CHAPTER 5

CLIMATE CHANGE MITIGATION RESPONSES IN URBAN AREAS

Mitigation – the reduction of greenhouse gas (GHG) emissions and their capture and storage – has been at the heart of policy responses to climate change over the past two decades. At the international level, the 1992 United Nations Framework Convention on Climate Change (UNFCCC) has as its core objective the 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.[1] Subsequent agreements, including the 1997 Kyoto Protocol and the 2009 Copenhagen Accord, have developed targets and timetables for the international community to reduce GHG emissions.[2] Many national governments have made commitments which go beyond the rather modest goals that have so far been agreed internationally. However, achieving these international and national ambitions is dependent on the implementation of policies and measures to reduce or capture GHG emissions on the ground. Cities are therefore critical places for achieving mitigation. As Chapter 3 has shown, a significant proportion of GHG emissions arise from activities undertaken in urban areas.[3] Cities represent concentrations of population and economic activities, with growing demands for energy for domestic services such as heating, cooling and lighting, as well as commercial buildings, industrial processes, telecommunications systems, the provision of water, the production of waste, leisure activities, travel and so on. Cities can therefore be seen as part of the problem of climate change and reducing GHG emissions in cities is a key policy challenge (see Table 5.1).

However, cities can also be seen as part of the solution to addressing climate change (see Table 5.1), both in terms of the role of urban governments and because of the potential for private-sector and civil society actors to respond to climate change at the urban level. Municipal authorities are potentially important actors in tackling the challenge of mitigation for three reasons. First, they have jurisdictional responsibility for key processes – land-use planning, transportation, waste collection and disposal, and energy consumption and generation – which shape GHG emissions. Second, the concentration of people/business in urban areas means that solutions (e.g. mass transit or requirements for energy savings in offices) are feasible. In other words, cities can act as laboratories where solutions for addressing climate change can be tried and tested. Third, municipal governments also provide a key interface for engagement with stakeholders in the private sector and civil society. It is increasingly clear that non-governmental actors have a significant role in addressing climate change at the urban level. Private-sector organizations and civil society groups are now involved in a range of measures (e.g. promoting behavioural change and reducing energy use in commercial buildings) independently of local and national governments.

Over the past two decades, cities have provided a crucial arena within which the challenges of climate change

Mitigation – the reduction of greenhouse gas (GHG) emissions and their capture and storage – has been at the heart of policy responses to climate change over the past two decades

Municipal authorities are … important actors in tackling the challenge of mitigation

Part of the problem	Part of the solution
• In 2010, half of the world's population lived in cities.[a] • Between 2010 and 2020, 95% of the global population growth (766 million) will be urban residents (690 million), and the bulk of these (632 million) will be added to the urban population of developing countries.[a] • Between 2000 and 2010, the number of slum dwellers in developing countries increased from 767 million to 828 million. The figure might reach 889 million by 2020.[b] • Cities represent concentrations of economic and social activities that produce GHG emissions.[c] • Cities and towns produce between 40 and 70 per cent of global anthropogenic GHG emissions.[c] • By 2030, over 80 per cent of the increase in global annual energy demand above 2006 levels will come from cities in developing countries.[d]	• Municipal authorities have responsibility for many processes that affect GHG emissions at the local level. • Municipalities can act as a 'laboratory' for testing innovative approaches. • Municipal authorities can act in partnership with private-sector and civil society actors. • Cities represent high concentrations of private-sector actors with growing commitment to act on climate change. • Cities provide arenas within which civil society is mobilizing to address climate change.

Sources: a UN, 2010; b UN-Habitat, 2010; c see Chapter 3; d IEA, 2008, 2009

Table 5.1

Cities and the mitigation of climate change

mitigation are being addressed. During the 1990s, these responses were primarily concentrated in developed countries and undertaken through three international municipal networks: Local Governments for Sustainability's (ICLEI's) Cities for Climate Protection Campaign (CCP), the Climate Alliance and Energie-Cités.[4] During the 2000s, the cities involved in responding to climate change have grown in number and now include cities in the developing world, in part facilitated by the emergence of new international initiatives such as the Cities Climate Leadership Group (C40), as well as the continuing work of more established networks.[5] Despite this recent growth in interest, and in their potential significance in responding to climate change, the understanding of how and why cities are responding to climate change remains limited, particularly in developing countries. Studies of the responses to the issue of climate change mitigation in cities rely heavily on individual case studies from 'pioneering' cities in developed countries,[6] with some notable exceptions.[7] This body of research suggests that the response of cities to the challenges of mitigation has been fragmented,[8] that significant gaps exist between the rhetoric of addressing climate change and the realities of action on the ground,[9] and that the possibilities, and responsibilities, for acting to reduce GHG emissions vary significantly between cities.[10] In short, attempts to mitigate climate change in cities have been far from straightforward.

Over the past two decades, cities have provided a crucial arena within which the challenges of climate change mitigation are being addressed

Given that cities lie at the heart of the contemporary neo-liberal political-economic model, this is not surprising. Cities are pivotal sites in the 'metabolism' of natural resources and the consequent production of GHG emissions, upon which this model of development rests:[11]

> *... cities have extended their ecological hinterland by importing natural resources or resource-based infrastructure services, like electricity ... from afar, but also by using ecosystems far beyond the urban bioregion as sinks for their emissions. The patterns of modern urbanization have thus been highly dependent on the functioning of the networks driving material flows in and throughout the city.*[12]

Responsibility for action, and the capacity to act, rest with affluent urban societies, but ... the brunt of the future impacts of climate change will be borne by vulnerable urban populations

This pattern of urbanization and its environmental consequences has been uneven. While cities in the developed world have historically been the source of the bulk of urban GHG emissions, as the location of production of goods and services shifts to cities in developing countries so do environmental burdens. At the same time, as the consumption of energy-intensive goods and services increases amongst affluent sectors of urban societies in developing countries, so too will GHG emissions. However, the levels of GHG emissions from poor urban populations remain negligible, suggesting that urban efforts to mitigate climate change need to be targeted at cities where there is both a responsibility and a capacity to act. Furthermore, climate change will deepen a range of existing inequalities; thus, discussions of climate change mitigation in cities need to include broader concerns about the vulnerability of different social groups. Specifically, the gender dimension of climate change mitigation, and the potential for women to contribute to climate change mitigation strategies, has not yet been fully acknowledged.[13]

The result is a complex geography of urban GHG emissions,[14] where responsibility for action, and the capacity to act, rest with affluent urban societies, but where the brunt of the future impacts of climate change will be borne by vulnerable urban populations.[15] In this context, building an understanding of how cities in developed countries are responding to the challenge of climate change mitigation – beyond the small number of case studies currently available – is a critical task. At the same time, there is a need to understand how climate change mitigation is being addressed in the world's megacities, which because of their sheer size are potentially critical sites of current and future GHG production, as well as the small urban centres within which the bulk of population growth and energy demand over the next few decades is forecast to occur.[16] In Asia and Latin America, recent industrialization and the growth of affluent urban communities suggests that climate change mitigation may be an increasingly pressing challenge.

This chapter seeks to address these knowledge gaps by providing a review of urban responses to climate change in a comparative context. It focuses on the responses of so-called 'global' cities (those regarded as having particular strategic economic and/or political importance)[17] and megacities (those with a population of more than 10 million people). These cities are critical to the urban mitigation of climate change both because of their current and potential contribution to GHG emissions and their wider economic and political influence.[18] First, the chapter considers the policy responses and initiatives that are emerging in cities. Second, it examines how such strategies and measures have been undertaken through different modes and mechanisms for governing climate change in the city. Third, the chapter assesses the opportunities and constraints that cities have encountered in institutional, economic, technical and political terms, before, fourth, providing a comparative analysis of emerging trends in urban responses to climate change. Finally, the chapter offers some concluding comments and lessons for policy.

RESPONSES TO CLIMATE CHANGE MITIGATION IN URBAN AREAS

Over the past two decades, municipal authorities have engaged in the development of urban climate change policies as well as initiatives and schemes to reduce GHG emissions in the city. More recently, a range of other actors – including non-governmental organizations (NGOs), donor agencies and private corporations – have also become involved in urban climate change mitigation initiatives. This section reviews different policy approaches that municipalities have developed for dealing with climate change mitigation before considering the strategies and measures that have been adopted by both public and private actors in five key sectors: urban development and design; built

environment; urban infrastructures; transport; and carbon sequestration.

Municipal policy approaches

The policy approaches adopted by municipal governments to address the mitigation of climate change in urban areas vary considerably in terms of the sources of GHG emissions that are targeted – whether these are from the municipalities' own activities or from across the urban community – and whether they are undertaken on a strategic or ad hoc basis (see Table 5.2). In each case, a variety of mechanisms for developing and implementing climate change mitigation measures have been used.[19]

Municipalities have undertaken ad hoc measures to reduce GHG emissions from their own operations, often on a *reactive* basis – for example, in response to a particular funding opportunity or the initiative of an individual (see Table 5.2). Municipal authorities have also been *opportune* in developing one-off schemes or projects at the community scale, often in collaboration with other partners. Such ad hoc approaches are popular and 'numerous cities, which have adopted GHG reduction targets … prefer to implement … measures on a case by case basis'.[20] The wide range and significant number of such ad hoc responses suggest that given the right financial and political conditions, municipal governments have been more than able to respond positively to the challenges of mitigating climate change.

Strategic approaches, in contrast, have usually been developed where there has been access to secure funding, new institutional structures – such as a central unit for addressing climate change – and strong political support for action. These can either involve setting out a programme of goals and measures through which municipalities seek to reduce their own GHG emissions over the medium to long term (a *managerial* approach), or a *comprehensive* approach, developed by only a few municipalities, involving target setting, planning and the development of initiatives at the community level.[21] Such strategic approaches were first promoted by ICLEI's CCP Milestone programme established during the mid 1990s (see Box 5.1). A similar approach has also been adopted by the Climate Alliance in its Climate Compass initiative (see Box 5.2). Evidence suggests that some substantial reductions in GHG emissions have been achieved by these means. For example, in 2006, 546 local governments in 27 countries were members of the CCP campaign, accounting for 20 per cent of global GHG emissions. Estimates suggest that the annual emission reduction by these cities was 60 million tonnes of CO_2eq, which amounts to a 3 per cent annual reduction among the participants and 0.6 per cent globally.[22] However, while those municipalities that have focused on their own operations have made substantial progress against their targets, achieving such goals beyond the confines of the municipality itself has been both more difficult to monitor and more challenging to implement.

Despite differences in the approaches that municipalities have adopted to the formation and implementation of climate policy, research suggests that attention has primarily been focused on initiatives in the energy sector, and in particular on improving energy efficiency.[23] Energy efficiency is a particularly potent issue as it can 'advance diverse (and often divergent) goals in tandem',[24] serving to translate various interests into those concerning climate

	Ad hoc	Strategic
Municipality	Reactive	Managerial
Community	Opportune	Comprehensive

Table 5.2
Typology of policy response to climate mitigation in the urban arena

Box 5.1 Strategic approaches to urban climate change policy: The CCP Milestone Methodology

- *Milestone 1:* establish an inventory and forecast for key sources of GHG emissions in the corporate (municipal) and community areas, and conduct a resilience assessment to determine the vulnerable areas based on expected changes in the climate.
- *Milestone 2:* set targets for emissions reduction and identify relevant adaptation strategies.
- *Milestone 3:* develop and adopt a short- to long-term local action plan to reduce emissions and improve community resilience, addressing strategies and actions for both mitigation and adaptation.
- *Milestone 4:* implement the local action plan and all the measures presented therein.
- *Milestone 5:* monitor and report on GHG emissions and the implementation of actions and measures.

Source: www.iclei.org/index.php?id=810, last accessed 18 October 2010; see also Box 2.7

Box 5.2 Strategic approaches to urban climate change policy: The Climate Alliance's Climate Compass

Module 1 – Initiation:
- informing relevant departments of the administration;
- clarifying needs and expectations;
- raising awareness of local climate change policies;

Module 2 – Inventory:
- analysing the setting;
- surveying previous priorities and activities;
- characterizing the initial conditions;

Module 3 – Institutionalization:
- building organizational structures;
- assigning responsibilities and nominating persons in charge;
- forming a Climate Compass working group;

Module 4 – Climate action programme:
- defining targets;
- selecting priority measures;
- formulating strategic resolutions (on criteria, standards, etc.);
- agreeing the mid- and long-term climate strategy;

Module 5 – Monitoring and reporting:
- developing indicators;
- collecting data for CO_2 monitoring;
- preparatory work for future reporting.

Source: www.climate-compass.net/_modules.html, last accessed 18 October 2010

change and effectively forging new partnerships. While energy efficiency still dominates many municipal responses to mitigating climate change, the growing diversity of those cities involved in mitigating climate change together with the range of private-sector and civil society actors becoming involved with this policy agenda has led to a growing array of projects and measures being adopted.

Nonetheless, it is possible to identify five key sectors in which urban responses to mitigating climate change have been concentrated: urban form and structure; built environment; urban infrastructures; transport; and carbon sequestration. Reviewing the evidence across these sectors, the following sections examine the range of activities being undertaken by municipal authorities and other actors in the city to reduce GHG emissions and the strengths and weaknesses of the initiatives that have been undertaken.

Various strategies of land-use planning … have been used in order to limit urban expansion, reduce the need to travel and increase the energy efficiency of the urban built form

In developing countries, there are few initiatives to explicitly mitigate climate change through urban design and development

In developed countries, private developers and community groups have led new urban development, brownfield regeneration and neighbourhood renewal projects which seek to address climate change

Urban development and design

The use of energy within a city, and the associated production of GHG emissions, is dependent on both the form of urban development (i.e. its location and density) and its design.[25] As urbanization continues apace, one of the critical challenges is managing the process of urban development and, in particular, the twin challenges of urban sprawl and the growth of informal urban settlements (see Box 5.3).[26] Urban sprawl is an increasing challenge for cities in developed and developing countries. As the distances between home, work, education and leisure activities increase, so often does the reliance on private motorized transport. In some cities sprawl has meant the development of middle-class urban fringe districts where dwelling sizes tend to increase, leading to an increase in per capita GHG emissions. In other cities, sprawl is fuelled by the growth of informal settlements. Between 2000 and 2010 the number of slum dwellers in developing countries increased from 768 millions to 828 million, and estimates suggest that the number of slum dwellers will increase to 889 million by 2020.[27] Slum populations lack adequate access to reliable and affordable energy supplies and shelter, meaning that, in parallel with the other significant challenges that such settlements pose for sustainability and well-being, many households are unable to heat or cool their dwellings effectively and experience fuel poverty.

In seeking to address these challenges, various strategies of land-use planning, including land-use zoning, master-planning, urban densification, mixed-use development and urban design standards, have been used in order to limit urban expansion, reduce the need to travel and increase the energy efficiency of the urban built form.[28] Such approaches can be deployed at a range of locations within the city and at different scales (see Table 5.3). Overall, research suggests that large-scale schemes, including large regeneration projects, projects to prevent urban expansion and the reuse of derelict land appear to be a more common response for mitigating climate change than small regeneration projects. Most such projects are undertaken in developed countries. In developing countries, there are few initiatives to explicitly mitigate climate change through urban design and development, and where they do exist, the local governments' capacity to implement such measures is often limited.

Most often, these projects are led by municipal authorities through the use of planning regulations and planning guidance. This is the case, for example, of the principles of 'compact city planning'[29] incorporated within the municipal ordinances of cities such as São Paulo (Brazil) and Cape Town (South Africa),[30] although, in practice, it is not clear that such principles can actually be implemented in an effective way. These principles advocate a combination of planning measures to combine high-density development and mixed land-use principles to prevent urban sprawl and reduce the dependence on motorized transport, while focusing on the integration of green areas in the city. Although this principle may appear to be linked with more sustainable urban form models, research in developed country cities[31] suggests that the effectiveness of the compact city model in reducing GHG emissions depends on the lifestyle and space demands of the city inhabitants.

