to meet insurgent climate challenges. We recommend pursuit of policies that:

1. Enable local governments to initiate climate action. For cities historically located near water (such as ports and/or along rivers for waterpower), the costs of inaction will be very high in the face of rising seas and inland flooding, with the global economic costs from flooding in cities due to climate change projected to amount to US$1 trillion a year by mid-century (World Bank Group, 2013a).
2. Provide cities with local economic development benefits as economies shift to new realities associated with weaning themselves from reliance on fossil fuel.
3. Reward cities that initiate actions that can lead to domestic implementation of nationwide climate change programs.
4. Empower cities to stimulate and accelerate the diffusion of good ideas and best practices to other cities internationally and thus to lead by example.

7.1.2 The Costs of Inaction

Climate change and extreme weather patterns in cities across the globe have already demonstrated the risk of major socioeconomic disruptions in urban areas. Because of their spatially integrated infrastructure, city economic sectors are strongly interdependent and interlinked, sharing many potential consequences from climate change although individual neighborhoods may be less tightly linked. While effective adaptation methods, notably diversification of the city economy away from dependence on one sector, can reduce vulnerability, such moves are risky and add policy uncertainty. Uncertainty about the extent of change and costs from inaction as well as the inability to reliably calculate costs and benefits cannot be a barrier to action: cities should act on their current knowledge and evolve their approaches as new evidence and scenarios emerge (Rosenzweig and Solecki, 2014).

Hallegatte et al. (2008) elaborate the importance of "localizing" understanding of benefits and costs associated with climate change action plans by tapping into regional business, lawmaker, and stakeholder knowledge and experience. They argue for downscaling present knowledge of global and regional climate and socioeconomic scenarios to the municipal or even neighborhood level in order to inform local discourse about mitigation and adaptation plans. Cost-benefit analysis at the city-level must also include a vision of how different local communities will develop over the course of time as demographic, economic, and technological changes occur (UN Framework Convention on Climate Change [UNFCCC], 2011). A city's ripple effects on its surroundings must also be included in the analysis because cities are not isolated economic systems, but part of an interrelated spatial network.

Cost-benefit analysis (CBA), however, can never be more than a partial contributor to decision-making at the city level because many systemic effects cannot be quantified and monetized. Consider lives lost due to climate disasters: economists' measures are fraught with ethical, cultural, and social differences across any city population (Hallegatte, 2006). Valuation of the future poses another barrier to decision-making using CBA; discounting involves incorporating the fact that future costs and benefits are less important to current decision-makers than are those impacts that occur more immediately. The problem is that even massive disruptions in the distant future can be rendered insignificant in current terms in CBA with even a relatively low discount rate. Multi-criteria analysis (MCA), which considers noneconomic impacts and those not easily aggregated, is often used to complement CBA in order to incorporate aspects that

cannot be quantified or monetized and, at the same time, to enhance stakeholders' participation (Bell et al., 2003).

7.1.3 Economic Development Benefits

City economic development and efforts to improve energy efficiency in transportation or buildings, generate renewable energy, and adapt to imminent threats from climate change recognize a range of local economic benefits beyond simple financial returns. Unlike financial incentive programs and infrastructure investments that depend on returns from the attraction or retention of successful businesses, many climate change investments, in addition to reducing carbon emissions, provide direct short- and medium-term secondary local economic benefits such as potential expanded sales and employment gains associated with lower business energy costs, multiplier effects of recirculating more local income through reduced utility bills, and the benefits of more stable and predictable energy supplies and costs (Meyer et al., 2013a). Furthermore, evidence shows that more compact urban growth combined with mixed-use development and efficient public transport systems can not only increase economic productivity and generate other benefits, but also have a substantial impact on reducing carbon emissions (Floater et al., 2014a) (see Chapter 5, Urban Planning and Design). These benefits include:

Job creation: Direct jobs in new construction and more permanent positions are associated with the continued operation of any new economic activity involving operation and maintenance of new transit systems, energy management for buildings, or distributed energy systems. Additional indirect jobs are created as the result of the new local spending generated from the payroll associated with the direct jobs. This growth further fuels urban and regional economic gains if it is not offset by loss of fossil fuel industry jobs (van den Berge, 2010).

Energy cost savings: Reducing a city's traditional energy consumption through efficiency gains or renewable power generation can expand the local economy simply by saving money for local utility customers. Any changes that increase the ability of a local economy to provide for its own needs keeps money within the local economy longer, thus multiplying the direct impact of increased payrolls or energy-cost savings and raising local well-being.

Higher energy cost certainty: The cost of consumed power is determined in part by fuel cost – and climate-friendly solar, wind, and geothermal fuel supplies are free. Once a renewable energy infrastructure is in place, there is lower risk of rising energy-supply costs due to an increase in fuel or carbon prices. This increased certainty, independent of any cost savings, reduces overall climate change risks and facilitates further response by eliminating the costs of hedging fluctuating fossil fuel prices and utility bills (Grafakos and Flamos, 2015).

Higher electricity supply certainty: Distributed energy and local microgrids made possible by renewable energy provide both climate change adaptation and mitigation returns. Renewables replace fossil fuels and reduce emissions, but the microgrids can also provide electricity service when the grid is down due to weather damage or other system problems, a major climate change adaptive response (see Chapter 12, Urban Energy).

Improved local business competitiveness: Local businesses benefit from climate change adaptation and mitigation investments because these enable them to outperform market competitors, to expand the range of goods and services they offer, or to broaden the markets they serve. Savings linked to lower energy consumption or greater power certainty thus can help to further expand the local economy.

Improved property values and higher tax revenues: Given limited funds available for occupancy of premises, lower power bills make higher-cost mortgages or rentals more affordable for households and businesses alike. Lower mortgage costs may have the same effect, so urban areas may take advantage of national or subnational policies, such as the availability of lower interest rates on government-insured energy efficiency mortgages in the United States, to reduce housing costs by investing in energy efficiency (Meyer et al., 2013a). Buyers and renters with more money to spend may drive up property valuations (Pivo, 2014; Fuerst et al., 2013). Those higher prices may be important to local revenues if real estate value is taxed. If business expansions and associated growth in payrolls are made possible by lower operating costs associated with responses to climate change, they may contribute to government revenues via sales or value-added taxation and/or payrolls and profits, if those gains are subject to taxation.

Sectoral clustering: Enterprises select locations based on the availability of markets, of resource supplies that are expensive to move, and/or of specialized technological knowledge and worker skills. Promoting climate change response investments may enable development efforts to stimulate new sectoral clusters presenting opportunities to a city's economy. An example of climate technology clustering can be found in Copenhagen (Floater et al., 2014a).

Marketing and reputation: Success often breeds success, and special features of a winning economic development effort can provide the basis for a city's marketing campaign that complements and strengthens local efforts to provide new economic opportunities. Cities and local authorities pursuing new investments in real estate or infrastructure that qualify as "zero net carbon" or promoting other "green" or "climate proof" characteristics often are doing so for the reputational gains, not just the environmental benefits. That may explain why many of these efforts are located in the economic development, rather than the environment or sustainability offices in their local governments. These green investments are intended to promote the attraction and retention of skilled workers and businesses.

Quality of life: Actions taken to address climate change can also benefit urban areas through such outcomes as reduced

health costs from air pollution, lower construction costs from more compact urban development, increased social inclusion from higher-quality housing and better public transport links, amenity opportunities and reduction of heat island effect from urban greening, and improvements in environmental, social, and economic equity (see Chapter 6, Equity and Environmental Justice; Chapter 10, Urban Health; and Chapter 11, Housing and Informal Settlements).

7.1.4 Leading Domestic Implementation

Examples of cities more actively engaged in climate policy than their own national governments are quite common (Bulkeley, 2010). This is unsurprising because cities often bear the brunt of concentrated effects of extreme climate events. Such events are less significant at the national than the local scale, so cities may take the lead in climate change action, providing great "bottom-up" learning. There is evidence of proactive cities demonstrating (1) planning and policy implementation for adaptation, risk management and disaster response; and (2) target setting of climate goals (e.g., greenhouse gas [GHG] emissions reduction targets and other mitigation efforts) (Erickson and Tempest, 2014).

Rio de Janeiro has put in place a cross-sectoral Low-Carbon City Development Program (LCCDP), which is an ISO-compliant environmental management system helping the city government to plan, implement, monitor, and account for low-carbon investments and climate change mitigation actions across all sectors in the city over time. The LCCDP Assessment Protocol is aligned with ISO 14064–2, ISO 14001, and the World Resources Institute and World Business Council for Sustainable Development Greenhouse Gas Protocol. Although flexibility has been at the core of the Protocol design and its application – in order to meet the needs of cities globally in developing city-wide, low-emission strategies, regardless of their scale – the requirements of the LCCDP Assessment Protocol provide a concrete and tangible way for cities to operationalize what might otherwise remain vaguely described and summarized as low-carbon development efforts (Scholz and Sugar, 2012; Scholz et al., 2014).

Portland, Oregon, established a locally generated green building program to enhance competitiveness. The city pursued a strategy of incentivizing nationally prominent energy-efficient buildings while developing a local green economic sector that attracted specialized companies and labor from around the country (Allen and Potiowsky, 2008). While Denmark and Sweden are energetically pursuing climate policies at the national level, Copenhagen and Stockholm are pursuing even more stringent policies than their national governments. The 600 local governments in the United States that have established climate change plans have enjoyed far greater success in effective implementation of actions to mitigate carbon emissions than cities without such plans (Millard-Ball, 2012).

Evidence suggests that aspirations of local governments to achieve significant reductions of carbon emissions and reduction of climate change risk often lead them to outperform their countries. According to a recent Stockholm Environment Institute study, city actions could decrease global GHG emissions by 7 Gigatons of carbon dioxide equivalents ($GtCO_2e$) below what national actions are currently on track to achieve in 2030, and by 13 $GtCO_2e$ in 2050 (Erickson and Tempest, 2014).

7.1.5 Accelerating Diffusion of Innovations

If the economic development benefits of climate actions are realized, climate-active cities will gain relative to those that do not undertake comparable efforts. Their successes are likely to have a demonstration effect on cities that have not yet addressed climate change (Rosenbloom, 2008). In turn, this will create interurban competition for economic activity and populations that will drive more city climate change efforts. The first generation of global impacts arising from the efforts of a small number of cities will be multiplied as other cities adopt their practices or adapt them to their situations. In some places, legal constraints or unique environmental conditions may constrain local authority participation, but, in an increasingly globalized economy linked by the flow of goods, services, and now by electronic information, rapid diffusion of knowledge about the successes of initial initiatives should be expected.

The issue, then, becomes how to stimulate and accelerate that diffusion. Assuring financial capacity to act is an essential first step.

Cities could potentially be key allies for disseminating and diffusing a wide range of disruptive innovations that provide jobs for the poor, support green investments, and buck the trend toward building massive, poorly performing infrastructure. Examples of actions that could also address both mitigation and adaptation include distributed solar power, rooftop gardens, urban farming, green spaces through recycled water, cashless transactions, and innovative mobility solutions, as well as recapturing public space for greening and reuse of streets formerly dedicated to transport, such as for street art, street cuisine, and theater (see Chapter 5, Urban Planning and Design).

7.2 Role of Funding and Finance

Adequate financial resources are essential to undertake climate change mitigation and adaptation activities, particularly for those cities in low-income countries that also need to reduce poverty and ensure economic and social development (see Table 7.1)

Access to such financial resources will become increasingly significant as cities take on more responsibilities to mitigate GHG emissions and adapt to ongoing changes. This is to be expected because the impacts of climate change are felt at the local level, and city governments typically are the first responders (Rosenzweig and Solecki, 2014); those impacts will become more prevalent. At the same time, existing development demands and day-to-day tasks have already strained the financial capacity of many cities, while external funding for specific climate change programs is scarce.

Table 7.1 *Costs for climate change actions and green bonds subsidies. Source: OECD, Organization for Economic Co-operation and Development*

Mitigation	**Scale**	**Timeframe**	**Cost (US$)**	**Source**
Investment in capital infrastructure	Global	–	$25 trillion	World Bank Group (2013)
Investment gap without climate change	Global	Annual	$1 trillion	World Bank Group
Potential savings in terms of energy costs	Global	–	$950 million	Climate Major Group
Money used for climate-related projects and programs	Cities	2012	$359 billion	Climate Policy Initiative
Impacts and Adaptation	**Scale**	**Timeframe**	**Cost (US$)**	**Source**
Costs from flooding due to climate change per year (impacts)	Global	2025	$25 trillion	World Bank Group (2013)
Response to anticipated 2°C temperature rise	Global	–	$14 trillion	World Economic Forum
Annual cost of climate change adaptation	Global	Annual	$80–100 billion	–
Average annual infrastructure investment needed for 2°C temperature rise	Cites	Annual	$5.7 trillion	World Economic Forum
Green Bonds	**Scale**	**Timeframe**	**Cost (US$)**	**Source**
Issuance of green bonds by State of Massachusetts	Regional	2013	$100 million	Climate Bond Initiative
HSBC estimate for green bond issuance by end of 2014	Cities	2015	$40 billion	Climate Bond Initiative
HSBC estimate for green bond issuance for 2015	Cities	2016	$100 billion	Soffiatti (2012); Merk et al. (2012)
Funds used by UK Green Investment Bank for modern green infrastructure	Cities	–	$5.9 billion	UKgov.greeninvestmentbank.com
Issuance of green bonds Gothenburg	Cities	2013	$79 million	Climate Bond Initiative
Issuance of green bonds Johannesburg	Cities	2013	$136 million	Climate Bond Initiative
Other	**Scale**	**Timeframe**	**Cost (US$)**	**Source**
Pension fund assets at the end of 2012 in OECD countries	Global	2012	$78 trillion	OECD (2013)
Sovereign wealth funds held by national governments	Global	2014	$7.2 trillion	SWFI (2015)
Money raised by São Paulo using Land Value Capture	Cities	–	$1.2 billion	Soffiatti (2012); Merk et al. (2012)
World Bank loan for Mexico Urban Transport	Cities	2010	$200 million	World Bank Group (2010a)
Clean Technology loan for Mexico Urban Transport	Cities	2010	$200 million	World Bank Group (2010a)
Profits from “Rail plus Property” model in Hong Kong	Cities	2013	$940 million	World Bank Group (2010a)
Investment by Curitiba for conversion of highway to BRT corridor	Cities	–	$600 million	Soffiatti (2012); Merk et al. (2012)

Municipalities also face legal and structural financial difficulties due to national regulations on local governance and fiscal management, as well as limited financial absorptive capacity. Particularly for adaptation, Revi et al. (2014) state that there is limited current commitment to provide finance from different levels of government and international agencies. We discuss the challenges that confront municipalities attempting to fund climate change activities, available funding sources, and how to increase the access of cities to those resources.

7.2.1 Infrastructure Financing Needs in Cities Related to Climate Change

The World Bank recognizes the need for additional partnerships to make more climate change funding available for local governments (World Bank Group, 2013). Partnerships with the private sector and key stakeholders are essential in successful adaptation and mitigation processes at the city level. The World Economic Forum (WEF) summarized estimates of necessary

infrastructure investment calculated by several institutions such as the International Energy Agency, Food & Agricultural Organization, Organization for Economic Co-operation and Development, and the United Nations Environmental Program (World Economic Forum [WEF], 2013). Under a business-as-usual scenario (i.e., without taking climate change into account), the WEF arrived at an investment gap of US$100 trillion. Responding to an anticipated 2°C temperature rise will add only $14 trillion, or 14% to the total gap. The biggest investment challenges, therefore, appear to exist independent of climate change. Mobilizing the funding for infrastructure that will be required through 2030 is a daunting task, but, it may be made easier by the threat of climate change and the role that climate-resilient public infrastructure can play in reducing the risks involved and in catalyzing private investments.

National infrastructure gaps are much larger than those faced by any one city or even the totality of global conurbations. But, due to their density and total populations, cities are the places most likely to suffer the adverse consequences of inadequate infrastructure. This suggests that cities should make sure that funding dedicated to closing the gap is deployed in a manner that takes climate change considerations into account. Thus, it is crucial that mitigation and adaptation not be thought of as activities separate from urban infrastructure development. Rather, climate change considerations must be mainstreamed into such investments, especially due to their long-term nature and the need for climate-resilient and low-carbon infrastructure development paths.

7.2.2 Challenges for Cities in Financing Climate Change Activities

Lack of reliable financing often goes back to capacity and regulatory barriers that limit cities' access to finance for climate change activities (Beltran, 2012). Project development and management capacity may be limited by the absence of specialist staffing and limited availability of geographical information systems (GIS) and risk exposure mapping, GHG inventories, and/or acceptance of the measurement, reporting, and validation (MRV) protocols required for adaptive program planning. Those capacities also may be limited by constraints on local authorities' powers to act independently, requirements for bidding and procurement that limit access to specialists, and/or barriers to subnational public bodies gaining access to international financing and its associated expertise (New Climate Economy [NCE], 2014).

The biggest barrier by far, however, in accessing capital for urban infrastructure is the perceived lack in private capital markets of creditworthiness on the part of city governments. An analysis by Lall (2013) of the 500 largest cities in developing countries shows that only about 4% are creditworthy in international financial markets and only 20% are creditworthy in local markets. In relation to this, the World Bank notes that US$1 invested in raising creditworthiness can leverage more than US$100 in private-sector financing for smart infrastructure (World Bank Group, 2013b). Creditworthiness of the city government may depend on the (1) types and bankability of the projects executed by the city municipality; (2) fiscal stability and governance, including transparency; and (3) national financial regulations and institutions. In particular, fiscal stability depends on the effectiveness of the local tax and service charge collection system of the city government. The capacity to manage revenues and expenditures in the local fiscal budget is a key for municipalities to strengthen their creditworthiness – and thus their ability to leverage external funds. In this context, the World Bank and its partners have designed a City Creditworthiness Program to help city financial officers conduct thorough reviews of their municipal revenue management systems and take actions to qualify for a rating (see Box 7.1).

For cities to take effective action on climate change, their fiscal management and project development and implementation capacities must be upgraded. Specific climate change–related tools such as GHG inventories, vulnerability assessments, and action plans can strengthen cities' capacity to develop and execute climate change projects and leverage the required resources.

7.2.3 Finance Opportunities for Cities

In an important tracking effort, the Climate Policy Initiative (2013) estimated that US$359 billion flowed into climate-related projects and programs in 2012. Comparing this to the average annual US$5.7 trillion infrastructure investment needed to achieve the 2°C stabilization target (WEF, 2013), it is clear that public funding mechanisms will be inadequate – even with stepped-up contributions to the Green Climate Fund, a global platform that invests in low-emission and climate-resilient development. Cities therefore must tap into a full spectrum of opportunities to raise money for climate action.

Figure 7.1 shows how municipal governments could raise climate finances and how this could be invested in programs and projects, although both the inflow and outflow of a municipality's finances will vary depending on its level of fiscal autonomy.

7.2.3.1 Domestic Public Finance

Domestic public finance is a key source of finance for climate change activities at the subnational level. For municipalities, there are four sources:

- Local taxes and service charges
- Transfers from the federal or state governments
- Borrowing from domestic financial institutions
- Bond and equity finance from domestic capital markets

7.2.3.1.1 Local Tax, Service Charges, and Transfers from the National Government

Indigenous revenues from local taxes and service charges are a limited but stable source of finance for cities. Although most countries collect taxes through national systems, local governments

Box 7.1 The World Bank City Creditworthiness Initiative: Innovation to Improve Cities' Access to Funding for Low-Carbon, Resilient Infrastructure

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Cities are challenged to deliver basic services to their populations, and, with the pressure from accelerated growth, urbanization, and climate change, the matter of financing infrastructure services takes on additional urgency. City budgets alone are often unable to meet these growing demands, and subnationals' weak creditworthiness is a major constraint to raising other financing. A World Bank analysis of the 500 largest cities in developing countries shows that only a fraction of them are deemed creditworthy: Approximately 20% have access to local market financing, and a mere 4% can access financing in international markets. Helping cities access private financing is a smart investment. Internal estimates from the World Bank indicate that every dollar invested in the creditworthiness of a developing country city has the potential to mobilize more than US$100 in private-sector financing for low-carbon and climate-resilient infrastructure.

In this context, the World Bank launched the City Creditworthiness Initiative in 2013, in partnership with the Public Private Infrastructure Advisory Facility (PPIAF), the Korean Green Growth Trust Fund, the Rockefeller Foundation, and UN-Habitat.[1] The Initiative is designed to systematically identify and reach reform-minded cities with customized technical assistance to assist them in accessing long-term financing for green growth and climate-smart infrastructure. Design of the Initiative was informed by a prior engagement the World Bank and PPIAF had with the Metropolitan Municipality of Lima, Peru, which led to the city achieving investment grade ratings and raising capital that helped finance the city's bus-rapid transit (BRT) system.

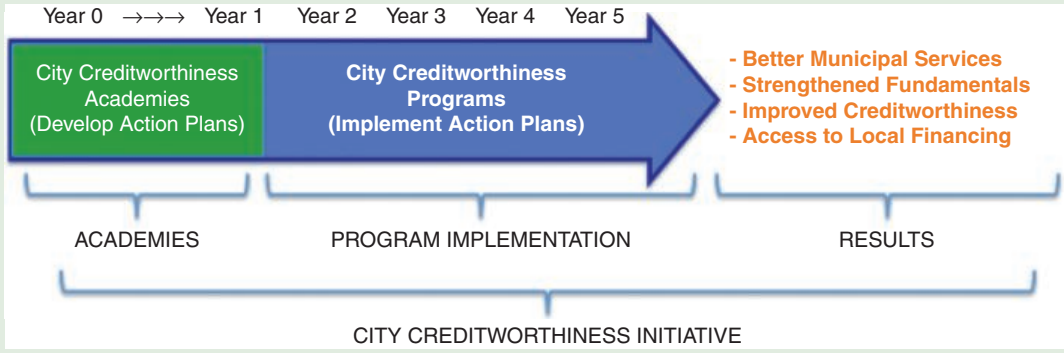
Among other things, the City Creditworthiness Initiative assists city financial officers in conducting thorough reviews of their municipal revenue management systems, in understanding how rating agencies and potential investors assess credit quality, and in taking the first steps to qualify for a rating while recognizing that achieving an investment grade will likely take several years of effort. Improving credit standing is important even where private capital lending is not yet possible because the factors that contribute to creditworthiness can be broadly interpreted to stand for good governance and administration.

The City Creditworthiness Initiative comprises different elements/stages designed to achieve impact with efficient use of limited resources (as summarized in Figure 1).

Engagement typically starts with the delivery of an "Academy," a five-day interactive workshop dealing with the full range of factors affecting cities' financial management performance, including issues determined by the national enabling environment and options for financing, including the use of special-purpose vehicles and public–private partnerships.

During the Academy, participants complete self-assessments that lead to customized draft action plans to improve their overall management and facilitate their ability to plan, finance, build, and operate infrastructure projects. More targeted support is provided during the post-Academy phase, when cities finalize and approve these action plans.