Alongside initiatives undertaken by municipal authorities, particularly in developed countries, private developers and community groups have led new urban development, brownfield regeneration and neighbourhood renewal projects which seek to address climate change specifically, such as the Onion Flats in Philadelphia (US), the Green Building in Manchester (UK), the A101 neighbourhood in Moscow (Russia) and the project T-Zed in Bangalore (India).[32] The combination of sustainability and climate mitigation objectives with business interests has led to the development of large-scale flagship urban developments that may bring together local and international partners to advance economic interests alongside environmental ones. One famous example from China was the proposed eco-city Dongtan, in Shanghai's 'last piece of pristine land' in Chongming Island. The developer, Shanghai Industrial Investment Corporation, contracted Arup, the international professional services firm in 2005 to design a master plan for Dongtan as an 'experiment' to showcase a national model for sustainability, energy efficiency and environmental awareness.[33] Some

Box 5.3 Urban development challenges for mitigating climate change: Thailand and Canada

In Chiang Mai (Thailand), research found that urban and commercial development coupled with growing economic prosperity has led to a surge in personal vehicle usage, related to both work commuting and leisure. The number of registered passenger cars and motorcycles increased more than 20-fold between 1970 and 2000, while the population only doubled, with a significant impact on greenhouse gas (GHG) emissions.[a]

Few Canadian cities appear to be prioritizing climate change-related action in land-use planning. While most cities do not acknowledge the emission reduction benefits of growth management and increased density, Calgary, Vancouver and Toronto are making explicit connections between land use and emissions. Yet, even in these three cities – which are leading climate change action in Canada – few specific initiatives address these connections. Research has attributed this to two main reasons: first, cities depend on provinces to review land-use planning policies, and this relationship may act in delaying or even discouraging action in this area; and second, actions required may be extremely divisive, openly challenging the traditional preference for suburban development in Canada.[b]

Sources: a Lebel et al, 2007, p101; b Mackie, 2005; Gore et al, 2009, p11

commentators, however, cast doubt on whether the Dongtan plans will ever be realized.[34] Whether the reason is the lack of leadership,[35] the conflicts of interest between local developers and international partners[36] or the permissive policies of local authorities,[37] many have criticized the project as not offering real solutions to address climate change.[38]

Furthermore, even where individual developments may be successful, the logic of developing greenfield urban fringe sites as a means of addressing climate change mitigation can be questioned, both in terms of their overall carbon footprint and, because of their exclusive nature, their potential for exacerbating social inequalities. Despite these criticisms, the trend for developing new 'eco-cities' shows little sign of abating in developed and developing countries alike. For example, the Clinton Climate Initiative has recently launched the Climate Positive programme, focusing on large-scale developments in 17 cities on six continents which are aiming to become carbon neutral.[39] A contrasting trend is the proliferation of initiatives, primarily in developed countries for the regeneration of brownfield land and neighbourhood renewal, which combine social and environmental justice objectives (see Box 5.4).

While municipal authorities can be crucial to the development of these projects, grassroots civil society organizations are also important. In the US, the Tent City project in Boston, the Plaza Apartments in San Francisco and the Intervale Green and Louis Nine House in New York[40] are all associated with civil society actors, sometimes led by NGOs, and have sought to promote carbon-saving technologies as suitable cheap alternatives for providing energy to low-income residents.

The confluence of a variety of interests and material circumstances in initiatives to mitigate climate change through urban design and development makes them complex and difficult to manage. The development and implementation of 'low-carbon' planning principles by municipal governments may encounter political opposition, lack enforceability, and have limited impacts upon the behaviour of individuals who live and work in the city. Furthermore, such principles may be socially divisive, reinforcing patterns of inequality in the city by creating enclaves of 'sustainable' living while failing to address the basic needs of the majority of urban citizens. Moreover, gender concerns have not been fully integrated within climate change policies and planning.[41]

In terms of low-carbon urban development projects, the circumstances that lead to their inception may change rapidly, thus challenging their feasibility, as was the case in the Dongtan project in Shanghai (China). One means of ensuring the long-term feasibility of such schemes is to take other issues of social and environmental justice into consideration, either through public consultation or through the participation of a range of stakeholders in the design and management of the project. Current examples suggest that small-scale developments which aim to simultaneously address environmental and social issues (e.g. homelessness, poverty, etc.) are more likely to find support from civil society groups, who in turn can facilitate their implementation. This, however, does not dismiss the idea that visionary cutting-edge projects may be able to provide best practice examples to challenge current socio-technical barriers, but suggests that the focus needs to change towards the development of projects that can address global demands for climate change mitigation and local demands for quality of life.

Table 5.3

Climate change mitigation through urban development and design

Type of scheme	Description
Urban expansion, informal settlements or suburban development:	Application of land-use planning and design policies to limit energy use in the expanding areas of existing cities.
New urban development:	Application of land-use planning and design policies to limit energy use in new urban areas.
Reuse of brownfield land:	Urban development on old industrial or other derelict areas of the city to encourage densification, mixed-use development and reduce energy use in the city.
Neighbourhood and small-scale urban renewal:	Schemes which seek to renew existing housing stock and redevelop urban layout and design at a neighbourhood or street scale in order to reduce energy use in the city.

Built environment

The design and use of the built environment is a critical arena for climate change mitigation because 'the building sector consumes roughly one-third of the final energy used in most countries, and it absorbs an even more significant share of electricity'.[42] The built environment includes public (e.g. government offices, hospitals, schools) domestic (housing) and commercial/industrial (e.g. offices, factories) buildings, with the latter increasingly recognized as important in driving peak demand and significant sources of GHG emissions in cities in developing countries.[43] The use of energy within the built environment is the result of complex interactions among building materials, design, the systems used

The design and use of the built environment is a critical arena for climate change mitigation

Box 5.4 Sustainable living and brownfield development, Stockholm, Sweden

Hammarby Sjöstad, Stockholm's largest new urban development project, is a model for closed-loop sustainable urban development. Their strategy is outlined in the Hammarby Model, an eco-cycle that optimizes resource use and minimizes waste in order to meet a wide range of sustainability targets in the areas of land use, energy, water, transport, building materials and socio-economic indicators. The new district, expected to house 25,000 inhabitants, is built on 200ha of industrial and harbour brownfield land in southern Stockholm, using tested eco-friendly building materials.

The district has its own recycling model, an underground vacuum-based system, which reduces waste and its associated collection costs (by 40 per cent overall, and 90 per cent for non-recyclable waste). Rainwater harvesting and the diversion of storm water from the sewerage system to be reused for heating, cooling and power generation help to offset demands for both water and power. The Hammarby district achieves 100 per cent renewable energy in its district heating network and transport use by making use of heat recovery from waste incineration, and biogas from the digestion of organic waste and sludge for household and transport use. Rooftop solar panels are also widely employed.

Suggested reasons for the successful realization of the Hammarby project (due to be completed in 2015) include acknowledgement of Stockholm's strong leadership in sustainable development planning; the implementation of innovative policies, high stakeholder involvement and commitment; and the successful coordination between and within the municipality and the Swedish national government.

Source: Hammarby Sjöstad, 2010

Type of scheme	Description
Energy-efficient materials:	The use of energy-efficient materials in the construction of the built environment.
Energy-efficient design:	The use of energy- and water-efficient design principles, such as 'passive' heating and cooling.
Building-integrated alternative energy supply:	The use of renewable and low-carbon energy technologies to provide energy to individual buildings.
Building-integrated alternative water supply:	The use of off-grid water supply and processing techniques which reduce energy use in the production and heating of clean water.
New-build energy and water-efficient technologies:	The use of energy- and water-efficient devices in the construction and development of new buildings.
Retrofitting energy- and water-efficient technologies:	The use of energy- and water-efficient devices in the renovation of existing buildings.
Energy- and water-efficient appliances:	The use of efficient appliances within the built environment.
Demand-reduction measures:	Measures aimed at reducing the demand for energy and water within the built environment.

Table 5.4

Climate change mitigation in the built environment

to provide buildings with energy and water, and the ways in which buildings are used on a daily basis.[44] Gender differences may play an important role in how energy within the household is used.[45]

Policy approaches for reducing GHG emissions from the built environment have primarily focused on issues of energy efficiency, with approaches grouped into 'three categories: economic incentives (e.g. taxes, energy pricing); regulatory requirements (e.g. codes or standards); or informational programmes (e.g. energy awareness campaigns, energy audits)'.[46] More recently, there has been a growth in voluntary rating systems (e.g. Energy Star in the US and the Carbon Trust Standard in the UK) and in the involvement of private actors (e.g. the C40 and Clinton Climate Initiative) in schemes to reduce energy use, which has led to an increase in expectations concerning energy efficiency in the (commercial) built environment. This combination of financial, regulatory, education-based and voluntary mechanisms[47] has led to an explosion in the range of schemes deployed to address energy use in the built environment, which has also been assisted by the development of microgeneration technologies and new building materials (see Table 5.4).

Policy approaches for reducing GHG emissions from the built environment have primarily focused on issues of energy efficiency

Despite the potential range of initiatives that could be undertaken, measures in the built environment sector tend to focus on energy-efficient technologies, alternative energy supply technologies and demand-reduction practices. Existing evidence suggests that initiatives in the built environment sector have primarily been located in cities in developed countries.[48] In particular, efforts have been concentrated on retrofitting existing buildings, those which are municipally owned and in the residential sector, with energy-efficient technologies – for example, in the European cities of Vienna (Austria), Stockholm (Sweden), London (UK), Munich (Germany) and Rotterdam (The Netherlands) (see also Box 5.5). National governments in developed countries have also intervened in implementing retrofitting programmes at the local level. For example, the US Department of Energy has led the Weatherization Assistance Program, which since 1999 has sought to increase the energy efficiency of low-income households while ensuring their safety in New York and other US cities.[49]

Research also suggests that in developed countries, many successful projects are led by grassroots organizations and housing co-operatives, such as the case in Tel Aviv (Israel), where a group of house buyers announced in 2009 the launch of the first Tel Aviv ecological housing project.[50] This suggests that innovative forms of social organization are emerging to coordinate and lead initiatives to address climate change in the built environment, with significant potential for addressing issues of social and environmental justice. Private developers may also have a strong role in promoting and implementing sustainable technologies. However, dealing with existing building stock poses problems in terms of conservation of heritage and dealing with demolition materials: in the UK, in order to achieve the existing targets for GHGs emission reductions, higher rates of demolition are advocated if sustainable technologies alone cannot meet the heating needs of insufficiently insulated housing.[51]

Despite the focus on measures to address climate change in the built environment, few cities in developed countries have sought to develop energy-efficient building materials or to address issues of the sustainable supply and use of water. However, when the intention is to establish best practice examples or to showcase new technologies, projects often include a range of different measures, including novel materials as well as low-carbon energy and water systems and passive designs. The ability of these measures to make significant gains in emissions reductions will depend on the current building standards, which vary greatly from city to city. Universities, architectural practices and engineering firms have been important sources of innovation, leading pilot projects designed to showcase a range of technologies.[52] The use of energy-efficient materials is not

Box 5.5 Retrofitting domestic, public and commercial buildings in the UK and the US

- *London (UK):* the Carbon 60 project followed the commitment of the Sandford Housing Co-operative to reduce greenhouse gas (GHG) emissions by 60 per cent. The combined financial support from private energy companies, the UK government and the rent increases within the co-operative made possible the retrofitting of 14 houses with wood pellet boilers and solar water heating.[a]
- *Birmingham (UK):* the Summerfield eco-housing project in Birmingham (supported by Birmingham City Council and Urban Living and the Family Housing Association) developed a demonstration project in a Victorian house featuring solar photovoltaic panels; grey water recycling and air source heat pumps; sunpipes; high-performance insulation made from recycled paper, denim and sheep's wool; and kitchens made from recycled materials.[b]
- *Manchester (UK):* the Cooperative Insurance Services 'Tower' was built in 1962 and is the tallest office building in the UK outside of London. In 2004, the Cooperative Financial Services started a UK£5.5 million project to retrofit photovoltaic technology, funded by the Northwest Regional Development Agency.[c]
- *Philadelphia (US):* the Friends Center Building Project, initiated in 2006, involves the retrofitting of an 1856 building with sustainable technologies. The project integrates recycled materials, recycled construction waste, white roof, and windows with spectrally selective glass, alongside sustainable and renewable technologies (e.g. geothermal exchange; solar array; wind power; storm water capture and reuse) and green building design with natural light.[d]

Sources: a Sanford Housing Co-operative, undated; b Office of the Deputy Prime Minister, 2003; c Energy Planning Knowledge Base, undated; d www.friendscentercorp.org, last accessed 18 October 2010

only possible in individual household projects, but can also be promoted as a strategy for commercial projects or, more widely, to encourage social and environmental sustainability (see Box 5.6).

In cities in developing countries there has been less emphasis on retrofitting residential buildings or on reducing demand for energy and water use. However, initiatives have been established to install energy-efficient appliances in municipal buildings in several cities, including Mexico City and Cape Town (South Africa),[53] and to reduce energy use in commercial buildings, especially in cities in Asia.[54] In addition, the use of energy-efficient materials has been an important means through which municipal governments and other actors have sought to address GHG emissions reductions and the provision of low-cost housing to low-income groups. South American cities such as Buenos Aires (Argentina) and Rio de Janeiro (Brazil) have piloted the use of energy-efficient and low-cost materials to deliver sustainable houses in low-income areas. In June 2009, the Argentinian Ministry of Infrastructure signed a contract with the Housing Institute, the National University of La Plata and the National Institute of Industrial Technology to start a pilot project to deliver social housing 'bioclimatic houses' in Buenos Aires.[55]

In addition to measures to improve energy efficiency and reduce demand, cities are also experimenting with alternative forms of renewable and low-carbon energy supply. In the built environment, initiatives have primarily focused on the use of solar water heaters, relatively simple devices used to heat water using sunlight,[56] rather than other autonomous energy supply devices, such as photovoltaic cells, wind power or biomass technologies. Some cities – such as Barcelona (Spain), São Paulo (Brazil) and Buenos Aires (Argentina) – enforce the adoption of solar water heaters in municipal ordinances. In China, given its leading position in the manufacture of domestic solar water heaters, there is potential for this technology to be widely adopted. The main barrier for the adoption of solar water heaters is their large initial installation cost; but given that solar water heaters have a longer lifetime, the overall costs of solar water heaters may be considerably lower.[57] A study of a project to install 200,000 solar water heaters in the quickly urbanizing and industrializing district of Yinzhou (China) concluded that such a project could have significant benefits (see Table 5.5). In addition to their climate change benefits, the decentralization of energy provision is often seen as a way of addressing the energy needs of those actors who do not have access to a reliable supply of energy. From a gender perspective, low-carbon options for cooking, such as biogas digesters and solar cookers, may facilitate women's access to energy as long as they are adapted to the local context and compatible with women's daily routines and workloads.[58]

Within the built environment, the potential for mitigation gains from reducing the demand for energy is also significant. Municipal governments, private-sector companies and civil society groups have undertaken a wide range of initiatives aimed at changing the ways in which their own employees and urban citizens use energy. To date, these efforts have not taken issues of gender into account.[59] This could be a critical omission as women are often thought to have a greater share of decision-making within the household. For example, in Organisation for Economic Co-operation and Development (OECD) countries, women make over 80 per cent of consumer decisions in the household[60] and thus may determine the sustainable consumption decisions within the home. In general, women appear to be more prepared for behavioural changes than men, as men tend to rely most on technological solutions. For example, women tend to place more emphasis on eco-labelled food, recycling and energy efficiency than men.[61] This suggests that women-oriented sustainable consumption policies could work as a tool that municipalities and other urban actors could use to reduce GHG emissions from households.

Cities are also experimenting with alternative forms of renewable and low-carbon energy supply

Among the approaches to mitigate GHG emissions in the built environment applied over the last two decades, the emphasis has been on energy efficiency measures – both in terms of technologies and initiatives to reduce demand – with far fewer projects to reduce GHG emissions through alternative forms of energy supply and limited evidence of other initiatives targeting resource use. Initial climate

Box 5.6 Sustainable and affordable houses for the poor in Bishnek, Kyrgyzstan

A project developed by the Habitat Kyrgyzstan Foundation has provided more than 48 affordable environmentally sustainable homes for low-income families using a traditional cane reed and clay construction technology. Heating is provided by an innovative coiled-circuit under-floor heating system. The houses meet local building regulations, but allow families to save up to 40 per cent of the construction costs compared with conventional brick housing. The use of volunteer labour further reduces the cost of the houses, and low-cost housing loans help to ensure affordability.

The use of traditional building methods and locally available materials relies on the revival of a traditional cost-effective building technology commonly used during the 19th century, but replaced during the 20th century by brick building. The Habitat Kyrgyzstan Foundation has adapted the traditional cane reed construction method to include a timber frame with cane reed and clay wall sections, improving insulation without compromising comfort.

Source: www.worldhabitatawards.org, last accessed 18 October 2010

Table 5.5

Costs and benefits of a project to install 200,000 solar water heaters in the residential sector in Yinzhou, China

Benefits	
Climate benefits:	Abatement of 88,900 tonnes of CO_2eq per annum, 1.3 million tonnes over 15 years.
Other environment effects:	Reduction of sulphur dioxide, nitrogen oxides, other air pollutants and wastes.
Economic and social effects:	Potential health improvement. Low-cost water heating supply.
Costs	
Subsidy:[a]	US$1.28 million.
Estimated gross financial costs:[b]	400 million RMB (US$48 million).
Administrative, institutional and political considerations:	Transaction costs likely to reach US$2 per heater to meet the need for advertisements and a good distribution system (US$0.4 million).
The cost of certified emission reductions:	Approximately US$1.3 per tonne CO_2eq.

Notes: a Subsidy is calculated as the amount necessary to cover the cost differential between the solar water heater and the electric water heater for the first five years, including the electricity cost reduction.
b Gross financial costs here refer to the total cost of initial purchase and installation. The price of residential electricity adopted here is 0.65 RMB (US$0.08) per kilowatt hour (kWh).