Technical assistance provided through the Initiative may encompass everything from improving national legal and regulatory frameworks for local government finance, promoting the use of data in decision-making and policy formulation, and improving revenue collection and management systems and procedures, to reforming local capital planning and budgeting processes. Some financial advisory support will also be provided for obtaining private capital investment for selected adaptation and/or mitigation projects. Knowledge management and sharing is a strong focus of the Initiative. An online information repository is being developed to provide



Box 7.1 Figure 1 *Elements and stages of the World Bank City Creditworthiness Initiative.*

1 Additional partners support specific components of the Initiative such as the "Creditworthiness Academies" or technical assistance programs. For example, IFC, USAID, Findeter, Fitch Ratings, the Municipal Institute of Learning (MILE), C40, and Agusto were all key partners for specific Academies.

opportunities for asking questions and sharing experiences related to creditworthiness.

MAIN CHARACTERISTICS AND HIGHLIGHTS

Scalability/replicability: The Initiative aims to assist 300 local governments from as many as 50–60 developing countries directly. It is expected that as many as 3,000 subnational entities will benefit through knowledge sharing and dissemination and take action to improve their creditworthiness gaps.

Flexibility and low cost of first engagement: It is estimated that Academies cost less than US$2,000 per city, making it a relatively low-cost form of first engagement. The core academy curriculum addresses all creditworthiness factors and is adapted to each host country and to the characteristics of invited participants.[2] The materials are adapted for work with local governments of various sizes, from small districts in low-income countries to megacities in middle-income countries. As of April 2015, four Academies have been delivered: in Nairobi (for East Africa), Seoul (for East and Southeast Asia), Arusha (for Tanzania), and Bogotá (for Colombia). These academies covered 23 countries and included 83 cities and 258 participants. Four additional Academies occurred in May 2015: three organized by the World Bank and covering Uganda, Rwanda, Jordan, and West Bank Gaza. The fourth, organized by the C40 network of cities is for 10 global megacities and was held in Jordan.

Practicality and results: Local stakeholder engagement is key. The self-assessment process throughout the initial engagement invites the participants themselves to prioritize critical challenges and potential actions. To date, more than 150 cities have joined the Initiative, completed self-assessments producing diagnostics, and developed basic action plans as a result. Identification and implementation of post-academy support is ongoing and includes:

- US$1 million raised for technical assistance programs for 34 municipalities in Tanzania, already in full implementation
- Similar funding levels being secured in the short-term for Colombia, Uganda, and Rwanda
- Ongoing support to the Kampala Capital City Authority, in Uganda, with more than 80% in enhanced revenues and the first credit rating delivered to a local government in the country
- Support to Dakar, Senegal, with own-source revenues enhancement activities and transaction support for a bond issuance

The City Creditworthiness Initiative's long-term objective is to facilitate municipalities' creditworthiness to make them more attractive to private investors and help them access markets to get finance flowing for low-carbon planning. The Initiative complements other development goals, and, along the way, municipalities can reap benefits from short- and medium-term achievements.

often have legal authority to collect residual taxes on their own. In practice, there is a tension between national and local taxes and between different localities that impose lower taxes to attract industrial and commercial investment, thus limiting the municipal revenue that can be achieved. Another relatively limited source of revenue for cities is the collection of service fees. Cities provide public services such as public transport, waste collection/disposal, and drinking water supply. These services generate stable but price-sensitive sources of municipal revenue that add to local budgets but are often earmarked for specific use.

Thus, local governments have only limited opportunities to raise discretionary revenues. Typically, they are financially reliant on national governments. For example, whereas the highly decentralized national government in Indonesia has limited influence over urban policy, it can provide a financial incentive through the Specific Allocation Fund (DAK-EE) to encourage urban investment to reduce air pollution, increase adaptation, improve basic services, or otherwise contribute to green growth (Indonesia Ministry of Finance, 2014). In addition to transferring part of their budgets to the local government, in the case of large infrastructure projects (e.g., mass transit systems), national governments often take responsibility for undertaking urban infrastructure development. Even though the national government can manage larger public investments in more climate-resilient infrastructure than can municipalities, the national government may not necessarily invest.

In some instances, despite limited resources, national governments compensate local authorities for the positive environmental spillovers of their spending. Examples include Brazil's tax-based Payment for Ecosystem Services and Sweden's Climate Investment Program (KLIMP) (Revi et al., 2014).

Local tax revenue, service fees, and allocations from national governments can form core stable finance sources for cities. The scale and stability of these sources of revenue are the key factor in municipal creditworthiness. Municipalities need to build their capacity to manage these core revenues and expenditures in order to strengthen their creditworthiness, thereby helping them to manage their funds effectively and attract private investment.

7.2.3.1.2 National and Regional Development Banks

Some countries have their own national development banks. In general, they are established as publicly owned entities and national governments are major shareholders, but they collect funds from the market and/or savings and deposits. National development banks play an important role

2 Host country partners assist in identifying the core set of local governments to be invited.

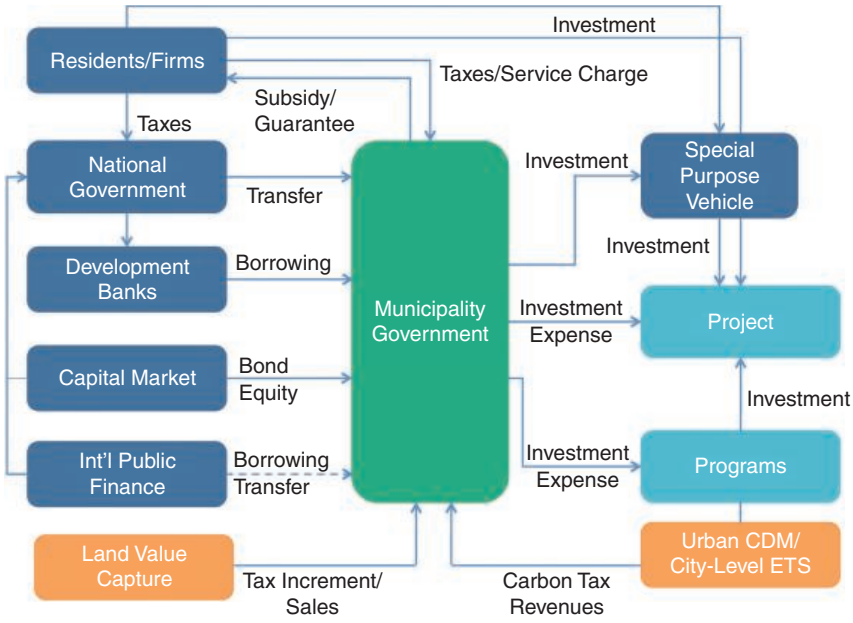


Figure 7.1 *Climate finance opportunities for municipalities.*

as agents for governments to provide long-term finance in line with their policies (IDFC, 2013). City governments and municipalities may be able to apply to these domestic public banks for resources under special lines with favorable lender conditions in the field of climate change mitigation and adaptation (KfW, 2013).

One emerging case of a regional development bank is the New York Green Bank that has been established as a public–private partnership (PPP). It is a state-sponsored specialized financial entity designed to address gaps in clean energy financing and to transform those markets as part of an integrated strategic statewide energy plan (greenbank.ny.gov). Another example is the UK Green Investment Bank, founded in 2012 by the government of the United Kingdom with US$5.9 billion to leverage private funds for modern green infrastructure.[3]

7.2.3.1.3 Local Government Bonds

Depending on the powers granted by higher levels of government, some cities may be able to issue local government bonds in domestic and/or international markets. The bond issuer can earmark the use of proceeds as well as designate the source of funds for repayment, so the tool can be focused on financing climate change actions. Some bonds earmarked for environmental or climate purposes are being called "green bonds" or "climate bonds." In 2013, Massachusetts initiated this form of bonds, authorizing the municipal issuance of US$100 million in green bonds. Gothenburg, Germany, and Johannesburg, South Africa, followed, issuing green bonds for SEK 500 million (US$79 million) and ZAR1.45 billion (US$136 million), respectively. The green bond market is growing rapidly, and HSBC estimated that green bond issuance would reach US$40 billion by the end of 2014, rising to US$100 billion in 2015 (Climate Bond Initiative, 2014).

Subnational entities are often perceived to be high-risk borrowers, which increases their borrowing costs. By obtaining formal public credit ratings, creditworthy subnationals can increase their lenders pool, raise cheaper funds, and borrow without sovereign guarantees. *Shadow*, or *confidential*, ratings allow subnationals to identify the issues that need to be addressed to improve their creditworthiness before obtaining a formal rating. The World Bank Group's PPIAF's Subnational Technical Assistance (SNTA) program can assist subnational entities to prepare for and obtain credit ratings.[4] The SNTA program can also provide technical assistance to improve a subnational's creditworthiness and address weaknesses highlighted by a rating assessment. Although the possibility of bond issuance as well as borrowing from financial institutions depends on national and local regulations for fiscal management of municipalities, municipalities should explore this possibility for direct access to climate finance.

7.2.3.2 International Public Finance

Bilateral and multilateral donors have increasingly focused on providing financing specifically for climate action, and corresponding programs and funds have been established that support activities in urban areas.

International public funds dedicated to climate change include:
- Multilateral Development Banks
- Global Environment Facility
- Climate Investment Funds

3 UKgov.greeninvestmentbank.com
4 (http://www.ppiaf.org/page/sub-national-technical-assistance).

- Green Climate Fund
- Sustainable Development Goals Fund (SDG-F)
- Least-Developed Countries Fund
- Special Climate Change Fund
- Millennium Development Goal Achievement Fund
- Adaptation Fund
- Global Facility for Disaster Reduction and Recovery (GFDRR)
- Bilateral sources (national donor funding)

Most international donors and funds channel their resources through national governments of the recipient country (World Bank Group, 2011). The Mexico Urban Transport Transformation Program, for example, is co-financed by a US$200 million World Bank loan and by another US$200 million loan from the Clean Technology Fund. Although these resources will benefit Mexican municipalities that reduce GHG emissions in the urban transportation sectors, participating cities access them through the Banco Nacional de Obras rather than receiving them directly from the donor institutions (World Bank Group, 2010). Multilateral grant finance benefiting cities is usually distributed through or at least in close cooperation with national governments.

There are several reasons for the central role of national governments in the distribution of multilateral funding to subnational actors. Most importantly, the activities of international donors usually follow agreements negotiated with national governments, for example bilateral contracts or the World Bank's Country Assistance Strategies. Furthermore, internationally funded projects need to be planned and implemented in a manner consistent with national development plans, which are likely disclosed to funders before monies are awarded. For lending operations and guarantee instruments, the role of national governments is even more important because a sovereign guarantee is usually required for these modalities to be used. If cities want to benefit from multilateral funding, they will therefore usually have to negotiate access with their national government.

Nevertheless, under certain conditions, donors can deal directly with city governments. In the case of the Inter-American Development Bank, loans and guarantees can be provided to municipalities through the Bank's private-sector facility without requiring a sovereign guarantee. Multilateral sources providing direct access for cities also include the Adaptation Fund and the Millennium Development Goal Achievement Fund (World Bank Group, 2011). Nevertheless, consistency with country strategies and the non-objection of the national government are still required. Therefore, even though cities could access multilateral finance directly, these provisions are rarely used. This is unfortunate since the incentive and capacity to leverage external funds may be greater at the local than the national level.

The limits and barriers to accessing international donor funding imply that most of the funding needed to tackle the challenges of climate change in cities will have to be mobilized by local governments themselves, in the best case with support from their national governments. As such, it is crucial that cities mainstream climate change considerations into their sectoral infrastructure activities. This is especially true because responding to climate change can be achieved by closing the current development gap, although special attention to low-carbon and resilience transformation will be required (World Bank Group, 2011).

7.2.3.3 Private Sources of Finance

7.2.3.3.1 Private Investment in City Infrastructure

In some instances, private finance takes the form of actual ownership of, rather than lending for, needed infrastructure. That is, the private sector may construct or purchase public assets and operate them, thus freeing up public-sector resources for other investments as the private firms manage and deliver public services. Private capital has funded water and sewage systems, transportation systems, telecommunications, and other needed infrastructure for decades (Smith, 1999; Harris, 2003). Privatization has its costs in terms of some decline in the level of public control over prices and quality of services, but its benefits may include making funds available for public efforts that no private investor would fund itself, such as population relocations and other climate adaptation measures for the most vulnerable urban populations with minimal ability to pay for such protection.

Over the long term, the need for private investments to return profits to their owners means that public services or facilities owned by private firms may generate lower public benefits than those owned publically, especially after the debts incurred in their construction are paid for (Harris, 2003; Kessides, 2004). But provision of needed infrastructure through private ownership may be one way for cities to overcome the problems of their limited creditworthiness when pursuing loans, even from favorably inclined development banks. As climate risks become more severe and the need for adaptation measures more acute, the public benefits to be gained from freeing capital for adaptation investments that would not otherwise be available in urban areas with low credit status may warrant support for private ownership of assets that traditionally have been held in public hands. On the other hand, such developments may pose problems for public provision due to concerns over allocation of associated risks (Ng and Loosemore, 2007).

7.2.3.3.2 Pension Funds

By far the largest individual investment pools in the world include public and private pension or superannuation funds. Pension fund assets at the end of 2012 in countries of the Organization for Economic Co-operation and Development (OECD) alone totaled more than US$78 trillion (Organization for Economic Cooperation and Development [OECD], 2013b). Globally, sovereign-wealth funds held by national governments, some of which provide pensions to their citizens with these public assets, amounted to US$7.2 trillion in 2014 (Sovereign Wealth Fund Institute [SWFI], 2015). With the responsibility of investing to provide funds for retirees, such funds can be characterized as "patient capital." That is, they do not need to show immediate returns to impatient individual investors, but rather need to

have earned returns by the time their members reach retirement age; that is, typically decades in the future. At the same time, they have stringent fiduciary responsibilities and must concern themselves with capital preservation. Thus, they can only accept innovative opportunities if their risk of loss is minimized. They may, however, be modernizing their investment criteria (OECD, 1998, 2008).

To the extent that climate change becomes more acute over time, any investments that successfully respond to those changes, whether providing adaptation and/or mitigation services, will increase in value over time. If the services are sufficiently in demand today that their provision involves a break-even investment, sector-level losses are unlikely and future profits could be exceptionally high. City climate action programs that can meet this threshold condition, therefore, may be able to access the large amounts of capital controlled by pension funds.

7.2.3.4 Market Mechanisms and Other Innovative Finance Sources

7.2.3.4.1 Clean Development Mechanism

The Clean Development Mechanism (CDM) is one of the "flexibility mechanisms" defined under the Kyoto Protocol.[5] Its objective is to assist developing countries in achieving sustainable development and mitigating GHG emissions that cause climate change. In addition, CDM aims to assist industrialized countries in achieving compliance with their quantified emissions limitations. Despite its great success, with more than 7,500 CDM projects registered within many countries and sectors, some important emission sources, sectors, and countries are still underrepresented within the CDM, especially in some of the least developed countries of Africa and Asia (Spalding-Fecher et al., 2012). A relatively high number of approved methodologies are applicable in the urban context, and several successes demonstrate that CDM activities are possible in cities.

Urban areas have the highest populations, which leads to increased demand for energy resources and high levels of GHG emissions. Implementing sustainability and emission mitigation measures in cities has great potential to be replicated in other cities and countries and may lead to positive co-benefits. Although the CDM instrument, given its evolving nature, has limitations for wider application in mitigating carbon emissions in cities, mitigation measures in cities that are initiated by city councils or municipalities should cover more than one sector/technology. The United Nations Environment Program (UNEP) and Gwangju City (2012) demonstrate that the CDM has evolved by introducing the concept of a Program of Activities (PoA) that allows for the combination of an unlimited number of emission mitigation activities under a single umbrella using different methodologies.

The World Bank's citywide approach proposal follows the basic principles of a CDM PoA that is based on a multisector approach (World Bank, 2010). Under such an approach, the coordinating entity (e.g., a municipality) would have the flexibility to combine relevant technology options across different sectors given its financial and development abilities. This PoA concept refers to relevant CDM methodologies for quantification of the emissions reductions. Note, however, that the demand for Kyoto credits remains low, possibly due to the uncertain future of CDM under the Post Kyoto Paris Agreement framework. According to the World Bank (2014), there is a growing feeling in the CDM market that demand is saturated. With little prospect of a significant recovery, the biggest players have begun to leave the market, along with their skills and expertise.

Other innovative approaches include setting aside the funds saved from increased energy efficiency investments for adaptation or further mitigating efficiency efforts (Meyer et al., 2013b; Revi et al., 2014) or revolving loan pools that replenish themselves as projects mature and that might be funded through revenue streams from CDM projects (Puppim de Oliveira, 2009).

7.2.3.4.2 City-Level Emissions Trading Systems

A city-level GHG emissions trading system (ETS) is a mitigation approach to encourage municipalities and their private sectors to foster low-carbon project financing. The Governor of Tokyo, Shintaro Ishihara, submitted a bill to the Tokyo Metropolitan Assembly in June 2008 that introduced mandatory targets for reductions in overall GHG emissions for large-scale emitters as part of an emissions trading program. The Tokyo Metropolitan Assembly passed the bill, thus introducing Japan's first cap-and-trade emissions trading program, which took effect in fiscal 2010. Since then, the Tokyo Metropolitan Government (TMG) developed a cap-and-trade program that many advanced nations and regions are also moving to implement. TMG's program is the first one to be implemented in Japan and Asia (Tokyo Metropolitan Government, 2010) (see Case Study 7.3).

The government of China announced its plan to develop seven official ETS pilot programs (Beijing, Shanghai, Tianjin, Chongqing, Guangdong, Hubei, and Shenzhen) in 2011. This plan began phase-in during 2013. By April 2014, six of the seven pilot schemes started trading. Carbon markets are now officially open for business in China. The total 2013 allocations of these six pilots combined amount to 1,115 MtCO2e, making China the second largest carbon market in the world, after the European Union (EU) ETS. The Guangdong ETS, the largest of the Chinese ETS pilots, itself covered 388 $MtCO_2e$ in 2013, equivalent to of France's GHG emissions in 2012 (World Bank, 2014).

7.2.3.4.3 Land Value Capture

Cities usually own substantial assets that could be managed to facilitate climate change mitigation and adaptation. One approach, already frequently used for financing transportation

5 www.cdm.unfccc.int

systems, is land value capture. Land value capture, like local taxes, user charges, and licenses are local public sources of finance. As Smith and Gihring (2006) describe, transit infrastructure can be at least partly funded by capturing the increase in the land value of properties close to transit stations.

There are different variations of land value capture: development impact fees, tax incremental financing, public land leasing and development right sales, land readjustment programs, connection fees, joint developments, and cost-benefit-sharing (NCE, 2014). For example, in Hong Kong, the government's "Rail plus Property" model captures the uplift in property values along new transit routes, ensuring efficient urban form while delivering US$940 million in profits in 2009 for the 76% government-owned MTR Corporation (Rode et al., 2013). São Paulo has raised more than US$1.2 billion in 6 years using related instruments, and Curitiba is funding the conversion of a highway into a BRT corridor, complemented by higher-density, mixed-use spaces and green areas – an investment of US$600 million (Soffiatti, 2012; Merk et al., 2012).

Certain climate change–related activities provide immediate co-benefits that similarly could help with project finance and leverage appropriated or granted project-specific funds. For example, providing public green spaces would increase surface permeability and improve air quality, but it also would increase the value of the surrounding properties and thus the real estate taxes of the municipality. Also, vulnerability reduction could raise land and property values and generate savings by reducing insurance premiums. Where value capture is possible, the challenge is likely to be mobilizing upfront financing rather than medium- or long-term cost recovery.

Certain city assets can also be used directly for climate action. A prime example is public space designed to help in reducing risk. Green improvements to publicly–owned lands could reduce the need for more expensive gray infrastructure, another form of leveraging. Interventions like the creation of green corridors, green roofs, and urban gardens to separate sidewalks from vehicle traffic or the creation or redesign of parks as a network that facilitates runoff and retention of water, thus create mitigating inundations (GeoAdaptive, 2013) (see Chapter 5, Urban Planning and Design). At the same time, such interventions can reduce GHG emissions and provide additional co-benefits such as reducing the urban heat island effect. The effect of heat waves can be mitigated by simple measures like painting roofs in light colors that reflect rather than absorb solar radiation. These are only some of the many climate action measures that cities can take without having to resort to expensive infrastructure. Mainstreaming such innovations into city operations across sectors is therefore of utmost importance.

7.3 The Role of the Private Sector

As concentrations of people, cities produce agglomeration effects and attract business enterprises (NCE, 2014). Hence, the potential role of the private sector in urban climate mitigation and resilience is important and multifaceted. While private-sector engagement has become a buzz-word for policy-makers and climate experts, its role is poorly understood (Surminski, 2013; Averchenkova et al., 2016). This section aims to present modalities of private-sector engagement in urban climate mitigation and adaptation by looking at the challenges, barriers, and opportunities such engagement presents. The scope of the private sector here is restricted to businesses and does not include community, nongovernmental organization (NGO)-led, and household interventions.

7.3.1 Modalities of Private Sector Engagement

Policy-makers have growing expectations of how the private sector may be involved with meeting public policy goals for climate change, although it is still somewhat unclear what action qualifies as private-sector adaptation or if and how companies consider their efforts in the context of future climate trends rather than current risks (Averchenkova et al., 2016; Isaho and Surminski, 2015). A review of climate change strategies published by different cities (especially Tokyo, Delhi, Mexico City, New York, São Paulo, Dhaka, Calcutta, and Karachi) and published case studies (e.g., Copenhagen) (Floater et al., 2014a) show the different roles that the private sector may play. Key lessons learned from these cases are:

- The private sector may be involved in partnerships with city governments for the provision of technologies, the construction and operation of infrastructure, and the provision of insurance, to cite a few emergent fields. "Cleantech" clustering is a promising strategy for building partnerships and networks among private entities, the research community, and public institutions, which facilitates the commercialization of new products and services (applicable to almost all cities).
- Companies are a key vehicle for implementing climate change strategies because they have to comply with regulations for energy saving and GHG emissions reduction, such as standards, rating systems, or cap-and-trade schemes. They also have to comply with requirements of environment performance disclosure. This ensures their motivation in engaging in climate mitigation and adaptation activities (applicable to all cities).
- Low-carbon and resilient urban development provides business opportunities for innovative products and services in myriad sectors, including transport, waste, energy, civil construction, urban planning, food, insurance, knowledge management, and R&D. Local and national policies can create business opportunities for local firms to apply their technologies (many cities, but outstanding examples are Mexico City and São Paulo).
- Companies may receive support for financing the implementation of low-carbon technologies, for example, through collateralized bond obligations (CBO) or support instruments for renewable energy deployment, and for exploiting new business opportunities (e.g., Tokyo and Mexico City).
- Companies can increase efficiency and productivity and provide funding for climate-related solutions if correctly incentivized (e.g., São Paulo).

Case Study 7.1 London Climate Change Partnership: Public- and Private-Sector Collaboration

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Keywords	Resilient city, multisectoral partnership, policy, flood, heat waves, economics and finance
Population (Metropolitan Region)	14,031,830 (Eurostat, 2015a)
Area (Metropolitan Region)	12,091 km^2 (Eurostat, 2015b)
Income per capita	US$42,390 (World Bank, 2017)
Climate zone	Cfb – Temperate, without dry season, warm summer (Peel et al., 2007)

Mounting cross-cutting climate risks cannot be addressed successfully at any single institutional or spatial scale or by any one category of actor. Multisectoral partnerships (MSPS) are increasingly central to the new wave of climate governance. They hold the potential for innovative solutions but also raise considerable challenges in terms of power relations, accountability, equity, and effectiveness. Partnerships are often underpinned by complex multiscale governance arrangements that need to be better understood. One example of a long-established effort to bring together public- and private-sector players within an urban context is the London Climate Change Partnership (LCCP).