Source: adapted from Zhao and Michaelowa, 2006

change action within the built environment has focused on easy gains from energy and water efficiency, and the adaptation of existing technologies.[62] The combination of regulation, civil society action and the inclusion of sustainable building principles could have a big impact upon incorporating climate change mitigation technologies and principles within new buildings. Yet, there are obstacles to retrofitting existing buildings, such as inadequate returns on investment, difficulties in dealing with existing stock, lack of financial incentives and regulatory constraints, dependency upon occupancy cycles, and general lack of information about available technological solutions. The combination of social and environmental benefits that energy efficiency can generate is particularly relevant in developing countries, where environmental measures may tackle other social problems such as 'fuel poverty'. However, there is a case to look beyond these measures as their impact may be reduced by the 'rebound effect' – that is, the tendency to use efficiency gain to increase consumption.[63] In this context, energy efficiency measures need to be coupled with those to develop low-carbon renewable energy sources and the reduction of energy demand.

Municipal authorities … have undertaken a range of schemes in order to reduce GHG emissions through the refurbishment and development of urban infrastructure systems

Urban infrastructure

Urban infrastructure – in particular, energy (electricity and gas) networks, and water and sanitation systems – is critical in shaping the current and future trajectories of GHG emissions. The type of energy supply, the carbon intensity of providing water, sanitation and waste services, and the release of methane from landfill sites are important, though often hidden, components of GHG emissions at the local level. Infrastructure systems frequently lie outside the direct control of municipal governments, are intertwined with power struggles over the rights of those living in informal settlements,[64] and require significant resources and long-term planning. The significant upfront costs of renewing or replacing existing infrastructures, or of providing such systems to the expanding areas of cities, means that investment in infrastructure is often delayed in favour of more pressing immediate concerns. Furthermore, although urban infrastructure systems are often regarded as gender neutral, men and women are affected differently by water, waste and energy policies as their work and community roles differ. For example, while women are often responsible for ensuring energy supply at the household level, they may be excluded from technical work on the energy systems, often regarded as a male domain.[65] Equally, women's safety and security may be more dependent on adequate infrastructure systems, such as the provision of adequate lighting and sanitation facilities.[66] Urban infrastructure systems therefore pose unique and complex challenges for mitigating climate change.

In some cities in developing countries, the Clean Development Mechanism (CDM) has been an important driver of infrastructure projects

At the same time, the very nature of urban infrastructure systems is changing significantly. In developed countries, research has documented the demise of the nationally integrated, 'modern' homogeneous utility networks in the face of processes of market liberalization, privatization, neoliberal political ideologies, shifts in urban planning, new technologies and new practices of consumption, leading to the 'splintering' of urban infrastructure systems.[67] Similar processes, although often less apparent, are taking place in cities in developing countries. Thus, across a diverse range of cities, a sense of social, political and technical dynamism and instability now characterizes the provision of basic services and infrastructure development. Within this context, mitigating climate change is becoming an important issue, but one that competes for attention with other pressures for energy security and affordability, and the provision of basic services. Nonetheless, municipal authorities – together with other government, private and civil society actors – have undertaken a range of schemes in order to reduce GHG emissions through the refurbishment and development of urban infrastructure systems (see Table 5.6).

Of the three infrastructure areas considered in this section, research suggests that initiatives to explicitly address climate change have been concentrated in the energy and energy-from-waste domains and on the provision of new forms of energy supply, with fewer initiatives to address the carbon intensity of the provision of water, sanitation and waste services or to reduce demand. In some cities in developing countries, the Clean Development Mechanism (CDM)[68] has been an important driver of infrastructure projects, particularly landfill gas capture (see discussion below). Issues of energy security have also been important drivers for the development of low-carbon energy supply systems in developing countries and initiatives for demand reduction in some Latin American and African cities. In India, cities such as Chennai have been successful in promoting rainwater harvesting as a form of water conservation. In Latin America, concerns for water security are also leading to the development of initiatives with benefits for mitigating climate change. While urban infrastructure initiatives are often led by municipal governments or urban utility authorities, regional and national governments, international agencies and private companies are frequently involved because of the multilevel nature of such systems.

In terms of energy systems, three different approaches for developing low-carbon forms of urban energy supply can be identified. *First*, many municipalities have sought to reduce the carbon footprint of existing supply networks. An increasingly common initiative, found in cities such as Melbourne (Australia), Beijing (China) and Jogjakarta (Indonesia), has been to retrofit street-lighting systems with energy-efficient bulbs. Cities, particularly in Europe, have also sought to develop existing district heating and combined

Table 5.6

Climate change mitigation and urban infrastructures

Type of scheme	Description
Alternative energy supply:	Development of renewable energy or low-carbon energy supply systems at the city scale.
Landfill gas capture:	Use of gas produced by landfill sites for energy provision.
Alternative water supply:	Use of alternative forms of water supply, storage and processing to reduce energy use at city scale.
Collection of waste for recycling or reuse:	Development of alternative collection systems and ways of using waste to reduce methane produced at landfill sites.
Energy and water efficiency/conservation:	Enhancing the efficiency of existing infrastructure systems or development of new efficient systems.
Demand reduction:	Schemes to reduce demand for energy and water use, and for the collection of waste.

heat and power (CHP) plants. In Germany, Berlin is home to Western Europe's largest urban heat network, with over 1500 kilometres of pipes and over 280 district-level CHP plants stretching across the city, delivering low-carbon energy to a wide variety of consumers.[69]

A *second* approach has been for municipalities to purchase renewable energy, either for their own buildings and operations, or as a means of offering consumers access to green energy at a reduced cost. This approach is often facilitated by purchase agreements between the municipality and a private supplier of low-carbon or renewable energy, such as in the case between Cape Town and the Darling Wind Farm in South Africa, or the commitment of the City of Sydney (Australia) to achieve the supply of 100 per cent of the city's energy from renewable sources by using a system to accredit private energy companies.[70]

A *third* approach has been to develop new low-carbon and renewable energy systems within cities. In these initiatives, climate change mitigation is often expressed as a secondary objective in relation to ensuring energy security. This is the case in the growing interest of Latin American cities such as Quito (Ecuador), Bogotá (Colombia) and Rio de Janeiro (Brazil) in sources of energy that may reduce their dependence on oil by promoting the use of natural gas in households. In Cape Town (South Africa), the company Eskom, backed by the national government, has proposed the construction of a nuclear plant to meet the twin objectives of guaranteeing the energy safety of the region and reducing the city's carbon emissions; but the project has found considerable local opposition from both the City of Cape Town and diverse stakeholder groups, mirroring global debates about the role of nuclear power in climate change mitigation.[71] In China, the Beijing municipal government has accelerated the development of clean energy sources, including geothermal resources, biomass and wind power. In addition to the 118 plants already in operation by the end of 1998, 174 new geothermal wells were constructed between 1999 and 2006. Beijing now consumes about 8.8 million cubic metres of geothermal water each year, reducing CO_2 emissions by 850,000 tonnes during the period of 2001 to 2006.[72] Beijing is also increasingly looking at wind power and biomass generation, and the city had planned to increase the energy share of these renewable energy sources to 4 per cent by 2010. The Guanting wind farm, located on the southern bank of the Guanting Reservoir, is Beijing's first wind power generation station, with 33 wind turbines capable of generating 49.5MW of electricity per year.[73] It was completed in January 2008 as a CDM project.

While investment of the scale and ambition displayed by Beijing is difficult to imagine for the vast majority of municipal authorities, national and international drivers, together with partnerships with private-sector companies, are leading to a growing emphasis on renewable and low-carbon energy systems. For example, the US Department of Energy has established a partnership with 25 cities to deliver Solar American Cities. The cities selected will receive a combined US$5 million of funding from the department plus hands-on technical assistance over two years. In Boston, for example, the goal is to achieve 25MW cumulative installed solar capacity by 2015.[74] Although the costs of solar energy in the US are high, in Boston its adoption may be facilitated by the high local energy prices, and the municipality is due to remove some market barriers such as in urban planning charters, zoning regulations, building codes, permitting and inspections, coupled with city-level solar incentives such as solar rebates, financial assistance or tax credits. At the international level, the CDM has the potential to be an important driver for energy-from-waste projects in developing countries, including *Aterro Bandeirantes* and *Aterro San Joao* in São Paulo (Brazil); the Zámbiza landfill methane plant in Quito (Ecuador); the Bordo Poniente landfill biogas capture plant in Mexico City; and – in South Africa – the Bellville South landfill site in Cape Town and the gas-to-energy project in Johannesburg. While such schemes are frequently regarded as 'technical' fixes, there is evidence that they can be used to address broader social issues and may offer significant opportunities for the empowerment of women who work on the lower end of the waste chain (see Box 5.7).

The CDM has the potential to be an important driver for energy-from-waste projects in developing countries

Schemes to generate energy from waste have also proven popular in developed countries where private-sector companies have frequently provided the finances for municipal schemes. In Dallas (US), an interstate 'green' gas sale agreement will allow Dallas Clean Energy LLC to sell bio-methane captured at McCommas Bluff Landfill to Shell Energy North America.[75] The initiative Human Waste to Power the City, announced in June 2009 in Manchester (UK), is a UK£4.3 million two-year demonstration scheme, initiated by National Grid and United Utilities,[76] to convert human waste into bio-methane to power 500 homes.[77] However, despite these initiatives and the increasing interest in waste to energy, research suggests that, beyond small-scale demonstration projects,[78] the development of low-carbon energy systems remains a low priority in cities.[79]

Schemes to generate energy from waste have also proven popular in developed countries

Outside of the energy sector, and beyond the growing interest in generating energy from waste, there is relatively little evidence that municipalities are linking policies for

Box 5.7 Feminist action to gain recognition for women waste pickers in Mumbai, India

The Parisar Vikas (eco-development) programme was launched in 1998 by the *Stree Mukti Sanghatana* (Women's Liberation Organization), established in 1975, with the cooperation of the Municipal Corporation of Greater Mumbai. The programme aims to address the problems of waste management and of self-employed women engaged in the 'menial' tasks of collecting waste.

The action twins the objectives of improving the social status and economic situation of women waste pickers in Mumbai and recognizing their potential role in achieving the goal of a 'zero waste' Mumbai. In parallel with activities to achieve the active liberation of women waste pickers (such as the organization of training programmes, the arrangement of day-care centres, facilitating their access to health and educational programmes for their children, counselling centres and the development of cultural events which display the reality of these women), *Stree Mukti Sanghatana* is now collaborating with staff at the Baba Nuclear Research Centre to train women in composting, maintenance of biogas plants and fine sorting, and to involve women waste pickers in the operation of a pilot methane gas generation facility.

Source: Mhapsekar, 2010; see also www.streemuktisanghatana.org, last accessed 18 October 2010

Box 5.8 Raising public awareness for waste reduction in Yokohama, Japan

Yokohama's success in waste reduction is attributed to the city's public awareness campaigns and the active participation of stakeholders in the city's '3R' activities (i.e. reduce, reuse and recycle). In 2003, Yokohama launched its G30 Action Plan to reduce waste by 30 per cent by the financial year 2010, using waste quantities from the financial year 2001 as baselines. Apart from attributing responsibilities for waste reduction to all stakeholders, the plan also includes environmental education and promotional activities, such as 11,000 seminars for neighbourhood community associations to explain waste reduction methods, 470 campaigns at railway stations and 2200 awareness campaigns at local waste disposal points.

The waste reduction target of 30 per cent was achieved in 2005, and by 2007 waste had fallen by 38.7 per cent relative to 2001 figures. The reduction in waste from 2001 to 2007 is equivalent to 840,000 tonnes of CO_2 emissions. The scheme also had economic benefits, including US$23.5 million from selling recyclables and US$24.6 million from electricity generated from waste incineration.

Source: Suzuki et al, 2009

recycling and reducing waste directly to climate change. However, in Nigeria, the Lagos State Waste Management Authority argues that although African cities have comparably less GHG emissions than cities in the developed world, a great portion of these emissions can be attributed to waste management issues. Thus, they expect that their ongoing strategies to improve waste transport planning and the management of landfills, as well as their campaign to reduce the private burning of refuse, will have positive impacts upon the reduction of Lagos GHG emissions.[80] Besides better management, education and awareness initiatives have been demonstrated to be effective in reducing the contribution of landfill sites to GHG emissions, as in the example of Yokohama (Japan) (see Box 5.8). However, such initiatives to reduce the amount of waste sent to landfill may paradoxically weaken the viability of current and future energy-from-waste plants, which rely on a secure stream of waste as a fuel. The potential conflicts between 'technical' and 'behavioural' approaches to reducing GHG emissions from landfill highlight the dilemmas facing urban mitigation efforts where the impacts of policies and measures are uncertain and the benefits and costs of action are divided across a number of different stakeholders and communities.

Energy efficiency schemes … may fail to deliver long-term GHG emissions savings as initial reductions in energy use may be limited by the 'rebound effect'

Initiatives which specifically aim to reduce the carbon intensity of water and sanitation systems at the urban level are also rare. One example is in Mexico City, where the upgrade of network infrastructure will include the upgrade of 2300km of damaged networks and the establishment of 336 separate hydrometric sectors to facilitate the detection and repair of leaks. These actions will require the investment of 2970 million pesos (US$240 million) and may save up to 45,500 tonnes of CO_2eq/year.[81] In addition, there is an innovative proposal to generate energy from the flows of water in the network, similar to that under consideration in Durban (South Africa).[82] It is estimated that this measure alone could reduce the city's emissions by 40,700 tonnes CO_2eq/year.[83] While the viability of such innovative measures will depend on the particular characteristics of water supply systems, the potential GHG emissions savings that could be achieved through these sorts of maintenance, modernization and efficiency measures that are already taking place in many cities may be substantial.

In developing countries … although transport's share of GHG emissions is low, it is growing much faster than other sectors

In summary, initiatives in the urban infrastructure domain have focused on energy efficiency schemes, primarily driven by concerns for energy security and financial savings. While such projects are politically and economically attractive, they may fail to deliver long-term GHG emissions savings as initial reductions in energy use may be limited by the 'rebound effect' as demand for energy continues to grow. However, with limited evidence of mitigation initiatives in terms of the development of renewable energy systems – or in the water, sanitation and waste sectors – a key finding from this analysis is that there may be significant hidden potential to mitigate climate change at the urban level through infrastructure networks.

Nevertheless, there remain substantial barriers to the realization of these mitigation gains, not least in terms of the economics and politics of renovating existing infrastructure systems, building new networks, and meeting the basic needs of urban communities, particularly those in informal settlements. Few of these projects address social inclusion issues explicitly, or appear to specifically target low-income groups, disadvantaged areas or slums. In some cases, social inclusion concerns have been at least acknowledged – in anticipation of potential social conflicts generated by these measures – as is the case of the landfill gas to energy project in Johannesburg (South Africa), which will include a public consultation before its completion. In general, however, urban infrastructure projects rely on the assumption that any improvements on current infrastructures will be beneficial for all the inhabitants of the city, an assumption that requires critical scrutiny as climate change tends to deepen the existing inequalities amongst urban populations in terms of access to basic services.

Transport

The transport sector is a significant contributor to GHG emissions, representing 23 per cent (worldwide) and 30 per cent (OECD) of CO_2 emissions from fossil fuel combustion in 2005.[84] In developing countries, especially China, India and other Asian countries, although transport's share of GHG emissions is low, it is growing much faster than other sectors.[85] One of the key reasons for this rising trajectory is the challenge of urban sprawl, discussed above; but the growth in GHG emissions from the transport sector also represents the widespread modal shift that is taking place in cities in developing countries as household incomes and the affordability of motorized individual transport increases and aspirations for such forms of mobility, at both an individual and municipal level, increase. Moreover, urban sprawl may increase the demand for travel in ways that may not be easily met by public transport.[86] For example, 'the transport sector … [is] the "carbon time bomb" ' in Yogyakarta (Indonesia), as 'the fastest growing fossil fuel consuming sector in the city'[87] in part because 'non-motorized transport modes such as the "*becaks*" (peddycabs) have been banned' due to their perception as being insufficiently 'modern' for municipal aspirations for the city.[88]

However, the growth of private transport is not gender neutral. A Swedish survey from 2007 showed that 75 per cent of all cars were owned by men; moreover, women's cars are generally smaller (thus, generally emit less) than those owned by men.[89] In the UK, 27 per cent more men than women hold driving licences, and women are 38 per cent more likely not to have access to a car, as well as twice as likely to be a non-driver in a household with a car.[90] In the US, men constitute two-thirds of long-distance commuters, while women tend to become dependent on and favourably inclined to using public transport.[91] Perhaps because of their lesser dependence on private transport[92] it has been suggested that women may be more willing than men to accept policies and measures that restrict cars.[93]

At the same time, as the proportion of journeys made in cities by cars and other forms of personalized motorized transport increase, so do the challenges of congestion and air pollution. The synergy between mitigating climate change and these twin issues that are both highly visible in the city and which have popular support has meant that the transport sector is one in which a range of schemes have been developed to reduce GHG emissions (see Table 5.7).