Launched in 2001 by the then Mayor, Ken Livingstone, the LCCP supports climate risk reduction and climate change adaptation across London. As a large city with complex cross-boundary environmental risks, London´s collaborative management of climate risks across spatial, political, and organizational boundaries is critical. Such risks cannot be dealt with solely by just one category of actor, and LCCP's approach has focused on harnessing the understanding and expertise of local, national, and London-specific organizations and representatives, including a range of public and private groups. This strategy has facilitated the delivery of advice, research, and understanding of how London can become a climate-resilient city. The LCCP has a long-term outlook with a range of actions to prepare London for extreme weather events and future impacts of climate change (see Table 1).

Coordination and facilitation of the LCCP is government-led, with funding from the Environment Programme budget from the Greater London Authority (GLA), the city government for London. There are over 20 members consisting of experts in the fields of environment, finance, health and social care, development, housing, government, utility, communications, transport, and retail sectors. The partnership's work is structured around several projects that involve research on specific climate risks as well as resilience actions (see Table 2). These include additional projects for climate resilience, such as Drain London; a cross-boundary strategy to develop surface water management plans for London and its boroughs (city government).

THE PARTNERSHIP APPROACH: WHAT CAN WE LEARN?

The LCCP provides an important example of how an urban partnership approach can address climate risks. Although the LCCP has proved effective in many ways, the partnership also faces multiple challenges including financial constraints and complex funding arrangements, political barriers, and divergent perspectives and expectations amongst partners, as well as difficulties in assessing impacts of partnership activities and functions. This is particularly relevant in the context of the broader scope of adaptation. Our survey of LCCP members has revealed that the dominant focus of past and current work is on knowledge-sharing and information dissemination, whereas the implementation

Case Study 7.1 Table 1 *An overview of the LCCP including key actions.*

Characteristic	Detail
Members	Twenty-four members representing a range of public-, private-, and community-sector organizations.
Spatial scope	Greater London
Sector	Public-based organization, but members are public, private, or voluntary
Key actions	• Collecting and sharing information about expected climate change impacts on London and possible adaptation options • Raising awareness of organizations and individuals of the impacts of climate change • Facilitating and encouraging adaptation in London • Informing policy with local evidence • Monitoring London's preparedness for climate change • Seeking opportunities to improve resilience to climate change
Established	Established in 2001 by the Government Office for London and run by the Greater London Authority
Wider scope	LCCP members work with the London Resilience team, and LCCP is part of Climate UK, a UK-based community interest group.

Case Study 7.1 Table 2 *Key past and present projects delivered under the LCCP.*

Project	Involved lead partners
Adaptation Economy	Greater London Authority
Observing London	The Met Office, Greater London Authority, Reading University, Lloyd's of London
Retrofitting London	Sustainable Homes, Greater London Authority, Thames Water and the Environment Agency
Resilient Business	Greater London Authority
Overheating Thresholds for Londoners	Environment Agency and Greater London Authority
Joint Strategic Needs Assessment Guidance	Greater London Authority and London Boroughs
Capturing Adaptation Research for London	UK Climate Impacts Programme (UKCIP), Environment Agency
Retrofitting social housing: Barking and Dagenham	Sustainable Homes, London Borough of Barking and Dagenham, Mayor of London, Sprunt, United House, Environment Agency
London Health and Social Care Climate Action Plan	London Climate Change Partnership

of adaptation measures rests predominantly with the individual partnership members and other stakeholders. This Case Study forms part of a large European Union-funded research project ENHANCE. ENHANCE aims to develop and analyze new ways to enhance society's resilience to catastrophic natural hazard impacts and develop supportive multisectoral partnerships and to understand the relationships between partners in delivering climate mitigation and resilience.

- Companies can help in advocacy and generate mass awareness, especially when they are subject to disclosure requirements about their GHG emissions and climate risks (many cities).
- Private business can collaborate with tertiary education and research institutions in the search of innovation excellence in the area of mitigation (e.g., Copenhagen).
- Scientific information is key to inform business management decisions to ensure business resilience within climate change mitigation and adaptation strategies (e.g., New York).
- Local entrepreneurship and foreign private capital are drivers of urban transformation, growth, and competitiveness, but financial and information barriers to attracting finance remain in the clean technology sector. These barriers can be overcome through coordination between national and local-level policies (e.g., Copenhagen).

These examples demonstrate that private-sector engagement can occur in many shapes and forms. These can be categorized according to four modalities: business continuity, business opportunities, business finance, and risk transfer (Khattri et al., 2010). Each type of engagement is considered next, highlighting its relevance for the broader capacity of cities to respond to climate change.

7.3.1.1 Business Continuity

Climate change is already having negative impacts on many types of businesses, including operational disruptions, increased costs of maintenance and materials, and higher insurance premiums. Catastrophic events are drawing the attention of companies to such climate-related risks, which are expected to increase and become more severe in the future. Consequently, businesses are interested in participating in both mitigation and adaptation for their own private benefits (NRT/NBS, 2012). Business continuity is a mode of private-sector engagement that derives from safe-guarding business interests by climate-proofing supply chains and operations (Khattri et al., 2010).

Reduction of GHG emissions by private-sector entities is likely to be driven by the benefits of corporate social responsibility (CSR). Leadership in this area can enhance reputation, which is of high value to companies. For example, the relationship between stock performance and disclosure of climate change strategies is positive where companies face pressure about climate change issues. As awareness of global warming increases, such investments could become more attractive (Zieger et al., 2011).

While adaptation actions are also influenced by CSR considerations, they can have in addition a direct effect on the company and improve its performance under more volatile conditions. An effective adaptation strategy can result in competitive advantage, but, at the same time, it can be based on cooperation between companies (WRI, 2012). Certain business enterprises are also interested in contributing to the adaptation of the cities where they undertake their activity because these provide the

infrastructure, human capital, and potential markets that companies require. Resiliency of urban infrastructure, communication, and transport systems helps to minimize climate-related risks. Well-designed cities are also less exposed to risks and thus to insurance price increases, delays or shortages of key inputs, and other often-fluctuating expenses.

Climate-related risks to a business's competitiveness and profits are of both a direct and indirect nature. In the city context, four types of risks are becoming prominent: hazard-related, financial, operational, and strategic (see Table 7.2).

Some companies are starting to consider these risks in their business or risk management plans: they conduct vulnerability assessments, utilize climate-specific risk models or other instruments to inform their decisions, and/or rely on insurance (Crawford and Seidel, 2013). Preparing for the effects of climate change will become increasingly important as businesses seek to maintain their current operations and competitive advantage. To name some examples, AT&T, Monsanto, Coca-Cola, and Munich Re have identified potential threats of climate change for their activities and are working to minimize risks through appropriate adaptation measures. Company-specific efforts and public-sector efforts need to be integrated.

Consideration of climate risks may affect decisions about the location of new and existing facilities. Several companies are already trying to minimize exposure to severe weather conditions by taking into account projected threats when selecting locations (Castán Broto and Bulkeley, 2013; Crawford and Seidel, 2013; Sussman and Freed, 2008). Thus, municipalities able to guarantee the security of investments by promoting urban resilience will be more able to attract and retain companies (Revi et al., 2014). In this way, response to climate change becomes a source of "competitive differentiation" both for cities and companies (Carbon Disclosure Project [CDP], 2012).

In cases of cities with limited capacity to manage climate risks, the private sector may add to municipal risk management capability, knowledge, skills, and resources. By forming partnerships with insurance and engineering companies, for example, cities can gain access both to information about risks and expertise in resilience planning (public–private partnerships (PPPs) are described in more detail in Section 7.3.1.3). Companies and cities both benefit by joining efforts to generate information about future climatic and socioeconomic trends at the urban level (Carmin et al., 2013). For example, in the design of the Chicago Climate Action Plan, the city authorities collaborated with private companies to finance science-based assessments of alternative policies and plans (Rasker, 2012).

Table 7.2 *Typology of climate risks faced by the private sector (Crawford and Seidel, 2013), based on a review of documentation from companies listed in the Standard and Poor's (S&P) Global 100 Index.*

Risk type	Short description	Relevance by sectors (% of companies in a sector)
Hazard risks	Inability to do business due to damage to facilities, communications or transport systems[a] Increasing maintenance costs Supply chain interruptions	Banking & Financial Services (20%) Consumer Goods, Healthcare, Materials (10%) ICT & Services, Manufacturing & Industrials (5%)
Financial risks	Increased operational cost due to higher costs for key supplies, backup power or other commodity price shocks[a] Increased capital cost due to plant or equipment upgrades, higher insurance and business loans prices[a]	Banking & Financial Services (60%) ICT & Services, Consumer Goods (50%) Healthcare (50%) Materials (40%) Manufacturing & Industrials (10%) Consumer Goods (30%) Banking & Financial Services (25%) Materials (10%) ICT & Services (5%)
Operational risks	Reduction/disruption in production capacity due to power outage, shortage of key input, changing resource availability and quality[a] Reputational risk: customer obligations not met due to supply interruption	Healthcare (90%) Materials (75%) ICT & Services (>60%) Consumer Goods, Manufacturing & Industrials (>50%) Banking & Financial Services (40%)
Strategic risks	Reduced demand for goods/services due to shifting market preferences or ability to pay[a] First-mover advantage for meeting new market demands	Banking & Financial Services (25%) Consumer Goods, Healthcare, ICT & Services (12%)

[a] *Top five current or expected impacts from climate change within the risk types. Figures indicate percentage of companies in a sector that have identified the different risks.*

Case Study 7.2 Public Enabling of Private Real Estate in New York

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Keywords	Adaptive capacity, real estate, private sector, economics, coastal, storm surge
Population (Metropolitan Region)	20,153,634 (U.S. Census Bureau, 2016)
Area (Metropolitan Region)	17,319 km^2 (U.S. Census Bureau, 2010)
Income per capita	US$56,180 (World Bank, 2017)
Climate zone	Dfa – Cold, without dry season, hot summer (Peel et al., 2007)

John Jacob Astor, the first millionaire in America, earned his wealth almost entirely through the speculation of real estate in New York (NYC). As in Hong Kong and London, the real estate sector in NYC today is a significant component of the economy of the city. The real estate industry in NYC accounts for US$106 billion in annual economic output, which equals approximately 13% of the Gross City Product (GCP) (AKRF, 2014). At just over 519,000 jobs, the real estate industry makes up an estimated 11% of the city's employment and contributes US$15.4 billion in annual taxes to the city or 38% of total municipal tax revenues (AKRF, 2014). The initial land use of the 18th and 19th centuries relating to the commerce of the sea dictated the continuous expansion of a working waterfront, one often created through tenuous infill development through the leveling of the city's topography. As industrial uses now give way to the waterfront as an amenity for residential populations, there is a resurgence in the city's relationship with the waterfront. Yet this re-engagement of the waterfront through increased real estate and infrastructure development is not without risk (see generally, Metropolitan Waterfront Alliance, 2015).

In the past decade alone, the city has been subject to several tropical storms that led to floods of varying intensity, including the devastation wrought by Hurricane Sandy in September 2012. The New York City Panel on Climate Change (NPCC) estimates that not only it is more likely than not that there will be an increase in the number and strength of such intense storms, but also that more frequent precipitation downpour events and inundation from sea level rise are likely to pose unprecedented risks to the city over the next several generations (2015). Based on recently revised flood insurance rate maps (FIRMS), the city comptroller estimates that US$129 billion dollars of real estate is at risk within the 100-year floodplain (City of New York, 2014). Such flood events, and other similar events such as power outages from heat waves, pose significant risks to the commercial operations of the city even for those properties that are not directly affected by on-premises casualty losses because business continuity insurance is less than accessible in terms of cost and geographic availability (RAND, 2013).