Evidence suggests that there is a contrast between areas where the transport sector features quite prominently in climate change plans and initiatives (such as in Europe and Latin America), and areas where the transport sector has received considerably less attention than other sectors, such as energy infrastructure and the built environment (i.e. North America, Australia and New Zealand).[94] Cities in developing countries show a growing interest in the development of new public transport infrastructure and technical innovation, such as programmes for the introduction of new technologies, fleet replacement with energy-efficient vehicles and fuel switching. Because of the significant investments in infrastructure and technology involved, initiatives to reduce GHG emissions in the transport sector frequently

Table 5.7

Climate change mitigation and transportation

Type of scheme	Description
New low-carbon transport infrastructure:	The development of new transport infrastructure to encourage low-carbon modes of transportation.
Low-carbon infrastructure renewal:	The renewal or upgrading of transport infrastructure to reduce GHG emissions.
Fleet replacement:	Replacement of vehicle fleet with energy-efficient or low-carbon vehicles.
Fuel switching:	Switch from the use of fossil fuels for powering fleet to alternative low-carbon or renewable fuels.
Enhancing energy efficiency:	Measures to enhance the energy efficiency of existing vehicles and their use.
Demand-reduction measures:	Measures aimed at reducing the demand for individual motorized transport.
Demand-enhancement measures:	Measures aimed at enhancing the demand for alternative forms of travel (e.g. public transport, walking and cycling).

The growth of private transport is not gender neutral

Box 5.9 Congestion charges: Past, present and future

Congestion pricing is a system of charging road users a fee for using the road in certain areas at certain times. It has been introduced in a number of large European cities, such as Milan, London, Rome and Stockholm, with the aim of reducing inner-city traffic volumes, reducing air pollution and encouraging the use of more fuel-efficient and environmentally friendly vehicles. Generally, congestion charges apply upon entering a clearly demarcated urban area and are paid on either a daily or per trip basis using a range of methods (online, mobile phone text message, swipe cards, scratch cards or by sensors installed in cars). Sometimes they are adjusted to the time of day, traffic levels or type of vehicle, and usually include some form of exemption for residents, low-emission vehicles, public transport and two-wheeled motorized transport.

The first congestion charge system was introduced in 1975 in Singapore and was combined with car ownership restraints. Initially it was not linked with climate change, but focused on concerns about traffic congestion.

In Rome (Italy), the 'limited traffic zone' was set up in 2001 to improve mobility and limit private vehicle trips in the historic city centre. Around 250,000 vehicles (12 per cent of registered vehicles in Rome) were permitted inside the area, resulting in a 10 per cent decrease in traffic volumes overall, a 20 per cent decrease during the restriction period (06.30am to 18.00pm) and a 6 per cent increase in public transport use.

In Milan (Italy), arguably Europe's third most polluted urban centre, more than half of citizens use private cars and motorcycles, which led the mayor of Milan to introduce 'ecopass' in 2008. This is a pollution-adjusted congestion charge affecting the 8 square kilometre city centre (5 per cent of the city's total area), levied on a sliding scale of engine types (between 07.30am to 19.30pm on weekdays).

In the UK, the London Congestion Charge Zone, one of the largest in the world, was introduced in Central London in 2003 and extended to some parts of West London in 2007. A daily charge of UK£8 allows drivers to enter the 21 square kilometre zone (07.00am to 18.30pm on weekdays). This resulted in traffic volume reductions of 18 per cent at peak times (15 per cent overall); a traffic delay reduction of 39 per cent; increased cycling by 20 per cent; and a 20 per cent increase in taxi and bus use. It should be noted that this success has not been the case across the UK; a similar scheme established in Manchester has not achieved the same results.

In Stockholm (Sweden), congestion fees were implemented on a permanent basis in 2007. These are levied every time a user crosses the cordon area, with the charge varying over the day according to the congestion levels (highest during morning and afternoon peaks, moderate during the middle of the day, and zero during nights and weekends). This scheme has resulted in an overall traffic reduction of 25 per cent; a waiting time reduction of 30 per cent; and a 50 per cent reduction in traffic volume during the evening rush hour.

Overall, evidence of the success of these schemes has been positive and the initial public resistance seems to have waned following their implementation. There have been many implementation problems, especially surrounding the initiation of the schemes. These include resistance from stakeholders and citizens, a lack of alternative infrastructure and problems with payment operations. Some questions about the economical results of the congestion charge in London have also been raised.

Sources: Prud'homme and Bocarejo, 2005; Leape, 2006

Table 5.8

Bus rapid transit (BRT) systems planned or in operation in different regions

Region	Number of cities	Examples		
		Name	City	Status
Developed countries				
Europe	21	Ipswich Rapid	Ipswich, UK	In operation since 2004
North America	52	Rapid Ride	Albuquerque, US	In operation since 2004
		Super Loop	San Diego, US	In operation since 2009
Other	6	O-Bahn Busway	Adelaide, Australia	In operation since 1986
		Northern Busway	Auckland, New Zealand	In operation since 2008
Developing countries				
Africa	8	Lagos BRT	Lagos, Nigeria	In operation since 2008
		Rea Vaya	Johannesburg, South Africa	In operation since 2010
Asia and the Pacific	59	Transjakarta	Jakarta, Indonesia	In operation since 2004
		Transit Metrobus	Istanbul, Turkey	In operation since 1994
Latin America and the Caribbean	30	Trolmerida	Mérida, Venezuela	In operation since 2007
		Rede Integrada de Transporte	Curitiba, Brazil	In operation since 1980

depend on partnerships with private-sector organizations as well as the involvement of national and regional governments. Interventions by grassroots organizations or individuals in the transport sector are normally limited to projects for the promotion of non-motorized transport and demand management initiatives, such as car-sharing schemes.

A recent survey of climate change plans in 30 cities worldwide found that the most common climate change mitigation actions in transport were the development of public transport, the implementation of cleaner technologies, the promotion of non-motorized transport, public awareness campaigns and the implementation of cleaner technologies.[95]

Initiatives to reduce GHG emissions in the transport sector frequently depend on partnerships with private-sector organizations

Regulatory measures to manage demand – such as physical restraint (e.g. those implemented in Mexico City and São Paulo, Brazil), parking restraints, establishment of low emissions zones (implemented in Beijing, China, and several European cities) and speed restrictions – appear to be less common, with few examples of economic incentives being used. The examples discussed here also suggest that municipalities have a key role in the provision of infrastructure and the development of new technologies, and that they use a wide range of regulatory tools, including mandatory standards and targets, planning law or planning guidance, performance evaluation and the ban of certain fuels, together with some financial instruments such as subsidies, loans to modernize the fleet and taxes, such as congestion charges (see Box 5.9).

The mitigation of climate change is one driver behind the development of new mass transportation infrastructure

Turning first to issues of transport infrastructure, the mitigation of climate change is one driver behind the development of new mass transportation infrastructure. One of the most common initiatives is the operation of bus rapid transit (BRT) systems, guided bus lines or bus ways to improve the quality and speed of bus services. BRT and similar initiatives – which in many cases may be implemented at a fraction of the cost of an underground metro system – already exist or are planned in cities in all major regions of the world, although not all these initiatives are specifically tied with climate change mitigation objectives (see Table 5.8). The Transmilenio BRT System in Bogotá (Colombia) is often mentioned as a leading example, although it follows the pioneering experience of Curitiba (Brazil).[96] The service, opened in 2000, is administered by Transmilenio S.A., a public company, and operated by private contractors. The system consists of 84km of central bus lines connected with 515km of peripheral lines and 114 passenger-picking stations, and can transport up to 1 million passengers every day. In addition, its 9000 buses are to be replaced with energy-efficient models. However, Transmilenio has been criticized for being overcrowded, too expensive, slow and offering limited access to certain areas of the city. Nevertheless, the experience of Bogotá is often mentioned in other cities as an example of actions to extend or improve existing mass transportation systems. Other public transportation systems such as trams or trains may have received less attention in climate change mitigation plans because of their high costs; but the use of CDM credits may increase the number of these types of projects in developing countries. For example, the Egyptian Ministry of Transport and the National Authority for Tunnels, in cooperation with CDM-Egypt, are planning to build a third line for the Greater Cairo Metro Network between 2010 and 2031.[97] The project will cost €856 million and it is expected to be funded by CDM credits.

A second area in which municipalities have sought to take action is through the development of low-carbon vehicles and fuels. In Germany, Hamburg and Berlin have teamed up in the Clean Energy Partnership,[98] which foresees the development of public fuel cell buses and urban hydrogen filling stations. In Hamburg the aim is to have 10 fuel cell buses in operation by 2010, 500 to 1000 fuel cell vehicles by 2015, together with a public network of filling stations. In Rome (Italy), the urban public agency in charge of local public transport services and the Commune of Rome have been involved in the introduction of over 80 electrically powered buses and 700 methane buses. Stockholm (Sweden) has the largest green fleet in Europe, and is heading for 100 per cent renewable energy in public transport by 2010, with tram and rail being powered by wind and hydroelectricity, and ethanol and biogas fuels used in a large proportion of the city's own fleet, as well as private vehicles (35,000 in total, about 5.3 per cent of vehicles) reducing CO_2 emissions by 200,000 tonnes annually. Significantly, cities are also providing arenas for the experimentation and promotion of new technologies, such as in the cases of compressed natural gas use in transport in several cities around the world including Tehran (Iran), Mumbai (India),

Dhaka (Bangladesh) and Bogotá (Colombia),[99] while in Brazil biofuels are promoted in the country's megacities.

A third set of initiatives in the transport sector includes demand-reduction and demand-enhancement measures, led by a wide range of actors and involving different policy instruments, modes of transport and understandings of mobility. For example, a non-profit organization launched by transportation activists, Car Share, has launched City Car Share schemes in several US cities such as San Francisco, Oakland and Berkeley. Public bicycle sharing networks allow people to borrow or rent bicycles so that they can travel around the city without having to own a bicycle, reducing individual purchase and maintenance costs, and storage space requirements. Such programmes are popular in European cities and are used, amongst others, in Barcelona, Spain (*Bicing*); Milan, Italy (*Biciclette Gialle*); Paris, France (*Velib*); Rome, Italy (*Romainbici*); and Stockholm, Sweden (Stockholm City Bikes). A similar programme also exists in Montreal, Canada (Bixi). Municipalities may also impose traffic restrictions, such as congestion charges (see Box 5.9), although this may reduce the access to the city to social groups who cannot afford such tax.

Municipalities can also work with other institutions to reduce demand. For example, the City of Cape Town (South Africa) has a project to develop partnerships with the largest employers within the city to reduce the work-related mobility needs of their employees. However, the introduction of demand management measures is not always straightforward. For example, in Brazil, the Porto Alegre Charter to facilitate and promote pedestrian mobility within the city – which gave new rights to pedestrian and disabled people – had to be substantially modified before it could obtain the approval of local representatives in 2007, although the original proposal of shifting the right of way from motorized vehicles to pedestrians could be maintained.

The dynamism of the transport sector and its interaction with other sectors makes it difficult to anticipate the consequences and future of climate change mitigation measures, particularly when climate change mitigation plans and actions are confronted with the increasing mobility demands of the urban population. Measures to control and reduce demand need to be complemented with alternatives for mass transport and non-motorized transport that often require significant investments in new infrastructure. In many cities, climate change mitigation concerns have been preceded by concerns about urban congestion and air quality, which makes transport a central issue in urban planning and management. Recent transport studies suggest that differential prices of energy sources, based on carbon content, could help to promote better urban transport efficiency.[100] Yet, it is not clear how this could be implemented at the city level. On the other hand, the combination of improved car technologies and traffic management may complement carbon pricing to mitigate climate change while improving the sustainability of current urban transport systems.[101]

Carbon sequestration

In addition to reducing the amount of GHG emissions that are produced in the city, one means through which urban actors could address the challenge of mitigation is through carbon sequestration. Carbon sequestration involves removing GHG emissions from the atmosphere, either through enhancing natural 'carbon sinks' (e.g. conserving forested areas and enhancing river environments), the development of new carbon sinks (e.g. reforestation or afforestation) or through the capture and storage of GHG being produced within the city. The capture of methane from landfill sites for energy generation[102] is also a form of carbon sequestration. Traditionally, such activities have been peripheral to the main focus of urban mitigation activity. However, new developments in carbon capture and storage technologies, growing interest among national governments in carbon capture and storage, especially in developed countries and the more industrialized developing countries, and the increasing availability of carbon finance through international policy instruments – such as the CDM – are making carbon sequestration schemes more popular at the urban level (see Table 5.9). Regionally, carbon sequestration schemes are more common in developing country cities, often associated with gaining CDM credits or development programmes. However, it should be noted that actions promoting urban tree-planting and restoration, preservation or conservation of carbon sinks may be taken in cities in developed countries for reasons of environmental protection or the preservation of urban green spaces without associating them specifically with climate change mitigation objectives.

In many cities, climate change mitigation concerns have been preceded by concerns about urban congestion and air quality, which makes transport a central issue in urban planning and management

New developments in carbon capture and storage technologies … are making carbon sequestration schemes more popular at the urban level

Urban carbon sequestration, however, is still in incipient stages. The technology to facilitate carbon capture and storage is still under development, and proposals for its implementation in cities are only now emerging (see Box 5.10). Carbon offset schemes based at the city level are also rare and often reach beyond city limits. In the US, Philadelphia Zoo (in partnership with private actors) has initiated the Footprints scheme to green zoo operations, develop local and international carbon offset projects, and engage with communities in Philadelphia and beyond. The Footprints scheme includes two reforestation projects, one in a former scrub site close to the zoo and another in Sukau, Borneo (Malaysia). Offsetting projects are often led by individuals or NGOs; but sometimes governmental authorities may have a crucial role in mediating the schemes. For example, since 2008 the city of Rio de Janeiro (Brazil) has created its own 'carbon market', which facilitates the participation of private

Table 5.9

Climate change mitigation and carbon sequestration

Type of scheme	Description
Urban carbon capture and storage:	The development of schemes to capture CO_2 emissions from energy generation within the city and place in long-term storage.
Urban tree-planting programmes:	Schemes which seek to plant trees to develop the urban 'sink' capacity for CO_2.
Restoration of carbon sinks:	Schemes which seek to restore areas of natural carbon sinks in the city.
Preservation and conservation of carbon sinks:	Schemes which seek to preserve and enhance areas of natural carbon sinks in the city.
Carbon offset schemes:	The purchase of carbon sequestration offsets by actors within the city from schemes located either in the city or elsewhere.

Box 5.10 The future of energy? Piloting urban carbon capture and storage in Rotterdam, The Netherlands

The Rotterdam Climate Initiative combines the city administration, the regional environmental protection agency (DCMR), the Port of Rotterdam, and the businesses in the port. It has set a target of 50 per cent CO_2 reduction by 2025 (compared to 1990), two-thirds of which is to be achieved by the use of carbon capture and storage technology. At present, CO_2 is piped and sold to horticulturalists to stimulate plant growth. However, through the capture of emissions from two new coal-fired power stations, the process will be scaled up from current volumes (of around 400,000 tonnes per year) to approximately 1 million tonnes per year.

Once carbon capture and storage technology is more fully developed (anticipated by 2020 to 2025), around 20 million tonnes of CO_2 per annum will be stored in depleted offshore oil and gas fields. The scheme focuses explicitly on involving stakeholders from the early stages of the projects by presenting a realistic and detailed project timetable and formal consultation procedure for stakeholders, as well as making use of existing infrastructures.

However, carbon capture and storage has been criticized for not providing a long-term solution to greenhouse gas (GHG) reduction due to its high costs and lack of development of technology. Pilot schemes such as in Rotterdam may help to elucidate whether carbon capture and storage can fulfil its low-carbon promise in an urban context.

Source: Van Noorden, 2008

companies in carbon-offsetting projects by providing them with a methodology for calculating the amount that they need to reforest in order to abate carbon emissions, a helpline, and contacts with potential offset projects.

Most carbon sequestration initiatives at the urban level relate to tree-planting schemes and the restoration and preservation of carbon sink

Most carbon sequestration initiatives at the urban level relate to tree-planting schemes and the restoration and preservation of carbon sinks. Urban tree-planting programmes frequently rely on cooperation between municipalities and citizens. This is the case in several cities in Latin America where the municipality has developed technology transfer and promotion campaigns for urban tree planting. However, the results depend largely on the voluntary and non-monitored intervention of citizens – for example, the Tree Planting Incentives in São Paulo (Brazil), the One House, One Tree programme in Lima (Peru) or the Organic Urban Gardens programme in Caracas (Venezuela). In Johannesburg (South Africa), the Greening Soweto programme was intended to contribute to the preparations for the 2010 FIFA World Cup in addition to its carbon sequestration benefits. The programme started in 2006 with the objective of planting 300,000 trees in Soweto.[103]

The preservation and restoration of carbon sinks is also dependent on government intervention, For example, in Lagos (Nigeria) and surrounding areas, a ban on tree felling has been imposed. So far, more than 3000 trees in the state have been counted and tagged to prevent felling,[104] although is not clear how the ban is enforced. In Bogotá (Colombia), the Botanical Garden – in partnership with local authorities – has started an initiative to improve and regulate urban tree management for the protection and conservation of urban trees, and the creation of a tree registry that may help to preserve individual trees.[105] Carbon sequestration can be combined with city beautification, particularly when a range of measures to create and protect green spaces and facilitate public access are combined, such as in the case of Singapore (see Box 5.11).

In developing countries, CDM mechanisms may help to initiate afforestation and nature conservation programmes with carbon sequestration benefits. In Egypt, for example, the Environmental Affairs Agency, in cooperation with CDM-Egypt, is developing a project (2007 to 2017) for the afforestation of 10km of road (0.5 million trees) around the ring road of greater Cairo. The project, which will cost US$4 million, is expected to contribute to the reduction of GHG emissions (100,000 tonnes of CO_2eq per year) and to local sustainable development objectives. However, carbon sequestration programmes need to acknowledge the differential impacts that such programmes may have in different population groups. Further work on the role of gender in urban greening is needed to understand the different services that urban green areas offer to different social groups and their roles in maintaining them.

Despite their current low profile, carbon sequestration projects appear to be gaining ground in at least three ways. *First*, the development of carbon capture and storage technologies may lead to urban pilot projects, although this technology is heavily dependent on economies of scale and carbon storage facilities, with the result that few cities are likely to provide suitable locations. Carbon capture and storage has also been criticized for failing to address the root of the climate change problem in terms of the use of fossil fuels, and any decisions to locate carbon capture and storage plants in urban settings is likely to attract significant opposition. *Second*, the CDM and growing carbon markets may help to finance afforestation and nature conservation programmes in developing countries. It is important to highlight that these programmes may simultaneously provide carbon sequestration functions while also protecting water and soil resources that are crucial for the adaptation of cities to the potential impacts of climate change (see Chapter 6). *Third*, the rapid proliferation of initiatives such as carbon markets or offsetting schemes suggests that these schemes may have more prominence in the future, although often, they may transcend the spatial boundaries of the city.

Box 5.11 Planning for a Garden City in Singapore

Since the 1960s, a wide range of actors in both public and private partnerships have been developing Singapore into a 'Garden City'. The effort attempts to increase the aesthetic appeal of the city, providing public open spaces and improving air quality, protecting carbon sinks and reducing the urban heat-island effect. The key strategies to create a Garden City are:

- *tree-planting* on all roads, vacant land and new development sites;
- *providing adequate, attractive and accessible parks*, including 3300ha of parks, as well as larger parks, such as the 185ha East Coast Park along the coastal areas, and smaller parks, such as town parks and precinct gardens; over the next 10 to 15 years, Singapore aims to add another 900ha of park space;
- *linking parks and people* by introducing park connectors such as green corridors for people to stroll, jog and cycle between parks; to date, Singapore has about 100km of park connectors, which is expected to triple to 360km by 2020;
- *retaining natural heritage* in four nature reserves which cover more than 3000ha, or 4.5 per cent of Singapore's land area;
- *building 'gardens in the sky'* by encouraging developers to incorporate green roofing.

Source: Singapore Urban Development Authority, 2009

Assessing the impact of urban climate change mitigation initiatives

The above discussion suggests that many different initiatives to mitigate climate change are taking place in cities across the world. Despite this, there is still relatively limited information about the individual and collective impact of these measures, especially when they extend beyond municipal buildings and infrastructure systems or involve behavioural change. Municipal networks, such as the CCP campaign, Climate Alliance and C40, have sought to develop indicators of their achievements.[106] The CCP Australia programme, for example, calculated that its 184 members achieved '4.7 million tonnes [CO_2eq] abatement – equivalent to over a million cars off the road for one year' as well as 'A$22 million saved by councils and their communities through reduced energy costs'.[107] However, such figures have been limited by their reliance on self-reporting and the lack of a common methodology to enable comparison between different international networks or with cities that lie outside of these networks. One current initiative that may contribute to building a more accurate picture of the impact of urban climate change measures is Project 2°, which aims to provide 'the first global, multi-lingual emissions measurement toolset designed to help cities measure and reduce their greenhouse gas emissions 24 hours a day, seven days week, via the web'.[108] Independent studies explicitly examining the stocks and flows of GHG in cities have also been conducted.[109] Yet, these analyses are focused on understanding historical and future trends rather than any direct assessment of the impact of policies and measures that have been put in place. There is therefore a need for new research which applies these analytical approaches to the assessment of current policy measures. However, it should be noted that the International Standard for Determining Greenhouse Gas Emissions for Cities – jointly launched by the United Nations Environment Programme (UNEP), UN-Habitat and the World Bank at the World Urban Forum in Rio de Janeiro in March 2010 – provides a common method for cities to calculate the amount of GHG emissions produced within their boundaries.[110]

Despite such new methodologies, more general challenges of assessing the impacts of policy interventions, the relatively short time-scales involved, and the fragmented nature of the data available, especially with regard to levels and reductions of GHG emissions across urban communities, will remain. In this context, basic guidance about the potential of different measures may be more useful than measures of emissions reductions. For example, it is clear that systematic efforts to shift from fossil fuel-based energy and transport systems through the use of low-carbon technologies are likely to have a more significant impact upon reducing GHG emissions than small-scale short-term initiatives to improve energy efficiency, which may be compromised by the rebound effect once initial financial savings have been achieved. However, in reaching the 'low hanging fruit' – the sectors offering GHG reduction costs that yield long-term returns even without their participation in carbon markets – such schemes may have several additional benefits and act as a means of getting climate change on urban agendas. Figure 5.1 highlights the waste, transport and buildings sectors as the 'low hanging fruits' of urban GHG mitigations.

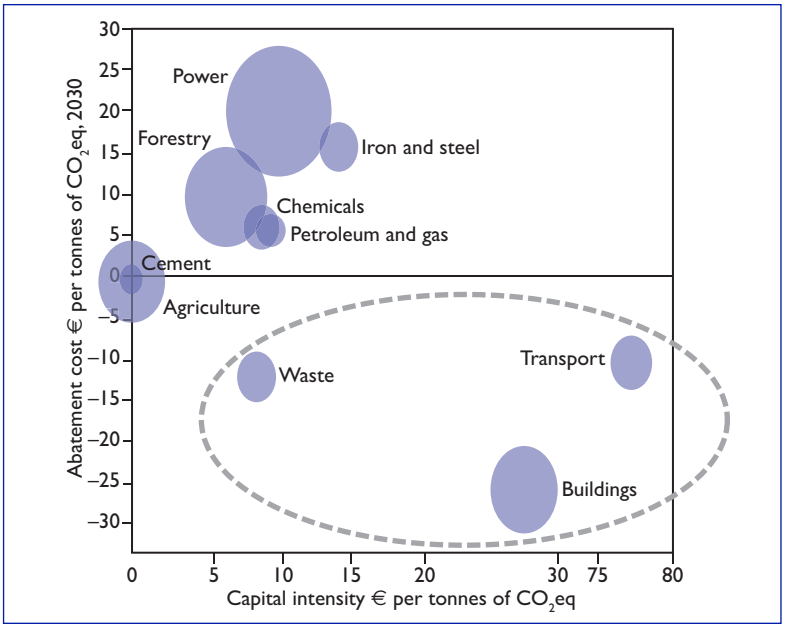


Figure 5.1

The 'low hanging fruits' of urban GHG mitigation

Source: ICLEI, 2010, p9

In short, decisions over which mitigation measures to adopt will be determined by the social, political and economic circumstances in individual cities and guided by the weight given to climate change concerns, rather than by any absolute evaluation of their effectiveness (see Table 5.10). The wide range of actions and the tendency to adopt piecemeal rather than strategic approaches documented in this section point to the multiple drivers and barriers to achieving climate change mitigation in the city. While in developed countries urban actors may be constrained by institutional factors and lack of public support or leadership, in developing countries there is often little incentive for municipalities to mitigate climate change when they cannot address the basic needs of current populations. In the face of these challenges, the following sections elaborate upon the modes of governing that municipalities and other urban actors have adopted to mitigate climate change and the opportunities and constraints that they have encountered.

Decisions over which mitigation measures to adopt will be determined by the social, political and economic circumstances in individual cities and guided by the weight given to climate change concerns, rather than by any absolute evaluation of their effectiveness

Based on the discussion of the differences between production and consumption perspectives to the measuring of GHG emissions in Chapter 3, Table 5.11 provides a more specific overview of mitigation activities – from each of these perspectives – that can stop or reduce the current growth in urban GHG emissions.

Table 5.10

Identifying and prioritizing climate change mitigation actions

Type of measure	Examples	Climate change benefits	Additional benefits	Limitations
Leadership	• Renewable energy demonstration projects • Education campaigns	• Limited direct impact upon GHG emissions	• Demonstrate commitment to climate action • Encourage action by others	• Impact assessment is difficult • Could be perceived as tokenistic
No or low upfront costs	• Energy- and water-efficient behaviour • Waste minimization	• Limited impact upon GHG emissions unless sustained over the long term	• Short-term financial savings • Environmental education	• Difficult to enforce and often involves changing ingrained organizational and cultural practices
Cost effective	• Energy- and water-efficient technologies	• Dependent on the scale and timeframe of measures	• Short- to medium-term financial savings • Impacts can be monitored • Address issues of resource poverty and security	• Energy and water savings can be limited by the rebound effect
Multiple benefits	• Travel demand-reduction measures • Reforestation and conservation projects	• Dependent on the scale and timeframe of measures • Provides opportunities for working with a wide range of actors and gaining political support for climate change	• Address multiple goals of sustainability and well-being, including air pollution, congestion, urban green space, resource security and meeting basic needs	• Assessment of impacts is difficult • Reliant on the involvement and actions of others • Climate change benefits may be sidelined if they conflict with other objectives
Deep cuts	• Low-carbon and renewable energy infrastructure projects	• Large-scale projects may have significant direct impact; small- and medium-sized projects can act as catalysts for change • Provides opportunities for working with a wide range of actors and gaining political support for climate change	• Offer opportunities to update infrastructure networks, provide access to services for poor communities and informal settlements	• High upfront costs and long payback periods • Usually reliant on external sources of funding and partnerships with other public and private actors, which can be fragile

Source: adapted from ICLEI Australia, 2008, p6

Table 5.11

Mitigating urban GHG emissions: Production versus consumption perspectives

Sector	What can stop or reduce the growth in urban GHG emissions?	
	Production perspective	Consumption perspective
Energy supply	A shift to less GHG-emitting power generation and distribution; incorporation of electricity-saving devices; an increase in the proportion of electricity generated from renewable energy sources and its integration into the grid; carbon capture and storage.	As in the production perspective, but also a greater focus on less consumption among high-consumption households; a shift to less GHG-intensive consumption.
Industry	A shift away from heavy industries and from industry to services; increasing energy efficiency within enterprises; capture of particular GHGs from waste streams.	As in the production perspective but with an extra concern to reduce the GHGs embedded in goods consumed by residents and to discourage consumption with high GHG emissions implications.
Forestry and agriculture	N/A (as no emissions are assigned to urban areas).	Encouraging less fossil fuel-intensive production and supply chains for food and forestry products; addressing the very substantial non-CO_2 GHG emissions from farming (including livestock); forestry and land-use management practices that contribute to reducing global warming.
Transport	Increasing the number of trips made on foot, by bicycle, on public transport; a decrease in the use of private motor vehicles and/or a decrease in their average fuel consumption (including the use of vehicles using alternative fuels); ensuring that urban expansion avoids high levels of private motor vehicle dependence.	As in the production perspective but with a stronger focus on reducing air travel and a concern for lowering the GHG emissions implications of investments in transport infrastructure.
Residential/ commercial buildings	Cutting fossil fuel/electricity use, thus cutting GHG emissions from space heating (usually the largest user of fossil fuels in temperate climates) and lighting; much of this is relatively easy and has rapid paybacks.	As in the production perspective but with an added interest in reducing the CO_2 emissions embedded in building materials, fixtures and fittings.
Waste and wastewater	Reducing volumes of wastes, and waste management that captures GHGs.	As in the production perspective but with a new concern to reduce waste flows that arise from consumption in the city but contribute to GHGs outside its boundaries.
Public sector and governance	N/A (as no emissions are acknowledged).	Governance that encourages and supports all the above; also a strong focus on lowering GHG emissions through better management of government-owned buildings and public infrastructure and services; includes a concern for reducing GHG emissions generated in the building of infrastructure and the delivery of services.

Notes: Based on the discussion of GHG emission drivers in Table 3.18.
N/A = not available.

Source: based on Satterthwaite et al, 2009b, pp548–549

URBAN GOVERNANCE FOR CLIMATE CHANGE MITIGATION

As the section above has demonstrated, municipal authorities and other actors have developed a range of strategies and measures for mitigating climate change in different policy sectors. Research suggests that the mechanisms which urban actors use to develop and implement these initiatives can be grouped into distinct 'modes of governing'.[111] First, the section reviews the changing nature of urban governance and the 'modes of governing' that public authorities and private actors use in order to address climate change. Alongside four modes of governing that have been identified within municipal governance – self-governing, provision, regulation and enabling – the growing importance of corporate, donor and civil society actors means that (quasi) private modes of governing – voluntary, private provision and mobilizing – are also becoming important. The section reviews municipal and private modes of governing, in turn, considering the mechanisms and policy instruments involved, comparing their use in the five key policy sectors discussed in the previous section, and their general strengths and limitations.

Modes of governing climate change mitigation

The term governance can be broadly understood in two different ways. First, in a 'descriptive sense, it refers to the proliferation of institutions, agencies, interests and regulatory systems' involved in managing societies. Second, in a 'normative sense, it refers to an alternative model' for organizing collective affairs, frequently assumed to be based on horizontal coordination between mutually dependent actors where governments may be one among many agencies involved.[112] While there have been many calls to develop 'good governance' in a normative sense, this section focuses on analysing different forms of governance captured in the descriptive definition of the term. Such new forms of governance are thought to have emerged as a result of a 'profound restructuring of the state' evident in:

- 'a relative decline in the role of formal government in the management of social and economic relationships';
- 'the involvement of non-governmental actors in a range of state functions at a variety of spatial levels';
- 'a change from hierarchical forms of government structures to more flexible forms of partnership and networking';
- 'a shift from provision by formal government structures to sharing of responsibilities and service provision between the state and civil society'; and
- 'the devolution and decentralization of formal governmental responsibilities to regional and local governments'.[113]

Understanding the nature, potential and limitations for urban climate change governance involves considering the different ways in which urban governments operate, as well as recognizing the important roles played by a variety of other public and private actors. In this context, research has shown that a small number of distinct '*modes of governing*' are being employed to address climate change in the urban arena.[114] In terms of the modes of governing deployed by municipal authorities, four approaches appear to be important:

1 *self-governing:* the capacity of municipalities to govern their own operations, estate and activities;
2 *provision:* the shaping of practice through the delivery of particular forms of services and resources;
3 *regulation:* the use of traditional forms of authority such as mandates and planning law, and the oversight and implementation of regulation created at other levels of government;[115] and
4 *enabling:* the role of municipalities in facilitating, coordinating and encouraging action through partnership with regional or national governments, private- and voluntary-sector agencies, and through various forms of community engagement.

Four modes of governing … have been identified within municipal governance – self-governing, provision, regulation and enabling

While municipal modes of governing climate change were dominant during the 1990s, more recently, new modes of urban climate governance are emerging in which private actors (such as foundations, development banks, NGOs and corporations) and public agencies outside the local authorities (donor agencies, international institutions) are initiating schemes and mechanisms to address climate change mitigation activities in the city.[116] Three approaches appear to be gaining ground, which in some ways mirror those being deployed by municipal authorities:

1 *voluntary:* the use of 'soft' forms of regulation to promote action either within an organization or amongst a group of public and private actors, combining features of the self-governing and regulation modes detailed above;
2 *public–private provision* of low-carbon infrastructures and services, either in place of or in parallel to government schemes, including initiatives developed through the auspices of the CDM; and
3 *mobilization*, where private actors seek to engage other organizations in taking action, such as through education campaigns.

New modes of urban climate governance are emerging in which private actors … and public agencies outside the local authorities … are initiating schemes and mechanisms to address climate change mitigation activities in the city

Each mode of governing relies on a different combination of policy instruments and mechanisms, and may be more or less effective in mitigating climate change in the urban arena. The following sections review municipal and public–private modes of governing in turn, assessing their use in different policy sectors as well as their strengths and limitations for achieving reductions in GHG emissions.

Municipal governance

The self-governing mode remains the dominant approach adopted by municipal authorities in response to climate change

These four approaches of municipal governance – self-governing, provision, regulation and enabling – are not mutually exclusive; rather, municipalities tend to deploy a combination of these modes at any one time. This is indicative of the impact of state restructuring, where – rather than governing in a direct, hierarchical, manner – the task for state authorities is one of 'meta-governance': of articulating and combining different modes of governance.[117] However, research suggests that the self-governing mode remains the dominant approach adopted by municipal authorities in response to climate change. While the self-governing mode has significant limitations in terms of the proportion of urban GHG emissions that can be addressed (see Table 5.12), it offers a visible and often short-term means through which municipal authorities can demonstrate their commitment to climate change. In developed countries, self-governing and enabling modes have been dominant, while initiatives in developing countries are often based on the provision of low-carbon infrastructures and services. While regulation is the least frequently used mode of governing, it is most common in the transport and urban development sectors, reflecting the roles of local authorities in controlling air pollution and land-use planning. The development of climate change initiatives in the urban infrastructure sector has primarily relied on the provision mode of governing, while the enabling mode dominates in the built environment and carbon sequestration policy sectors.