TECHNICAL ENABLING OF DESIGN AND CONSTRUCTION PRACTICES

Following Hurricane Sandy, Mayor Bloomberg impaneled the NYC Building Resiliency Task Force (BRT) composed of public-sector regulators and private-sector actors in real estate, insurance, engineering, design, and various construction trades. With adaptation being defined not only by specific interventions, but also by a capacity to implement those decisions (Adger et al., 2005), the BRT was designed with a capacity to provide a continuous dialogue by and between the public and private sectors so as to advance building codes that enable technologies, designs, and materials that serve to reduce known environmental risks – and, hence, promote the resiliency of buildings (New York BRT, 2013). The primary impetus of the BRT was to incorporate elements of the International Building Code, as well as best practices from high-risk states such as Florida, into the NYC building code. Each proposed element was subject to peer review evaluated by a cost-benefit analysis benchmarked against anticipated risk reduction, as well as by qualitative political, legal, and market considerations for practical implementation.

The technical recommendations include everything from allowing properties to capture excess flash flood water to requiring backflow valves to prevent sewage backflow in buildings located in special flood hazard areas. Beyond water-related elements, additional recommendations included breaking down barriers found in existing regulations to allow buildings to accommodate power outages with co-generation, solar, and natural gas autonomous power generation facilities. Beyond autonomous systems, passive building systems for potable water and lighting were also advanced. Aside from the technical recommendations, consideration was given to advancing preapproved emergency inspectors and recovery agreements, as well as accommodations in reducing liability for supporting the reconstruction work of Good Samaritans following disasters. Of the thirty-two recommendations, fifteen were officially implemented as a matter of local law.

STRATEGIC ENABLING OF REAL ESTATE OWNERS AND INVESTORS

The banking, private equity, insurance, and many other service-based sectors have advanced adaptive capacities through corporate disclosures and a broader effort of bringing transparency to markets where vulnerabilities to climate change may be overlooked or underappreciated. Unlike most markets, real estate is highly localized, and, as such, ongoing risk assessment and reduction are timely and potentially costly endeavors. However, the Department of City Planning, through the Vision 2020 Comprehensive Waterfront Plan (2011), and the New York Economic Development Corporation, through the Waterfront Vision and Enhancement Strategy (WAVES) (2014), have taken significant steps in comprehensively evaluating risks and promoting experiments and pilot projects that reduce those risks while setting new standards for performance.

Experiments have included sponsoring multiple competitions for marine construction, resilient technologies, and ecologically sensitive landscape designs, which are integrated with stormwater management programs. The implications of these efforts, specifically the pilot projects, have been to set a benchmark for the private sector with regard to (1) estimating more accurate construction costs, (2) setting risk performance thresholds, and (3) providing a roadmap for

environmental regulation, which has historically resulted in unpredictable outcomes.

Interviews with stakeholders and regulators have suggested that this final component of environmental regulation is perhaps the single greatest barrier in implementing innovative techniques and technologies that are flexible in adapting to changing and evolving risks. This friction highlights the multiple layers of regulation that are often beyond the control of the City. However, it is anticipated that, by building a coalition of public- and private-sector actors, there will be greater political leverage in advancing experimentation. By bringing measures of certainty and predictability to the development of infrastructure and real estate, the private real estate sector's adaptive capacity is arguably more robust by virtue of these collective public-sector actions and strategies.

7.3.1.2 Business Opportunities

Climate change is also a source of business opportunities. The risks can create opportunities in the form of increased demand for new and existing products/services, potential for winning over new customers, technology development, reduced operational costs, increased production capacity and investment, higher staff retention rates, and good publicity (Crawford and Seidel, 2013; Schroeder et al., 2013). These are elaborated in Table 7.3, which compiles examples of business opportunities for high-potential sectors.

Table 7.3 *High-potential sectors and examples of business opportunities. Source: Adapted from Khattri et al. 2010*

Sectors	Examples
Banking, financial services, micro-insurance, and micro-finance	Financing infrastructure resilience and affordable housing solutions Catastrophe-linked securities to transfer risks of extreme weather events Financing for farmers affected by weather risks Weather-related insurance for crops and forests Weather derivatives for electricity utilities
Health care and preventive care	Products to prevent water-related illnesses Treatments and vaccines for climate-related diseases Mosquito control Eye-care products for treatment of sun exposure, allergies, glaucoma, and infections
Urban infrastructure	Waste management and sanitation Water management and desalination Low-energy buildings, green infrastructure and retrofitting Off-grid energy and renewable energy Urban public transport, bikeways and railways Drainage and roadway construction/elevation
Materials	Insulating foams for temperature regulation Chemicals to bond roof tiles in hurricane areas Stronger building materials Systems to protect dikes from wave impacts
Manufacturing and industrials	Electric and hybrid vehicles New lighting solutions Cleaner coal technologies Biodegradable products Flood/drought-resistant seeds
Livelihood promotion	Mobile auction system enabling farmers to improve their livelihoods SMS broadcast to distribute messages on weather information Restoration of ecosystems providing income-generation opportunities (including revenues from carbon market through carbon sequestration)
Information and communication technology	Mobile technology to manage water footprint Digital solutions to dematerialize processes and services Smart grid solutions
Services and consulting	Risk assessments and management frameworks Energy efficiency and management solutions (including energy service company [ESCOs]) Environmental analysis and training
Waste and pollution control and recycling	Mobile and stationary air pollution source controls Water conservation, wastewater treatment and reuse technologies Pulp and paper, aluminum, and electronic recycling

Cities are major markets for new products and services. As intersections of transport, industries, supply nets, buildings, and infrastructure, they have a large potential for the implementation of new technologies to generate energy savings (see Box 7.2). The Climate Group (2008) provides estimates of the potential savings in terms of energy costs (US$950 million) and emissions (15% by 2020 globally) associated with the implementation of new technologies in cities. The technologies involved are LED/other energy-efficient lighting, solar electricity generation, low-energy buildings, compressed natural gas (CNG), hybrid vehicles, and smart grids (U.S. Conference of Mayors, 2014). Dissemination of new lighting solutions in cities could result in significant energy savings (60–70% in offices, schools, hospitals, etc.) according to Verhaar (2009). In addition to generating energy savings, smart grids enhance the competitiveness of megacities, improve the security of supply, and create green jobs (Evans, 2009). Consulting and engineering companies can specialize in providing climate-specific solutions in the design of urban form and in providing frameworks for decision-making under uncertainty (Bellamy and Patwardhan, 2009; Galal, 2009).

Box 7.2 Information and Communications Technology and Climate Change

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INTRODUCTION

The information and communications technology (ICT) sector is a critical part of the global economy and plays a significant role in the operations and economies of cities. ICT is also a key part of the equation as cities address climate change, where there are three primary links:

1. *ICT and mitigation*: As a growing source of GHG emissions, largely through high energy consumption, ICT providers face increasing regulation to reduce emissions through increased efficiency.
2. *ICT and climate risk*: With complex, sprawling networks of infrastructure and technology, ICT providers also face direct and indirect physical risks because they are exposed to changing weather and climate conditions that can stress thresholds and operating parameters.
3. *ICT and emergency management*: Functioning, resilient communication is vital for coordinating disaster response during extreme weather events associated with climate change.

Despite the multiple climate issues facing ICT planners and providers, there is limited research in this field to date. This section highlights overarching issues facing cities, ICT providers, and emergency services toward addressing challenges at the intersection of ICT and climate change.

ICT AND MITIGATION

The ICT sector's total emissions rose from 0.53 to 0.91 $GtCO_2e$ between 2002 and 2011 and are expected to rise to 1.27 $GtCO_2e$ by 2020 (GeSI, 2012). This represents 2.3% of global emissions in a business-as-usual growth emission scenario (GeSI, 2012). Even though the ICT sector's potential to abate the annual GHG emissions of all sectors is seven times higher than the ICT sector's own direct emissions (GeSI, 2012; Jacob et al., 2011). Many of the most transformative economic trends (e.g., social media, big data) are dependent on cloud computing for the storage, transfer, and processing of digital information. Operating large-scale data centers accounts for approximately 1.3% of worldwide electricity consumption. This percentage is expected to grow as high as 8% by 2020 (Deng et al., 2014).

However, the sector also offers technologies that support climate mitigation, such as intelligent building systems and intelligent transportation systems. These play a critical role in helping other sectors tackle climate change.

Data Centers' Sources of Energy

The carbon footprint of a data center is influenced by the type of energy used ($GtCO_2e$/kWh ratio) and its energy efficiency level. Building location influences a data center's carbon footprint owing to market differences in the mix of primary energy used for generating electricity (Shehabi et al., 2011). Locating data centers where renewable energy markets are strong and reliable could contribute to the reduction of their carbon emissions. However, powering cloud data centers with renewable energies is challenging due partly to the fact that global users require cloud services throughout the day and night. The intermittent nature of renewable energy consequently represents a challenge for data center operators that require consistent sources of power (Deng et al., 2014).

Data Centers' Energy Efficiency Level

The most common measure of energy efficiency is *power usage effectiveness*, which is the ratio of overall power drawn by the data center facility to the power delivered to IT hardware (Accenture, 2010). Heating, ventilating, and air conditioning (HVAC) is the dominant component of non-IT energy consumption (Shehabi et al., 2011). Enterprises often cool internal systems by routing outside air – a method called *free cooling* – into the data center, thereby reducing the energy demand associated with its operation. There has been a recent trend to deploy data centers in cooler climates. For example, Facebook revealed plans to locate one of their data centers near the Arctic Circle in Sweden (Stevenson, 2014). Data centers are also beginning to use "dry coolers (closed loops) … in combination with tech equipment capable of operating at higher temperatures based upon revised guidelines" (Adams et al., 2014).

Enterprises with local data center and cloud providers will have to find the appropriate balance between cost minimization, renewable and fossil fuel energy, and energy efficiency if they are to prevent the ICT abatement potential from decreasing.

ICT AND CLIMATE RISK

ICT networks rely on distributed physical infrastructure that can be at risk to a wide range of climate impacts. Climate change presents an increasing intensity and frequency of extreme events that can physically damage this infrastructure or sensitive equipment, resulting in service disruptions. Slower, incremental changes in climate also can lead to damage. As climatic conditions move outside the designed operational capacity and tolerance thresholds of ICT systems, this will result in heightened wear and tear that reduces the lifetime of assets or increases the need for maintenance (Adams et al., 2014). The ICT sector is also dependent on other sectors, such as water and energy, to function – sectors that are themselves at high risk from climate change. All of these risks can raise costs, reduce return on investments, and reduce quality of service.

There is also the threat of severe ripple effects to all other sectors that rely on ICT to facilitate their communications and operations, as well as the coordination of emergency responses associated with extreme weather (see the following section). A compounding risk factor is the trend toward companies sharing infrastructure or elements of the infrastructure (e.g., underground cables, transmission towers) to save on capital costs (Ricardo AEA, 2014). Business efficiency in this case might negatively affect ICT's redundancy level and thus its resilience.

Impacts from extreme weather are increasingly prevalent in the sector and will likely increase in severity. Reducing ICT's vulnerability to natural hazards can be achieved through different means, including relocating critical infrastructures and elevating the equipment off the ground. Local and remote data centers used by emergency response agencies for gathering critical information must also be designed to be disaster-resilient. Similarly, the deployment of smart grids and local power generation can help prevent localized disruptions in services caused by external stress from grid failures or power outages. Despite these challenges and opportunities to build resilience, there is still little awareness of climate risk in the ICT sector, and thus there has been limited action in the private or public sector to address these risks (Horrocks et al., 2010; Adams et al., 2014).

ICT AND EMERGENCY MANAGEMENT

High performance in disasters requires the ability to access critical information and to expand coordination between emergency response agencies. The proliferation of new technologies in urban areas generates a reconfiguration of the communication environment and offers new insights into public and private sectors for better disaster planning, management, and response. For example, ICT provides the backbone of advanced traffic management systems and intelligent transportation systems. The data collected through and information generated by these systems are critical for the emergency response (e.g., the management of evacuation and detour routes, movement and distribution of relief supplies). Other tools such as disaster management information systems – supported by ICT – are essential to interorganizational communications and to the creation of a common operating protocol among emergency response agencies (Houle, 2015).

The importance of information calls for new ways of ensuring data gathering and information sharing during a crisis. In emergency management, "an inability to communicate is a threat to national and human security and puts business value at risk" (Adams et al., 2014). The enhancement of the ICT sector's resilience must therefore include risk reduction measures to ensure lines of communication are maintained in the event of a disaster. One way of doing that is through a cloud-supported crisis response and management process (Buscher et al., 2014). Cloud disaster response can ensure rapid deployment of information services and resource management capabilities in the event that local infrastructures are damaged (Grolinger et al., 2013). However, these new advances may simultaneously represent a reduction of the responding agencies' ability to operate independently of other elements of the emergency system (Ricardo AEA, 2014).

CONCLUSION

Cities have a growing impetus to assess and address how the ICT systems they rely upon are tied to climate change through mitigation, adaptation, and emergency management. Cities must not only address these challenges in the context of municipal ICT systems, but must also engage with major telecom companies to develop robust and resilient responses.

The participation of the private sector in climate change "experiments'' provides evidence of business opportunities in activities that promote sustainability and urban resilience. Coined by Castán Broto and Bulkeley (2013), an "'experiment" is understood as an intervention to test innovative solutions in the context of climate change uncertainty. According to the review of case studies by Castán Broto and Bulkeley (2013), there are about 170 cases where the private sector has been involved in climate change experiments as a partner and almost 100 cases where the private sector was the leading actor. Their research shows that the private sector has already participated in transformative initiatives, but, in many cases, the public sector has taken the leading role. In the majority of the cases, climate experiments were led by a local government and consisted of greening of infrastructure and consumer services provided by different authorities or of supporting initiatives

led by other actors through information and resource provision and partnerships. When experiments were led by private companies, governments were partners in only 15% of the cases.

Many of these opportunities are still underdeveloped and require market-making support by the public sector (Khattri et al., 2010). For instance, municipalities can take the lead in the introduction of information and communication technologies (ITC) through the "dematerialization" of public services, by expanding the infrastructures of broadband, by implementing advanced technologies in their operations, and more. Such leadership translates into job creation, sources of tax revenue, and competitiveness for cities. The city platform called Forum Virium Helsinki is an example of cooperation between city actors to develop ICT-based services (http://www.forumvirium.fi/en) such as mobile phone services (that facilitate urban travel and living) and the opening up of public data (that has enabled companies and citizens to create new services) (Anttiroiko et al., 2014). Floater et al. (2014a) describe a number of actions municipalities can take to facilitate the exploitation of new business opportunities, such as scaling the market for energy efficiency, facilitating access to finance of the clean tech sector, and exploring new models of PPPs for delivering goods and services.

Other opportunities arise from innovative business models that create compelling proposals for consumers. This is the case of car-sharing/-pooling, for which the market has increased by more than 20% annually (Cohen, 2013). In addition, governments and private companies can work together on education programs about the benefits of smart technology (Osborne Clarke, 2015). According to North and Nurse (2014), an effective way in which local authorities can support transformation in the private sector is by promoting the diffusion of "war stories" from those entrepreneurs whose personal experience has led them to change their practices. Change-adverse business people might be convinced of the benefits of transformation when they become aware of the advantages of concrete experiences of other peers (e.g., cost savings, attraction of better human capital, reputation, among others). To facilitate the communication of these stories among small and medium enterprise (SME) owners is especially important, given that SMEs represent 60% of industrial GHG emissions. Today, green-tech innovation is concentrated in a few dynamic clusters close to cities. According to Kamal-Chaoui and Roberts (2009), between 2004 and 2006, 73% of green patents in the renewable energy sector in the OECD were produced in urban regions. The authors provide some examples like the Lahti Clean Tech Cluster in Finland or the London Hydrogen Partnership. By playing a facilitative and enabling role, cities can promote the creation of green clusters that will attract and retain innovative companies and propel competitiveness. The vision of becoming a global example of an eco-energy city guided the design of a successful policy mix (i.e., promotion of a renewable energy cluster, stimulation of local demand, and attraction of investment) in Dezhou, China. The Development Plan of this city is a good example of how to draw on local strengths to build a renewable industry cluster from scratch (Yong, 2013).

7.3.1.3 Business Finance

The lack of access to funding has been usually identified as one of the most critical limiting factors for climate actions in cities (Kernaghan and da Silva, 2014). The private sector is a source of finance, especially when there are opportunities to improve business performance, continuity, or opportunities to participate in profitable partnerships (Schuttenbelt, 2013). Finance organizations and companies across the world have shown their interest in the transformation of the city landscape, provided that the risk–reward proposition is attractive (Osborne Clarke, 2015).

Private investment can be also be motivated by noneconomic factors, such as reputational benefits or networking opportunities. In this regard, for example, the Bangka Botanical Garden in Pangkalpinang (Indonesia) was launched as a Corporate Social Responsibility project (Hardjosoesilo, 2011b).

Innovative governance structures such as partnerships between the private and public sector can stimulate private sector co-financing (Tompkins and Eakin, 2012). Partnerships are generally developed to meet the common interests between two or more parties. In the case of cities, PPPs are described as coalitions between local authorities that lack public funding and private entities and are commonly used to deliver critical infrastructure, housing affordability, and urban regeneration (Harman et al., 2015; Johannessen et al., 2013). The role of the municipality in PPPs consists of facilitating project development by removing barriers, while the private sector assumes part of the risk, provides funding, and manages the project. As a type of externalization, the proliferation of PPPs can be linked with budget constraints and the expiration of subsidy schemes (Bacheva-McGrath et al., 2008). PPPs are usually associated with innovation, spillover benefits, cost-efficiency, increased productivity, and political independence (IFC, 2011; Johannessen et al., 2013). Some promising PPPs are privately financed schemes in which the private sector expects a profit from the investment. However, PPPs are also criticized because the interests of the private entity might go against public interests (Harman et al., 2015).

In the case of water, sanitation, and hygiene (WASH) systems, Johannessen et al. (2014) argue that PPPs are a good solution to address the potential lack of public funding and thus to possibly manage resources more effectively. They also argue that to build long-term resilience, it is important to integrate long-term risks of climate change into business management and to build partnerships through a series of strategies for investments. These include re-examining the profitability of existing WASH investments taking into account ecosystem services, acknowledgment of the needs of adequate land area for water resources, creation of an institutional culture for private-sector investments, development of a better understanding of the customer base (especially focused on poor, more-vulnerable communities), creation of support for a new segment of private entrepreneurs, development of

Case Study 7.3 Raising Awareness of Negotiating, and Implementing Tokyo's Cap-and-Trade System

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Keywords	Cap-and-trade system, mitigation
Population (Metropolitan Region)	37,750,000 (Demographia, 2016)
Area (Metropolitan Region)	8,547 km² (Demographia, 2016)
Income per capita	US$42,870 (World Bank, 2017)
Climate zone	Cfa – Temperate, without dry season, hot summer (Peel et al., 2007)

Tokyo's Emissions Trading System (ETS) is the first city-level cap-and-trade system applied to greenhouse gases (GHG) emissions worldwide. Its overall target is to reduce CO_2 emissions by 25% below 2000 levels by 2020.

The ETS applies to the heaviest emitters of the industrial and commercial sectors: Industrial factories, office buildings, administrative institutions, and commercial buildings. Most of Tokyo's skyscrapers fall under the scheme. Around 1,400 large-scale facilities (1,100 business facilities and 300 industrial facilities), which account for approximately 20% of Tokyo's GHG emissions, have been selected on the basis of their energy consumption. The baseline is a total consumption of fuels, heating, and electricity of at least 1,500 kiloliters per year (crude oil equivalent) (Tokyo Metropolitan Government [TMG], 2010).

These facilities are awarded a limited number of allowances (i.e., "cap") that determine the total quantity of GHG emissions that they are authorized to release for a given time period. Facility tenants have the responsibility to control their CO_2 emissions and to adopt mitigation measures. Units that emit less than the credits they have can "trade" their unused allowances to other participants who exceed their cap (Lee and Colopinto, 2010).

Allowances are *grandfathered*, which means awarded free of charge. Their number is fixed on the basis of past emissions. Thanks to the "Tokyo CO_2 Emissions Reduction Program" launched in 2000, which included a voluntary emissions reduction plan with a mandatory reporting scheme for targeted facilities, data on emissions have been collected since that time. On this basis, the ETS base year is calculated as a function of the average emissions of the facilities over the 3 years between 2002 and 2007.

Allowances are allocated at the beginning of each compliance period. Their number is calculated as follows (first period):

Base year emissions – required reduction or "compliance factor" (6% for industrial buildings or 8% for rest of the buildings)] × compliance period (5 years) (Lee and Colopinto, 2010).

They are two compliance periods: the first one, from 2010 to 2014, foresees a reduction of 6% of GHG emissions for the 5-year annual average; the second one, from 2015 to 2019, aims at a reduction of 17% of emissions for the 5-year annual average. Monitoring and reporting are required on a yearly basis.

To support the efficient functioning of the scheme, a system of alternative credit offsets is also established. It consists of small and medium-sized installation credits within the Tokyo area and renewable energy certificates in the whole country. This second mechanism is favored by TMG. It allows companies to get credits on the basis of renewable energy certificates received by the company thanks to installations located outside of Tokyo and using renewable energy. Yet this is limited to up to one-third of the company's obligations (IETA, 2014).

The ETS started functioning in April 2010, and the first performance evaluation was made in 2015. As of 2014, only a few allowances have been traded because about 93% of facilities have largely met their targets for the first compliance period (IETA, 2014). In 2016, the Tokyo Metropolitan Government reported that the program had achieved a 25% reduction in emissions in its first 5 years. For participants who do not meet their targets, the system foresees financial fines and moral "shaming," where names of defaulting institutions are released. For now, the ETS covers only one GHG, namely CO_2. However the ETS plans to be extended to other gases in the future (TMG, 2010).

The ETS is an innovative tool in several ways. It is the first city-level carbon trading scheme that closely connects a global-level challenge with local action. It is also the only mandatory ETS with an absolute volume cap in Japan, and it is the only local ETS focusing on commercial activities and energy end-users.

The success of the scheme lies in the close relationship between the facilities concerned and the TMG. Through a series of meetings, they defined together the targets and potential actions. The mandatory reporting of data to TMG has been a key step in building up a sound dataset upon which the cap-and-trade mechanism could be further refined. It allows data collection, familiarity, and capacity-building for the stakeholders involved in the program. The evolutionary nature of the scheme, from voluntary activities to binding regulations, is also a relevant feature of the Tokyo experience.

The Tokyo process could inspire other cities of the world. Many cities today have emission targets, yet they lack concrete regulatory and mandatory measures to achieve their goals. The process that led to the adoption and success of Tokyo's cap-and-trade program could be an inspiring example for other cities.

micro-insurance mechanisms in dialogue with the most-vulnerable groups, and, linked to this, the creation of (micro)financial opportunities.

In the area of climate-related projects, the Chicago Climate Action Plan is a good example of an effective PPP for the design and implementation of adaptation policies at city level. Local business participated actively in the monitoring of policies and problem-solving and co-financed the downscaling of climate models, the assessment of the costs of inaction, and the implementation of the plan (Rasker, 2012). The London Climate Change Partnership, running since 2001, exemplifies a

multisectoral partnership that crosses spatial, political, and organizational boundaries to collaboratively tackle the complex goal of enhancing city resiliency (see Case Study 7.1) (Surminski and Leck, 2016).