This analysis suggests that municipal governments are making use of a wide range of policy instruments and mechanisms in seeking to address climate change. Given the cross-cutting nature of climate change as a policy issue, it is perhaps not surprising to find that there is no single 'recipe for success' – with the demands of different policy sectors, as well as different national and local contexts, leading to a 'patchwork' of approaches being adopted. However, the dominance of the self-governing and enabling modes and the limited role played by regulation point to the underlying challenges that municipal governments face in seeking to address climate change. On the one hand, accounting for the impact of regulation, provision and enabling measures – in terms of GHG emissions saved, and the financial and additional benefits accrued – is a complex task. In an era where municipal governments are required to audit their achievements, such measures may be deemed economically and politically unfeasible. At the same time, moving this complex policy issue into concrete actions beyond the areas within which they exercise direct control involves municipalities challenging the deeply ingrained relationship between

Table 5.12

Municipal modes of governing climate change

Mode of governing	Policies and mechanisms	Examples	Advantages	Limitations
Self-governing	• Management of local authority estate • Procurement • Leading by example	• Investment in energy-efficient street-lighting • Purchasing renewable energy for municipal buildingsbuildings • Behavioural change programmes for local authority staff	Self-governing measures are under the direct control of the municipality and can provide quick, verifiable and cost-effective means of reducing GHG emissions. They provide a means for municipalities to demonstrate leadership and commitment to addressing climate change.	Self-governing measures can only address a small proportion of urban GHG emissions. They may be limited to those that can provide a financial return within the (short) time horizons of local governments.
Provision	• Operation of municipal infrastructure systems • Green consumer services	• Investment in low-carbon transport systems such as BRT • Household energy surveys and subsidized renovation programmes provided by municipal authority	The provision of low-carbon infrastructure and services has potential for significant reductions in GHG emissions by changing the carbon intensity of utility provision and altering the choices available to households and businesses across the city. The development of new low-carbon infrastructure networks could improve access to basic services and improve livelihoods.	Municipal capacity for providing low-carbon infrastructure and services is hampered by a lack of finances, dependency on the terms and conditions of capital loans, and a limited remit for providing energy, water, waste and transport. In contexts where there is a lack of basic services, developing low-carbon networks is unlikely to be a priority. In addition, the provision of infrastructure and services is only one factor shaping their use and may not lead to an overall reduction in GHG emissions without additional measures.
Regulation	• Taxation • Land-use planning • Codes, standards, etc.	• Congestion charging schemes • Requirement for renewable energy technologies in new development • Energy and water efficiency standards for buildings	Regulative measures can provide transparent and effective means for reducing GHG emissions from a variety of policy sectors. They provide a level playing field for the business community. They may also yield additional revenue, which can be invested in additional low-carbon measures.	Regulative measures can be difficult to implement because of concerns about their impact upon businesses or particular sections of the community. Regulations are difficult to apply retrospectively (e.g. to existing buildings) and governments are often reluctant to regulate individual behaviour, meaning that the application of such measures may be confined to a small proportion of total urban GHG emissions. In a context of limited municipal capacity, regulations can be difficult to monitor and enforce.
Enabling	• Information and awareness-raising • Incentives • Partnerships	• Education campaigns for walking and cycling • Grants/loans for low-carbon technologies for households/ businesses • Development of voluntary GHG emissions reduction schemes for local businesses	Enabling measures can require relatively little financial or political investment. They enable municipal governments to benefit from the resources and capacities of a range of other urban actors in reducing GHG emissions. Through involving a range of different partners, they may increase the democratic mandate for acting on climate change.	Enabling measures are dependent on the goodwill and voluntary actions of businesses and communities who may not be forthcoming. Assessing and verifying the impact of GHG emissions reductions from such measures is often impossible and it may be difficult to evaluate their cost effectiveness.

Sources: Bulkeley and Kern, 2006; Bulkeley et al, 2009; Hammer, 2009; Martinot et al, 2009; ICLEI, 2010

the use of fossil fuels and economic development, and the political and social interests that this sustains.

Self-governing

Historically, self-governing has been central to municipal efforts to address climate change, particularly in cities in developed countries.[118] In this mode, there are three principal means through which municipal authorities have sought to reduce their own GHG emissions (see Table 5.12). The *first* is through the management of municipal buildings, fleets and services. Local authorities vary considerably in terms of the building stock, vehicles and infrastructure systems that are under their direct control; but in addition to local government buildings, this can include schools, community and health centres, libraries and leisure centres; vehicle fleets for waste collection and road maintenance; as well as energy systems that provide heat and power for municipal buildings or local authority housing. Actions can include technical measures, such as retrofitting buildings with energy efficiency measures – for example, in Yogyakarta (Indonesia), Johannesburg (South Africa) and Mexico City – and demand-reduction programmes for employees (see Box 5.12). In Buenos Aires (Argentina), for example, the local authority expressed concern that, because employees do not bear the cost of energy, energy-saving measures were not being put into place. Thus, employees were given new guidance and training to prevent wasting energy in public buildings. In order to encourage behavioural change, the City of Melbourne (Australia) has implemented a 0.5 per cent performance-related pay increase for staff if they meet targets for improving the environmental performance of the organization.

The *second* is through procurement policies. These can include purchasing renewable energy for the municipality and, in the transport arena, buying alternative low-carbon fuels.

Third, local authorities may aim to lead by example, establishing best practice principles, or demonstrate the use of particular technologies or social practices to facilitate their widespread adoption by other local actors. Projects implemented by these means include setting targets for reducing GHG emissions or the use of renewable energy, with a recent survey of 160 cities finding that at least 125 had such targets in place,[119] as well as demonstration projects and promotional campaigns.

Overall, research suggests that within developed and developing countries, the self-governing mode of addressing climate change is prevalent across different urban policy sectors. The 'reasons for embracing [local government], institutional actions are straightforward: they require minimal or no community buy in, creating little political debate; they usually produce direct returns with respect to cost savings; they produce quick, verifiable reductions in emissions'.[120] The ability to demonstrate leadership on climate change mitigation and accrue additional (financial) benefits at relatively little economic, political or social cost has led to a strong emphasis on municipalities undertaking self-governing actions. However, while such measures may provide the initial step towards establishing climate change policy, the effectiveness of self-governing measures in reducing urban GHG emissions is limited by the extent of the municipal estate and operations. In the majority of cases, municipal GHG emissions constitute a small proportion of the total emissions in a city. In this context, too much emphasis on the self-governing mode may detract attention (and resources) from the broader challenges of reducing GHG emissions across the city.

Box 5.12 The Green Lighting Programme in Beijing, China

The Green Lighting Programme was initiated in Beijing in 2004. One of its mandates focuses on replacing normal lights with energy-efficient light bulbs in 2046 primary and middle schools in 18 counties and districts. The result was that it replaced 1,508,889 light bulbs, which saved 14.4MW of electricity valued at 8.21 million RMB (US$1.05 million), and reduced annual CO_2 emissions by 14,535 metric tonnes. The project also increased student awareness and knowledge of the concept of saving energy. In 2008, the project was extended to install energy-efficient lighting in 1263 bathrooms inside the 2nd Ring Road, 70 subway stations, 114km of subway tunnels, and in government buildings, hotels, commercial buildings and hospital buildings. The Beijing Development and Reform Commission estimates that 39MW of electricity can be saved each year through the installation of energy-efficient light bulbs.

Source: Zhao, 2010

Provision

The provision mode for governing climate change involves both the development of low-carbon infrastructure systems and the delivery of 'green' consumer services by municipal governments (see Table 5.12). Historically, municipal authorities have had a strong role in the development of urban infrastructures – energy, water, waste, road and rail networks – and up until the mid 1990s municipalities continued to own their energy generation, water provision, public transport and waste services. In the years following World War II, local governments in the UK and North America began to sell off such assets, and with the rising tide of neoliberalism in the utilities sector, many such companies in other developed countries were sold during the 1980s and 1990s. As a result, most municipal governments in developed countries have limited capacity and direct responsibilities for delivering low-carbon energy infrastructures, although there are some notable exceptions (see Box 5.13). Rather, these networks are provided by an increasingly diverse set of partnerships and private actors.[121] In developing countries, municipal governments often retain some role in the direct provision of public services and public transport networks alongside new private providers and public–private partnerships, creating the potential for governing climate change mitigation through this mode. However, such networks are limited in their social and spatial coverage, and provide far from universal access to basic services. In contexts where meeting basic needs for energy, sanitation and mobility are pressing, the ability for municipal governments in developing countries to take climate change mitigation into account is limited.

The provision mode for governing climate change involves both the development of low-carbon infrastructure systems and the delivery of 'green' consumer services by municipal governments

Despite these limitations, municipalities have sought to pursue climate change policy through the provision of infrastructures and services. Municipalities have been involved in the creation of low-carbon communities, such as

Box 5.13 Provision of energy in Los Angeles, US

The City of Los Angeles is governed by a mayor–council system with 15 city council districts. It owns and operates its own electric utility, the Los Angeles Department of Water and Power, which is the largest publicly owned municipal utility in the US. The department provides water and electricity to the entire population of Los Angeles, and is a proprietary department, which means that it does not rely on taxpayer money. The mayor has driven the policy of achieving a renewable energy goal of 20 per cent renewable energy by 2010 and 35 per cent by 2030.

This goal is likely to be facilitated by the phasing-out of contracts with out-of-state coal-fired power plants and the need to expand solar, wind, biomass and geothermal to meet increasing energy demand and address possible future energy scarcity. The need to address an aging infrastructure problem further facilitates measures to achieve that goal.

However, there are also major obstacles to this goal. These include resistance to coal phase-out from the department's labour unions and environmental conflict resulting from the fact that the provision from renewable sources would require the building of new transmission lines, as renewable sources cannot be built in a location with access to existing transmission lines.

Source: Schroeder, 2010

the New Town Development Plan in Seoul (Republic of Korea), which aims to build 277,000 new apartments with district heating, estimated to cost US$2.6 billion.[122] In the built environment, municipal governments have been involved in the provision of energy efficiency measures to existing buildings – for example, Mexico City intends to install 30,000 square metres of green roofs per year until 2012 – as well as providing 'green' services to householders, including energy audits and retrofitting packages undertaken in cities such as Melbourne (Australia) and London (UK). Perhaps most notable have been measures to provide low-carbon mass transport services. In São Paulo (Brazil), the state government planned to invest more than US$7 billion from the Inter-American Development Bank during 2007 to 2010 in order to modernize train lines and provide new bus infrastructure – upgrades which it is thought will reduce emissions by 700,000 tonnes of GHGs that can then be sold in the CDM market.[123]

While … the regulation mode of governing is the least popular approach adopted by municipal governments, it can be very effective in terms of reducing GHG emissions

Seeking to govern climate change through the provision of infrastructure and services has the potential for far-reaching impacts upon urban GHG emissions by changing the carbon intensity of energy, water and waste services, reducing the carbon footprint of the built environment, fostering sustainable forms of urban development and providing low-carbon energy and travel choices for households and businesses. This potential appears to be most significant in cities where municipal governments may retain ownership or control of infrastructure networks and where basic needs have been met. However, such measures also have the potential to be socially progressive, providing the impetus for upgrading social housing and public transport services in deprived urban communities in developed and developing countries (see Box 5.14). In seeking to realize this potential, access to capital investment is likely to be a key barrier, suggesting that donor agencies and development banks may play a central role in making appropriate forms of finance available for the development of low-carbon urban infrastructure networks.

Box 5.14 Low-energy and passive housing in Ljubljana, Slovenia

In 2003, the Public Housing Fund of Ljubljana started a programme of environmentally sustainable refurbishment of existing properties to save energy and improve the quality of life of residents, most of whom had very low incomes and could barely afford their rent payments.

Work carried out to date includes two successful refurbishments in Steletova (60 apartments) and Kvedrova (20 apartments). New developments are being planned. They incorporate a range of energy-saving technologies, including high heat-recovery ventilation units, use of liquid earth-heat exchangers, solar thermal and solar photovoltaic. Although funding is provided by the municipality, the local community has been involved from the outset and has contributed to the municipality's annual housing action programme. The project appears to have contributed to the reduction of GHG emissions, as well as improving the relationship between tenants and the Public House Fund. The experience gained in Ljubljana is being extended to neighbouring countries with similar conditions.

Source: BSHF database (www.worldhabitatawards.org, last accessed 22 October 2010)

■ Regulation

While research suggests that the regulation mode of governing is the least popular approach adopted by municipal governments, it can be very effective in terms of reducing GHG emissions. Three different sets of mechanisms are deployed in this mode. *First*, and least common, is taxation and user fees, which have predominantly been deployed in the transport sector – for example, congestion charging (see Box 5.9) or levies on vehicle pollution.

Second, land-use planning, an area where municipal competencies are often strong (at least in developed countries), has been used across different policy sectors to address climate change mitigation. For example, in urban development and design, land-use planning is used to stipulate urban densities and to promote mixed land use in order to reduce the need to travel, and in the built environment sector to mandate particular standards of energy efficiency for new buildings or, as is the case of São Paulo (Brazil) and Barcelona (Spain), to introduce requirements for the compulsory use of solar energy supply in buildings of a certain size. Land-use planning is also being used to foster the development of low-carbon infrastructure. In London (UK), developments over a certain size are required to meet 20 per cent of their projected energy needs through onsite low-carbon or renewable energy generation, measures designed to increase the uptake of decentralized energy tech-nologies.[124]

Third, the setting of codes, standards and regulations are most common in the built environment sector, where they are often set by national governments, although examples can also be found at the municipal level, including the ban of certain building products in Vienna (Austria) and Melbourne (Australia); a mandatory energy performance requirement for large office developments in Australia;[125] and mandatory requirements for the use of solar hot water systems for some buildings in Delhi and Bangalore (India).[126] In the transport sector, several municipalities in Europe, such as Paris (France) and Athens (Greece), have experimented with schemes to ban vehicles coming into city centre areas on certain days to reduce congestion and pollution. A further set of indirect measures to reduce GHG

emissions includes the implementation of standards for improving the energy efficiency and emission of pollutants from vehicles in cities such as Lima (Peru), Delhi (India) or Bogotá (Colombia).

The regulation mode of governing provides municipal authorities with a set of tried and tested policy instruments through which to address climate change. The directed, transparent and enforceable nature of these instruments means that they can be very effective in achieving reductions of GHG emissions, especially in terms of targeting the use of particular technologies and encouraging behavioural change. However, regulation can be difficult to implement. The characteristics that give it strength – its targeted and enforceable nature – can also attract opposition from those who will be adversely affected by the need to comply with and bear the costs of new standards, plans and taxes. Moreover, local governments may lack the institutional capacity to enforce regulations, particularly in cities in developing countries with limited resources.

■ Enabling

Municipalities have also deployed mechanisms to enable other actors to reduce GHG emissions. Research suggests that the enabling mode of governing climate change has been particularly important in developed countries, though it may now also be gaining ground amongst municipal governments in developing countries.[127] Three main approaches have been used by municipalities to facilitate action to reduce GHG emissions within the city. *First*, various forms of information and education campaigns have been implemented. Such initiatives are usually targeted at behavioural change and are therefore most common in the two sectors – built environment and transport – where changes in behaviour can have an impact upon GHG emissions. For example, in Hong Kong (China), the municipality has established a programme to promote energy efficiency in the home through reducing the demand for cooling by keeping indoor environments at 25.5°C.[128] In Durban (South Africa), the municipality has established two energy efficiency clubs with local businesses.[129] Through these clubs, 'participants were introduced to techniques for energy management and auditing, monitoring and targeting, carbon footprint calculations, and making power conservation plans. Members who implemented efficiency measures reported savings of up to R220,000 [South African rand] (US$28,000) for the 1st quarter of 2009, and the concept of "clubs" was generally well received by the industries.'[130] This example is particularly interesting as measures targeted at reducing GHG emissions from large industries are not usually part of urban municipal climate change policy.[131] However, 'the effect of such [public information] campaigns is contested and difficult to measure since they are often part of policy packages'.[132]

Second, municipal governments can use incentives of various kinds – including grants, loans and the removal of subsidies or barriers to the adoption of new technologies[133] – to encourage the uptake of low-carbon technologies or to promote behavioural change. Such initiatives can be found in the built environment sector, such as grants for the installation of energy efficiency measures by households, in the urban infrastructure sector, where municipal governments have provided loans and subsidies for the purchase of renewable energy technologies, and in the transport arena, where subsidies for using public transport are common.