Another example of an innovative partnership enabling a successful climate policy can also be found in California: the Community Energy Partnership is a collaboration between seven cities and a utility, funded via a consumption fee, that promotes energy efficiency in households and companies (by means of energy audits, improvement of installations, etc.). The Association of Bay Area Governments' Energy Watch, funded by a utility, enhances the energy efficiency of the local government. In addition to associations with the private sector, the key element for the success of these initiatives is the generation of cost savings and economic development benefits. Using PPPs to facilitate the implementation of pilot projects of new technologies in urban areas has been demonstrated to work well. That is the case of Rotterdam with carbon capture and sequestration technologies (Rotterdam Climate Initiative [RCI], 2011).

Although PPPs have been demonstrated to work well in a number of cases, there is evidence from other fields, however, suggesting that PPP have not always delivered the expected advantages. In particular, the costs associated with these schemes have been often underestimated and used to evade restrictions on public budgets. Here, we list a series of recommendations about how to guarantee beneficial PPP projects (Bacheva-McGrath et al., 2008; Bunning, 2014):

- Use realistic predictions to calculate affordability.
- Establish restrictions, like annual limits on the total amount of payments that the authorities can commit.
- Contrast the convenience of PPPs with alternatives like public procurement, community-based initiatives, joint-ventures, cooperatives, and the like.
- Foster transparency and accountability in order to limit opportunities for corruption and inflation of projects.
- Specify conditions for the termination of contracts, penalties for poor performance, and benefit-sharing schemes for refinancing benefits.

An assessment of 165 empirical ex-post studies examining policies on low-carbon technologies suggests that there exists tradeoffs between efficiency and effectiveness, resulting in government-led policy instruments being more effective and private-led interventions being more efficient (Auld et al., 2014).

7.3.1.4 Risk Transfer

With increasing climate change impacts, the role of insurance as a tool for risk-sharing and transfer to address uncertainties is receiving growing attention (Mills, 2009a; Surminski et al., 2016). Some insurance sector initiatives (e.g., Climate Wise., ClimateWise and UNEPFI's Insurance Working Group), and industry organizations (e.g., the Chartered Insurance Institute) have actively engaged in policy debates, assessed climate impacts and opportunities, and initiated adaptation activities (Mills, 2009b; Surminski, 2014). Very recently, the Global Innovation Lab for Climate Finance announced its Energy Savings Insurance scheme. This is a pilot initiative consisting of insuring the value of savings generated by energy-efficiency projects. The initiative has received the support of the Inter-American Development Bank and the Danish Energy Agency.

While some authors note that insurance is not a silver bullet, it can help in driving response to climate change (Ranger et al., 2011; Mechler et al., 2014). In the urban context, insurance has three functions:

- *Compensate losses and fund recovery efforts*: Risk transfer is more cost-effective for increasing resilience than ex-post disaster aid (Ranger et al., 2011). Recent examples where insurance provision for climate risks has been taken into account in an urban context are Mumbai (Ranger et al., 2011) and New York (Aerts et al., 2011). In the case of Mumbai, Ranger et al. (2011) estimate that indirect losses could be halved if insurance penetration rate would achieve 100%.
- *Reduce the financial risk of investments*: Insurance could reduce barriers to private investment in climate actions (Surminski, 2013). Positive urban examples are New York and Rotterdam, where flood insurance schemes help control the vulnerability to flood risks and also reduce the barriers to potential private investments in the waterfront and port areas (Aerts and Botzen, 2011).
- *Incentivize risk management activities*: Purchasing an insurance risk transfer product can influence the behavior of those at risk (Surminski and Oramas-Dorta, 2013). If not correctly structured, it can provide disincentives, but otherwise, it puts a price tag on risks, signaling the need to address underlying risks (Kunreuther, 1996; Botzen et al., 2009; Shilling et al., 1989; Treby et al., 2006).

One particular type of risk-transfer instrument that could be suitable for climate risks in cities is the *catastrophe bond*. This is a financial instrument developed by insurers or governments to pass extreme risks on to private investors who are willing to assume them in exchange for high interest rates. For example, Allianz recently issued a flood bond for London. However, it must be noted that this instrument does not reduce risks if the proceeds are not used in risk reduction measures. In addition, catastrophe bonds might not be an appropriate instrument to protect against climatic risks in that they are narrowly designed for specific events in specific locations, tending to protect private investor interests (Keogh et al., 2011; Brugmann, 2012).

7.3.2 Challenges and Enablers of Private Sector Engagement

Key barriers for the private sector when implementing adaptive strategies are the lack of understanding of the uncertainties, poorly perceived risks, and limited knowledge and expertise. According to Crawford and Seidel (2013), many companies often lack in-house knowledge or expertise about extreme weather and climate change. Because of this, it is important to

engage with suppliers of key knowledge inputs to improve event response planning and capacity building.

Regarding mitigation, the main barrier is the lack of appropriate incentives. According to the Global Commission on the Economy and Climate, despite the high and multidimensional costs of the business–as-usual urban development model (i.e., urban sprawl), market and governance failures causing current problems continue in many cases unaddressed (Floater et al., 2014b; Rode et al., 2013). The NCE Report (2014) presents the case of the Netherlands as an example of how costly fuel subsidies increase the use of cars and the case of the Multilateral Development Bank's financial support as an example of how funding can be directed toward a model of development incompatible with resilience and sustainability. Low-carbon technology and resilient infrastructure also encounter barriers to attracting private investment at scale; one reason is the lack of appropriate information for investors, companies, and public authorities (Floater et al., 2014a). This could be addressed by complying with some of the recommendations about how to guarantee beneficial PPPs (see Section 7.3.1.3).

Enablers of private-sector engagement can be classified in three groups:

- *Demand-side enablers* such as financial products to enhance capacity to pay; demand generation by awareness-building programs; information-disclosure mandates; voluntary labeling initiatives; community buy-in with demonstration effects; public pilot and demonstration projects; city, regional, and national government procurement; and city-led initiatives of cross-border collaboration to create strong regional markets for low-carbon and other green products and services;
- *Financial enablers* can be public or private; for example, local/international seed capital for technical assistance by banks; high city credit ratings; project liquidity; monetization of avoided losses; innovative financial products to reduce risk including value-capture instruments, insurance, and reinsurance; catastrophe bonds; social impact bonds; securitization and structured finance; public subsidies and support programs; and the green bond market;
- *Supply side enablers* such as forging partnerships with market aggregators; PPP models; microfranchisors and technology platforms; associations with R&D organizations; public interventions to address externalities, coordinate policies and actors, and generate and disseminate information on the scale of opportunities and risks; and those types of enabling actions that capture opportunities for comparative advantage in global markets for green products and services.

Local authorities can play an important role as facilitators of all three groups by providing regulatory and fiscal environments that encourage the reduction of risks and the transition to a low-carbon economy (Cleverley, 2009). They can:

- *Provide incentives*: Encouraging or requiring the implementation of risk-management practices; guaranteeing the stability of policy interventions across levels and areas to correct externalities; setting standards for efficiency with consistent metrics for monitoring and verification; promoting behavioral changes toward sustainability goals, in some cases through market-based instruments or through providing education and information, including environmental labeling and support to R&D; reducing risks by setting long-term targets and supporting pilot projects; building capacity by promoting community engagement, civic movements, economic networks, partnerships, and clusters; and establishing enabling conditions in markets (e.g., Payment for Ecosystem Services) that deliver urban adaptation;
- *Redirect support*: Transferring incentives from industries flourishing under the business-as-usual development model to low-carbon, resilient businesses. Among the sectors offering positive outcomes in development and climate action are the renewable energy sector, electric cars, energy-efficient devices, affordable housing, green infrastructure, ICTs, and biodiversity conservation (da Schio, 2013);
- *Mainstream adaptation*: Implementing appropriate risk-reduction strategies; improving the efficiency of public-sector data centers, buildings, and operations; and sponsoring virtual infrastructure (i.e., cloud computing); policies and planning must incorporate the adaptation dimension to ensure that investments and actions by the private sector are protected (Kazmierczak and Carter, 2010; Mees and Driessen, 2011).

7.4 Areas for Further Research and Considerations for Policy

7.4.1 Further Research

Empirical evidence suggests that successful climate action at the local level benefits local inhabitants. However, this effect is rarely well-documented in the public domain, and local outcomes could be better communicated within a co-benefit framework of city-level climate policy. At the same time, we find that important spillover benefits from local climate action are already accruing at the national level and to other cities, as exemplified by diverse demonstration and learning effects. Both, in turn, justify public policy support for networking the activities of cities in this field and global research infrastructures, such as UCCRN, to document and communicate these effects.

There is an order of magnitude gap between mitigation and adaptation needs and available funding at the urban level. This gap, however, turns out to be more of a problem of access to private and public funds than a problem of availability of investment capital. Programs to improve access to finance the sustainability of cities (e.g., the World Bank Group) are under way but must be closely monitored with regard to identifying the key factors of success and failure, given the multiple barriers assessed in this chapter. The better documented those programs are, the more subsequent efforts may attract the masses of private-sector capital that have yet to consider climate change investments as key elements of their portfolios.

Given the similar efforts of funding programs for capacity-building and technology innovation, we recommend a special assessment report on "Sustainability Finance for Cities" in 2020 as a UCCRN Special Report. The Case Study Docking Station (CSDS) of UCCRN could be a promising source of knowledge for this report if structured for that need through the collection of more detailed cost, benefit, and non-monetized impact data on the cases profiled.

7.4.2 Policy Considerations

Private-sector agents respond to incentives. Accordingly, policy design is crucial. Policy measures for urban transformation will affect private-sector actors and can help reduce unavoidable resistance to change. But climate action will not necessarily generate losers if industries are able to incorporate into their plans the urgent need for an alternative development model and innovate accordingly. The private sector as a source of finance, capacity, and innovation constitutes a key partner for cities in the search for transformation. Cities and businesses can build a mutually beneficial relationship based on their shared objectives and complementary resources and capabilities.

Companies can better minimize climate risks and benefit from new business opportunities in those cities where the public sector is committed to playing a leading role in urban transformation. At the same time, municipalities can neither achieve the required transformation of unsustainable practices nor prepare themselves for the impacts of climate change without coordination with the private sector. Many cities have the legal power and responsibility to implement urban development and risk reduction, but they often lack the capacity and resources to tackle ambitious transformative projects. Thus, collaboration with the private sector may give cities access to finance and expertise on risk management, resource optimization, and technological solutions, thus facilitating at the same time the creation of jobs as well as addressing climate change challenges.

Annex 7.1 Stakeholder Engagement

This chapter benefited from important contributions and feedback from a variety of parties at conferences and meetings. The launch meeting included inputs from Richenda Connell of Acclimatise (London, UK), Stefan Denig and Michael Stevns from the London office of SIEMENS, and Mussa Natty of the Kinondoni Municipal Council, Dar es Salaam, Tanzania. Inputs during the process of chapter development were then collected from a webinar on "Show Me the Money" conducted for the U.S. Department of Energy in December 2013; the National Conference on Science and the Environment conference on Building Climate Solutions in Washington, D.C., January 2014; the ICLEI–Local Governments for Sustainability – Resilient Cities Congress in Bonn, May 2014; a workshop on cross-cutting chapters held after that ICLEI meeting; the CITY FUTURES III conference in Paris June 2014; the 11th Symposium of International Urban Planning and Environment Association in La Plata, Argentina, September 2014; the London Climate Change Partnership, with a survey of members on the role of the private sector in managing urban risks in November 2014; the Climate Change Risk Roundtables discussion on the role of insurance in February 2015; a panel debate on the role of insurance for climate risks at the Third UN World Conference on Disaster Risk Reduction in March 2015; and a workshop on the chapter in Bonn, June 2015, that incorporated views from GEF, World Bank Group, and the Rockefeller Foundation.

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