Third, municipal governments have developed various partnerships with business and civil society organizations to reduce GHG emissions. For example, in Hong Kong (China), the municipal government established a set of guidelines for reporting on and reducing GHG emissions from buildings in 2008, which identified areas for energy efficiency improvement and areas for voluntary action. Since 'its introduction, 37 institutions have signed up as Carbon Audit Green Partners, including private corporations, public hospitals and universities'.[134]

The enabling mode of governing climate change has been particularly important in developed countries

The enabling mode of governing may have significant advantages in terms of its potential impact upon the GHG emissions across the city and its (relatively) low upfront economic and political costs. Seeking to engage a range of communities and businesses in climate change policy can also increase the transparency and legitimacy of urban governance. However, there are also two critical limitations. *First*, such initiatives are restricted to those who are willing to participate. For example, in the Durban energy efficiency clubs, 'not all major players participated fully… Toyota, for example, pulled out after the initial two meetings'.[135] *Second*, the voluntary nature of such initiatives means that they are difficult to monitor and verify, and cannot be 'enforced', but rather depend on the capacity of municipal governments to persuade others to take action:

> *… the effectiveness of urban planning and governance depends not only upon the assumed command-and-control power of a master plan, but upon the persuasive power that can mobilize actions of diverse stakeholders and policy communities to contribute to collective concerns. The likelihood of such enabling power to emerge is higher in the societies where power is more diffused and is transparently exercised… On the contrary, in the societies where power is concentrated, and exercised through corruption and coercion, such consensual processes pose a formidable challenge.*[136]

The enabling mode of governing may have significant advantages in terms of its potential impact upon the GHG emissions across the city and its (relatively) low upfront economic and political costs

A recent assessment of policy instruments for GHG mitigation in the buildings sector concluded that:

> *Although instruments in [the support, information and voluntary action instruments] category might be considered rather 'soft' they can still achieve significant savings and successfully complement other instruments. However, they are usually less effective than regulatory and control measures.*[137]

Modes of public–private collaboration in urban climate governance

The implementation of climate change measures by private companies, international networks and external public agencies raises questions about the legitimacy of the decision-making process and how and by whom the benefits, and costs, are borne

As discussed above,[138] the restructuring of the state has resulted in the increasing involvement of a number of public agencies and private actors in urban climate change governance. In parallel to the approaches developed within municipal authorities, this Global Report identifies three 'modes' of public–private collaboration in urban governance – voluntary, private provision and mobilization – which are being developed in order to address climate change (see Table 5.13). This having been said, it should be noted that, in practice, there is some degree of overlap between these three 'modes'. Importantly, such initiatives do not only seek to reduce GHG emissions from one organization or group of partners, but do so explicitly in the name of one or more city. In this manner, the city has become a key arena within the broader landscape of climate governance.

The evidence reviewed for this chapter suggests that public–private collaboration in climate change governance can be found in both developed and developing countries, and across the urban development, built environment, urban infrastructure, transport and carbon sequestration policy sectors. While limited data on this relatively new phenomenon is available, these approaches appear most likely to be adopted by partnerships or networks than by individual organizations, and to be concentrated on the adoption of voluntary standards for energy and water efficiency, the provision of low-carbon urban developments and infrastructure networks, and the mobilization of behavioural changes to reduce energy and transport use.

Despite their relatively small scale, the emergence of these new forms of urban climate governance may have significant implications for achieving GHG emissions reductions. The involvement of private actors and external public agencies can provide additional sources of expertise and resource, as well as influence over sources of GHG emissions that may otherwise lie outside of the control of municipal authorities. The participation of a range of organizations and communities in addressing climate change can provide a high profile for the issue, easing the path for municipal policies, and potentially offer a means for enhancing the legitimacy and representativeness of local action.

However, partnerships should not be treated as a *panacea*. Coordinated action requires both substantial commitments from the partners and the ability of the organizations to participate effectively (see Box 5.15), and support may suddenly be withdrawn when the partnership fails to meet the objectives of one or some of its members. Partnerships can also be exclusive, serving to promote the interests of one group of actors at the expense of others.[139] This can be especially problematic in developing countries, where empirical evidence suggests that partnerships may lead 'to city government support for projects, programmes, and partnerships with powerful private-sector interests that have very large carbon footprints (in their construction and functioning) and also do little or nothing to address the key needs of low-income urban residents (including addressing the infrastructure deficit)'.[140] Likewise, the implementation of climate change measures by private companies, international networks and external public agencies raises questions about the legitimacy of the decision-making process and how and by whom the benefits, and costs, are borne.[141]

■ Voluntary

Voluntary approaches to addressing climate change include those which are based on changes to existing practices

Table 5.13

Public–private modes of governing climate change

Mode of governing	Policies and mechanisms	Examples	Advantages	Limitations
Voluntary	• Changing practices • Demonstration projects • Targets and standards	• Voluntary offsetting schemes • Building-integrated photovoltaics • Voluntary energy efficiency standards	Voluntary measures are under the direct control of the organizations involved and can provide quick and cost-effective means of reducing GHG emissions. Adopting voluntary standards or codes of practice can provide a testing ground for future legislative requirements. Voluntary measures are often adopted for reasons of corporate social responsibility and can provide a means for holding private-sector actors accountable for their carbon footprint.	Voluntary measures may be limited to those that can provide a financial return within the (short) time horizons of commercial organizations. Changes in political or economic circumstances can easily derail such initiatives. Undertaking voluntary measures can be a 'stalling' tactic to delay or avoid regulation. Such measures can also lack transparency and accountability with few if any penalties for failing to comply.
Private provision	• Urban infrastructure systems • Low-carbon technologies and services	• Investment in waste-to-energy schemes • Energy service companies	The provision of low-carbon infrastructures and services has potential for significant reductions in GHG emissions by changing the carbon intensity of utility provision, altering the choices available to households and businesses across the city.	The provision of low-carbon infrastructure and services may be limited by the terms and conditions attached to investment. In addition, the provision of infrastructure and services is only one factor shaping their use and may not lead to an overall reduction in GHG emissions without additional measures.
Mobilization	• Information and awareness-raising • Capacity-building • Incentives	• Energy efficiency advice schemes • Mentoring schemes • Access to subsidized energy efficiency technologies	Mobilizing other private- and public-sector actors to reduce GHG emissions can provide a means of spreading best practice and scaling up demonstration projects. By engaging a range of partners, organizations can limit the costs of acting and reduce any disadvantages of being the 'first mover'. By forming partnerships and networks of like-minded organizations, actors can strengthen their political position and claims to legitimacy.	In order to be effective, mobilization depends on the goodwill and voluntary actions of businesses and communities who may not be forthcoming. Partnerships and networks are reliant on continued interest and investment, which may be difficult to sustain through changes in personnel, politics and economic circumstances.

within organizations and communities, demonstration projects, and voluntary targets and standards. In the *first* category, for example, are voluntary commitments to change how energy and water are used within buildings, experiments with the use of alternative fuels, and voluntary carbon-offsetting schemes. The *second* category includes, for example, initiatives that seek to demonstrate the potential of energy-efficient buildings, or the economic and social feasibility of low-carbon technologies in the urban infrastructure sector. The *third* category includes schemes which set voluntary benchmarks for achieving GHG emissions reductions, such as those promoted by 'carbon reduction action groups' at the community level.[142]

Community-based climate change initiatives seem to adopt a mixture of these approaches. One such example are 'transition towns', community-based initiatives found in the UK, North America and Australia that seek to reduce GHG emissions and address the challenge of 'peak oil'[143] by encouraging the development of the local economy, local food production, reducing demand for energy and transport, and the use of renewable energy.[144] For example, the Transition Sydney initiative in Sydney (Australia) provides presentations and films for local groups on how to address the challenges of climate change and peak oil, a website for sharing information, and support for community groups seeking to reduce their use of fossil fuels. In Bristol (UK), the Transition initiative offers home energy auditing training and various types of information and support for members seeking to reduce their individual GHG emissions. Another example is the development in Mumbai (India) since 1996 of more than 200 'advanced locality management groups', mainly to organize local waste management programmes, which are now moving into climate change mitigation activities such as the installation of solar water heaters or the development of awareness campaigns in their neighbourhoods.[145]

Such schemes have the potential to offer a progressive and inclusive approach to mitigate climate change, tackling issues of social and environmental justice alongside reducing GHG emissions. However, they are – perhaps necessarily – small in scale and often politically marginal, suggesting that their wider impact upon climate change mitigation may be limited. Their very basis on voluntary action may also be a limitation, with few means to assess the contributions that are being made or for organizations to account for their actions. At the same time, a growing emphasis on voluntary, primarily community-based, responses may serve to shift accountability from actors with responsibilities for the bulk of (urban) GHG emissions to those who have little in the way of power to address either the causes or consequences of climate change.

■ Public–private provision

While municipalities can set the frameworks within which new urban development takes place and infrastructure systems are developed, they may have limited jurisdiction over the provision of housing and the development of energy, water, waste and transport services.[146] As a result, partnerships between public and private actors have become a common means through which urban development and infrastructure projects, including those which seek to address climate change, are delivered. In addition, the emergence of the CDM and other carbon markets has led to a range of new partnerships involving municipal governments, urban public utility providers, national governments and carbon 'brokers' in the implementation of low-carbon infrastructure projects, such as energy-from-waste schemes.[147]

A second means through which public–private provision is taking place is through the delivery of low-carbon technologies and services. One example of such an approach has been the establishment of the London Energy Service Company in 2006, a partnership between the London Climate Change Agency and the energy company EDF in order to develop decentralized energy systems.[148] The Clinton Climate Initiative has also sought to develop access to energy service companies amongst its partner cities through developing a 'unique set of contracting terms and conditions, including streamlined procurement, transparency in pricing, and other processes that reduce project cost, development time, and business risk'.[149] While doubts may be expressed about the potential applicability of such projects to a large number of cities, and of the politics of accessing such favourable terms and conditions, it does suggest that alternative business models and financial arrangements can provide a crucial mechanism for achieving reductions of urban GHG emissions.

Given the challenge of urban governance and the privatization of urban utility networks, in most cities municipal authorities have little choice but to work with other actors in the provision of urban infrastructures. As discussed above, partnerships may provide benefits – in terms of resources, knowledge and the pooling of different strengths – but also have significant limitations. In the case of climate change mitigation, these limitations may be exacerbated by the range of actors involved and their diverse interests, ranging from local community groups to international financial organizations and other actors in the carbon market. While it is too early to tell what the impact might be, care needs to be taken that such responses to climate change do not serve to deepen existing urban inequalities.

■ Mobilization

A third mode through which public–private urban climate change governance is taking place can be termed mobilization, where partnerships and networks seek to facilitate the reduction of GHG emissions through the provision of advice and information, capacity-building and incentives (see Table 5.13). These approaches can be deployed internally, amongst the members of a partnership or network, or externally, through broader constituencies of business organizations, communities or individuals. Several private organizations, partnerships and networks have sought to mobilize action through providing advice and information. For example, in Beijing (China), Friends of Nature Beijing have led a campaign to maintain indoor temperatures at 26°C and limit the use of air conditioning in order to reduce GHG emissions. In Manchester (UK), a consortium of public and

Voluntary approaches … have the potential to offer a progressive and inclusive approach to mitigate climate change, tackling issues of social and environmental justice alongside reducing GHG emissions

Partnerships between public and private actors have become a common means through which urban development and infrastructure projects, including those which seek to address climate change, are delivered

Given the challenge of urban governance and the privatization of urban utility networks, in most cities municipal authorities have little choice but to work with other actors in the provision of urban infrastructures

Box 5.15 Manchester Is My Planet: Mobilizing the community?

In 2005, Manchester Knowledge Capital, a strategic partnership comprised of universities, local authorities, public agencies and leading businesses in the Greater Manchester region (UK) launched Manchester Is My Planet, a programme of initiatives aimed at engaging local communities and individuals in reducing their greenhouse gas (GHG) emissions. Based on pilot studies, and supported by funding (approximately UK£150,000) from the national government, the programme asked people to 'pledge to play my part in reducing Greater Manchester's carbon emissions by 20 per cent before 2010 in order to help the UK meet its international commitment on climate change'. The scheme quickly gathered around 10,000 pledges, resulting in a visit by then Prime Minister Tony Blair and his Cabinet seeking to endorse an example of the successful mobilization of citizens around the climate change agenda. With further funding from the UK's Climate Change Challenge Fund (approximately UK£55,000), a further 8000 pledges were secured by March 2008. However, with reduced funding, work on the programme has been limited to the continued development of its website and the number of pledges currently stands at around 21,000, which according to the programme's organizers suggests an annual saving of 44,600 tonnes of CO_2.

This case illustrates the potential for collaboration between public and private actors to mobilize members of the community to act on climate change issues. However, there are a number of limitations to such schemes. First, the request to pledge to reduce GHG emissions has not been accompanied by measures to develop the knowledge and capacity of citizens to take action. Second, undertaking the pledge, as with other voluntary actions, carries no penalties for non-compliance. Third, in the absence of extensive monitoring the impact of such initiatives upon reducing GHG emissions is difficult to determine. Research conducted by Manchester Is My Planet suggests that over 90 per cent of the pledgers took some form of action, while over 70 per cent encouraged others to reduce their energy consumption. However, it is difficult to verify such findings or know whether changes are the result of this particular initiative.

Regardless of the potential impacts upon Manchester's GHG emissions, research suggests that the Manchester Is My Planet initiative has been politically important. First, it helped to establish climate change as an issue on local political agendas, signalling to politicians that members of the public were concerned about the issue. Second, it provided an example of 'best practice' for the national government and for replication by other local authorities and partnerships in the UK. This case therefore suggests that efforts of climate change mitigation taking place 'outside' the state and through the mobilization of individuals and communities can have a direct bearing on the future of urban climate change governance.

Source: Silver, 2010

The mobilization mode of governing is becoming an important means through which urban stakeholders and communities are undertaking climate change mitigation

private actors has sought to engage individuals in reducing GHG emissions through a 'pledge' campaign (Box 5.15).

International networks,[150] including C40, ICLEI, the Climate Group[151] and the Clinton Climate Initiative, have developed extensive programmes and tools for providing municipal authorities and private-sector actors with information about current and future levels of GHG emissions and potential strategies to mitigate climate change, including, for example, reducing energy use, and adopting low-carbon forms of urban development and alternative modes of transport. In addition to providing advice and information, these international networks – usually working in partnership with a range of municipal governments, public agencies and private-sector actors – have also developed strategies to build capacity and provide incentives in order to engage urban actors in climate change mitigation (see Box 5.16).

These examples suggest that the mobilization mode of governing is becoming an important means through which urban stakeholders and communities are undertaking climate change mitigation. However, as illustrated by the case of Manchester (UK) (see Box 5.15), the effectiveness of such initiatives in reducing GHG emissions may be limited. In parallel to the enabling mode of governance, mobilization efforts may be hampered by limited participation and its reliance on powers of persuasion. Furthermore, questions can be raised about the mandate of private and public–private partnerships to call on others to act upon climate change, and of the extent to which they can be held to account by those who participate in such initiatives. While mobilization efforts may enable a cross-section of urban stakeholders and communities to respond to climate change mitigation, they may equally serve to promote particular visions of what responding to climate change means at the urban level, failing to account for existing inequalities or challenging the fundamental causes of the problem.

Box 5.16 Climate change mitigation initiatives developed by international city networks

- *The Climate Group city partnerships* focus on the role of some of the world's biggest cities in demonstrating and delivering the public–private partnerships that, according to them, will build up the low-carbon economy. The initiative includes the partnerships Forward Chicago in the US, and the Mumbai Energy Alliance in India.
- *The C40 Urban Life* programme is a partnership between the C40 and Arup, a consultancy firm, that operates as a co-operative to implement Arup's Sustainable Development Integrated Approach in several cities. The approach will be piloted in Toronto (Canada), and there are plans to extend the programme to five other cities.
- *C40 Carbon Financing* is a capacity-building programme to assist existing and emerging megacities to harness the carbon finance opportunities of the Kyoto Protocol.
- *The Clinton Foundation Building Retrofit Program* focuses on energy efficiency in buildings and has, so far, completed 250 projects in 20 megacities around the world.
- *The Clinton Foundation Transportation Program* focuses both on developing urban transportation systems such as bus rapid transits (BRTs) and advancing carbon-neutral transport technologies such as hybrid cars.

Source: www.theclimategroup.org; www.c40cities.org; www.clintonfoundation.org, last accessed 18 October 2010

OPPORTUNITIES AND CONSTRAINTS

This chapter suggests that significant efforts are taking place to mitigate climate change in urban areas across the world. The level and range of activities being undertaken by cities demonstrate that climate change is an issue firmly on urban policy agendas in both developed and developing countries. What is also clear, however, is that in most cities mitigating climate change remains a marginal issue, and that despite ambitious policy targets the realities of reducing GHG emissions are often more challenging than anticipated.[152] The overall picture is one of policy fragmentation. Islands of best practice can be identified; but comprehensive approaches to addressing climate change remain the exception rather than the rule,[153] and significant gaps between the rhetoric of reducing GHG emissions at the urban level and the realities of putting such policies and schemes into practice can be found.[154] The critical factor shaping urban responses to the challenges of mitigating climate change seems to be governance capacity.[155] In this context, this section reviews the evidence concerning the opportunities and constraints that shape governance capacity according to three broad categories: factors that are institutional, those which are technical or economic, and those which are political in character (see Table 5.14).

	Examples of opportunities	Examples of constraints
Institutional	• Proactive national/regional government • Membership of international municipal networks • Formation of partnerships	• Limited formal powers for municipal authority • Absence of policy coordination
Technical and economic	• Knowledge of urban GHG emissions • Availability of external funding • Flexible internal finance mechanisms	• Lack of expertise • Lack of financial resources • Suitability of technology
Political	• Political champions • Recognition of co-benefits • Political will	• Departure of key personnel • Prioritization of other policy agendas • Conflicts with other critical economic and social issues or sectors

Table 5.14

Opportunities and constraints for governing climate change mitigation in the city

Institutional factors shaping urban governance capacity

Institutional factors which shape urban governance capacity include issues of multilevel governance (municipal competencies and the relationships between different institutions at international, national, regional and local levels); policy implementation and enforcement; and the presence of alternative institutional arrangements, such as international networks and partnerships through which governance capacity can be generated. The first two factors are discussed in the sections below, while the issue of international networks and partnerships is discussed in Chapter 2.

■ Multilevel governance

Urban responses to climate change do not take place within a policy or political vacuum. While municipalities are more or less coherent and have varying degrees of autonomy from international policies, and from regional and national governments, the relationship between these arenas of authority is critical in shaping the capacity to govern climate change. The 'multilevel' governance of climate change affects urban responses to climate change in three key ways: by providing the context within which urban responses are framed; by determining the autonomy and competencies – the duties and powers – for municipal authorities to act in response to climate change; and by enabling policy integration within and between local authorities.

First, international and national policies have provided the overall framework for municipal responses. National policies have also served as direct drivers for municipal actions. For example, in Sweden approximately 'half of all municipalities have adopted climate mitigation goals in accordance with the national objective of reduced climate impact as formulated in the Swedish climate strategy',[156] while in China, research suggests that the recent interest in addressing climate change at the local level has not been in response to the issue itself but instead as 'a response to the central government's expectation for these institutions to take action'.[157] However, there are two significant exceptions to this rule which suggest that an enabling national government context is not always necessary for urban responses to climate change. In Australia and the US, the number of cities developing responses to climate change grew exponentially during the late 1990s and early 2000s at a time when both national governments withdrew from the international process of implementing the Kyoto Protocol. However, in both countries, urban responses were organized through international municipal networks, drew heavily on the international policy framework, accessed financial resources from federal government funds, and frequently gained support from cooperative regional-level governments to support the development of urban policy. These examples suggest that an enabling *multilevel* framework is critical in fostering urban capacity even when the political support of the national government is absent.

Significant efforts are taking place to mitigate climate change in urban areas across the world … however, … in most cities mitigating climate change remains a marginal issue

A *second* critical aspect of multilevel governance concerns 'whether the local authority has broad policy development and implementation powers, or whether these powers are narrowly defined or constrained'[158] in relation to critical policy sectors, such as transport, land-use planning, infrastructure development, building standards and waste. The role of municipalities in these areas is usually defined by central or regional governments and is delegated to local authorities.[159] Municipalities that have specific competencies for the direct provision of waste, transport or energy services, such as is the case in many Northern European countries, can have significant capacity to address climate change that other local authorities lack.[160] However, in general, municipalities have limited powers and responsibilities with respect to energy policy, pricing and supply, the development of urban infrastructure (such as transport systems), the use of economic instruments (such as taxes and charges), as well as energy efficiency standards for buildings and appliances, and more autonomy with regard to land-use planning, education and voluntary programmes.[161] Municipalities can therefore be dependent on the policies and actions of national governments in order to achieve their

The critical factor shaping urban responses to the challenges of mitigating climate change seems to be governance capacity

policy goals. For example, in London, the Climate Change Action Plan recognizes the 'difficult truth is that in preparing this action plan we have been unable to present any realistic scenario in which we can achieve the 2025 target … without major national regulatory and policy change'.[162]

However, actions to reduce GHG emissions may be achieved in cases when municipalities have limited direct or formal powers. First, policy goals can be integrated across different levels of government enabling action. A study of the climate change responses in Helsinki (Finland) shows how energy consumption in the built environment is determined by European Union (EU) regulations, such as the Energy Performance of Buildings, national regulations, municipal regulatory oversight, and voluntary agreements between energy companies and government departments. In this policy area, 'the different levels of governance are working well together … the city is implementing energy performance policies by implementing the building code and granting energy aid, and also by participating in the voluntary energy conservation agreement scheme',[163] whereas when it comes to the promotion of renewable energy, policy initiatives at the city level remain in contradiction with EU and national policies of increasing renewable energy generation.

There is considerable evidence that municipalities go beyond their direct competencies in undertaking actions to address climate change

A second means through which municipal authorities can overcome limited direct competencies for acting upon climate change is through the development of the limited opportunities that do exist. In Japan:

> *… regional and local governments have the authority to take legislative action when the national government itself has not enacted any specific policies and measures toward climate change, and the national government does not prohibit them from doing so. Using this opening, some governors and mayors have introduced regional and local ordinances which mandate businesses and industries to formulate CO_2 reduction plans, introduce emission trading in the regional and local area, or buy renewable energy bonds.*[164]

the 'cross cutting nature of climate change governance means that environment departments or agencies are frequently not able to implement the policies … that are required to address the problem'

Third, there is considerable evidence that municipalities go beyond their direct competencies in undertaking actions to address climate change. For example, the carbon market created by Rio de Janeiro (Brazil) could have impacts at the national and international levels while creating partnerships between public, private and civil society actors within and beyond the city. The capacity challenges which emerge from limited autonomy and competencies are only partially derived from their relation with national government, but are also dependent on their relation with other partners, and on the ability of local governments to create an 'enabling environment for local civil-society action'.[165] Nonetheless, for many municipalities, a lack of formal powers to address climate change remains a significant barrier and is one reason for the current focus on 'self-governing' across municipalities.[166]

In many policy areas, municipal authorities, particularly … in developing countries, are unable or unwilling to enforce regulations and standards

The *third* aspect of multilevel governance that is significant in shaping municipal capacity concerns issues of governance fragmentation at the local level and the internal dynamics of municipalities. At the city-region scale, a key issue concerns the fragmentation of urban governance across multiple authorities. For example, a study of climate responses in Mexico City finds that:

> *… the administrative structure of city's governance differs from its boundaries and carbon-relevant socioeconomic and ecological functioning. Administratively, the city is managed by diverse federal, state and local tiers of government. Yet, the city functions as a complex system; its core area and localities, activities and households are interlinked by economic interchanges and transportation activities, by fluxes of materials and energy.*[167]

Research has found that in 'many cities expertise [of climate change] is still concentrated in the environmental department'.[168] This potentially limits municipal capacity for two reasons. First, environmental departments are often marginalized within municipal (and other) authorities and may be in conflict with other parts of the local administration. Second, the 'cross cutting nature of climate change governance means that environment departments or agencies are frequently not able to implement the policies … that are required to address the problem'.[169] This challenge of horizontal coordination has been exacerbated in many countries in the wake of neo-liberal reforms, which have led to the privatization or contracting-out of what were previously municipal services, increasing the number of actors with whom policy coordination needs to be undertaken. For example, in Johannesburg (South Africa), a process of 'semi-privatization' has occurred within the local authority that 'creates a silo effect where communication between different agencies, utilities and the city administration are fragmented', reducing municipal capacity to address climate change.[170] In this context, 'mainstreaming, coordination, and cooperation across government agencies is vital'.[171] In some cities, this is being achieved through the development of new administrative and institutional structures, such as special units or agencies which coordinate climate change policies. For example, in London (UK), a Climate Change Agency has been established, while in Zurich (Switzerland), an environmental protection unit has been established to supervise climate policy.[172] However, 'where there is a lack of capacity to do this joining up it is clear that the potential of local climate change strategies is curtailed'.[173]

■ Policy implementation and enforcement

A second set of institutional factors that shapes urban climate change governance capacity is the ability to implement and enforce policies and measures. In many policy areas, municipal authorities, particularly but not exclusively those in developing countries, are unable or unwilling to enforce regulations and standards. For example, in Nigeria increasing energy efficiency in the built environment and appliance sectors suffers from 'noncompliance resulting from lack of enforcement of the standards … exposing the Nigerian Energy

Market … and hence the consumers to all kinds of sub-standard technologies (of course energy inefficient) which may have even been outlawed in their countries of manufacture'.[174] In the Ukraine, research has found a similar situation characterized by a lack of building standards for energy efficiency coupled with the poor enforcement of those that exist.[175] The effectiveness of energy standards may be particularly low in developing countries, given difficulties with enforcement and corruption.[176] However, 'even in developed countries, the estimated savings from energy codes range from 15–16 per cent in the US to 60 per cent in some countries in the EU', suggesting that both the levels at which standards are set and the ways in which they are implemented vary significantly from country to country, in turn affecting the capacity of municipalities to address GHG emissions.[177] The avoidance and corruption of regulations is also a critical challenge. In Indonesia, research found that 'while zoning permit is theoretically supposed to be a tool to control land use, in reality corrupt practices have rendered it ineffective'.[178] However, while at least part of the problem of policy implementation may be laid at the door of corrupt practices or deliberate avoidance, it also stems from the use of inappropriate policy approaches and models. For example, in many developing countries 'the application of imported models of urban planning and government that proved inappropriate to local contexts and possibilities' has served to limit the access of poor communities to land for housing, in turn provoking the emergence of informal settlements and other slums that do not comply with building and planning regulations.[179]

Equally, the challenges of implementation are not confined to municipal authorities. Given the voluntary nature of many of the schemes being developed by the private, civil society and donor communities in cities to address climate change, issues of compliance, monitoring and verification of achievements also affect urban governance capacity. First, significant challenges exist in terms of reliably estimating the GHG emissions reductions attributable to specific schemes, a factor which has so far limited the use of the CDM in urban areas.[180] Second, issues of accountability are also significant. While most schemes rely on self-reporting, there is a growing movement for civil society actors to be involved in processes of verification, such as the development of the Gold Standard for CDM and voluntary carbon markets.[181]

Technical, material and financial factors shaping urban governance capacity

A second set of factors that provide opportunities and constraints for urban responses to climate change mitigation include issues of technical expertise, the material infrastructures and cultural practices that determine the possibilities for action, as well as the financial resources available.

■ Expertise

There are two main ways in which the availability of scientific expertise and knowledge has shaped urban governance capacity for mitigating climate change. *First*, the growing scientific consensus internationally about the nature of the climate change problem and the need for urgent action has been a motivating factor for many municipalities. As the scientific community has advocated increasingly stringent targets for reducing GHG emissions in order to minimize the risk of exceeding a 2°C warming of the atmosphere, cities have responded with ever more ambitious policy goals. London (UK), for example, has adopted a target of stabilizing 'CO_2 emissions in 2025 at 60 per cent below 1990 levels, with steady progress towards this over the next 20 years'.[182] In 2002, the City of Melbourne (Australia) adopted a target of reaching 'zero net emissions' by 2020, an approach that has been adopted by a number of other municipalities in the metropolitan area.[183] Equally, the growing scientific consensus surrounding the issue of climate change has been a significant factor influencing the growing importance of the issue on the agendas of private-sector and civil society organizations, leading to their mobilization and involvement in various initiatives.

The effectiveness of energy standards may be particularly low in developing countries, given difficulties with enforcement and corruption

Second, scientific knowledge has also been significant in the development of local inventories and forecasts of GHG emissions.[184] Such inventories are primarily derived from 'scaling down' regionally and nationally available data, which provides a general overview of the likely pattern of GHG emissions and potential areas of future growth. Some municipalities have sought to derive such inventories from 'the bottom up'. One example is Newcastle (Australia), where community-wide GHG emissions derived from consumption data, and the equivalent GHG emissions from electricity use are updated hourly and reported on the internet, on a billboard in the city and in a weekly television news report.[185] However, most local authorities lack the resources to develop such inventories, while those that have sought to develop a comprehensive picture of GHG emissions across the city have found their efforts constrained by a lack of data, much of which is either not collected on a routine basis or regarded as commercially sensitive by energy providers.[186] While the lack of data and the expertise or resources to gather and assess it is a constraint on the ability of municipalities to measure progress towards policy targets, it is clear that – for the majority of cities – a comprehensive picture of urban GHG emissions may be an impossible goal. It may be better to focus efforts on deriving a general overview of where policy attention should be directed.

The example of Durban (South Africa) shows the municipality's difficulties in participating in international actions such as the CDM because of a lack of staff training

Beyond the scientific realm, other sources of expertise are also important. The example of Durban (South Africa) shows the municipality's difficulties in participating in international actions such as the CDM because of a lack of staff training.[187] Once this training is completed, employees may choose to move on to more profitable private-sector jobs to develop the same projects. In addition, local authorities may have little access to recent developments in architectural and engineering professions. For example, in Nigeria, 'lack of information on trends in energy efficient architecture by professionals is a formidable obstacle. This has also encouraged lack of energy conscious building standards and regulations.'[188] Skills shortages, however, are not exclusive to developing countries, although they may be more severe and may affect other aspects of sustainable development not directly connected with climate change.

Urban systems: Infrastructures and cultural practices

Opportunities and constraints facing the urban governance of climate change are also structured by the social and technical networks that constitute cities – a 'seamless web' of material infrastructures and everyday practices that sustain them.[189] The *first* challenge that this raises for the capacity to mitigate climate change is that of urban morphology and design. The opportunities for reducing demand for travel, for example, in a city characterized by urban sprawl or the rapid development of informal settlements at the periphery will be very different from those in a historically compact urban settlement, and urban decision-makers may find their choices heavily constrained by existing infrastructure networks and spatial form.[190] Rather, the comparison of transport systems between Singapore and New York (US) suggests that a range of factors, including fuel pricing and tourism, will be able to shape urban form alongside urban planning.[191] Equally, traditional practices of building design can provide significant barriers to the development and implementation of mitigation measures. In the Ukraine, research finds that:

The opportunities for reducing demand for travel … in a city characterized by urban sprawl or the rapid development of informal settlements at the periphery will be very different from those in a historically compact urban settlement

> *… communal services, predominantly heating, are still very inefficient. Outdated systems in poor condition and high losses due to insufficient maintenance as well as no possibility for heat adjustment are the main reasons for the bad performance … the efficiency in using energy resources in the building stock in Ukraine is 4–5 times lower than in western countries.*[192]

A lack of finances to invest in basic service provision and in the development of urban infrastructures means that issues of climate change mitigation are far from a priority

In Nigeria:

> *… most buildings seem to be replicas of buildings in European countries in shape and form despite marked differences in climatic conditions... Window sizes and openings have not responded to physiological comfort thereby necessitating the use of mechanical devices for increased air movement. The choice of windows tends to be in response more too aesthetic needs rather than physiological needs.*[193]

A significant factor shaping the capacity of municipalities … to respond to climate change … is … the ability to establish novel mechanisms for distributing funding internally to facilitate investment in particular policy measures

Such traditional practices, whether as a result of particular political regimes or the importation of so-called 'modern' design, can have a detrimental effect on the capacity of cities to respond to climate change.

A *second* challenge arises from the nature of the infrastructure systems that supply services, such as energy, water and waste collection, as well as existing building stock. For example, in Helsinki (Finland), the EU target of increasing renewable energy to 20 per cent of energy supply by 2020 is seen as limited by the current district heating network in which biofuels are regarded as the only potential, but still costly and potentially ineffective, option.[194] The introduction of new vehicle fuels, such as in London's (UK) ambitious plans to create a 'hydrogen economy', are limited by the network of refuelling stations which may encounter local opposition during the planning and development process.[195] In Iran, the programme to substitute fuels by compressed natural gas has been clearly limited by the existence of fuelling stations; while 180 filling stations are planned, the pilot programme in Tehran will include only 2.[196]

Financial resources

Financial resources are both a driver and a barrier to fostering urban responses to climate change. Municipal authorities lacking the finances to provide even basic services for their constituents are unlikely to invest in climate change mitigation, given the many competing issues on urban agendas. A lack of basic service provision in cities in developing countries, and especially for those living in informal settlements, can reflect 'local governments lacking the resources to meet their responsibilities – and often with very limited capacities to invest (as almost all local revenues go to recurrent expenditures or debt repayment)'.[197]

A lack of finances to invest in basic service provision and in the development of urban infrastructures means that issues of climate change mitigation are far from a priority, and even where there is commitment to act, financial constraints may prevent the implementation and enforcement of policy goals. For example, in Tuzla (Bosnia and Herzegovina), the municipality had to drop proposals to tax the air pollution emissions of the local coal-fired power plant because of the lack of initial resources to administer the programme and the lack of support at the national level.[198] While this is an acute challenge for cities in developing countries, a lack of adequate finance can also act as a barrier to action on climate change mitigation in cities in developed countries. For example, in the UK, local authorities are bound by strict central government controls over their finances, and their ability to provide capital for infrastructure projects and service provision is limited. At the same time, increasing pressure on local government finances has meant that limited funding is available for even small-scale projects.[199] Often, finding a source of finance is not the only problem: allocating the resources in an efficient way is also challenging (see Box 5.17).

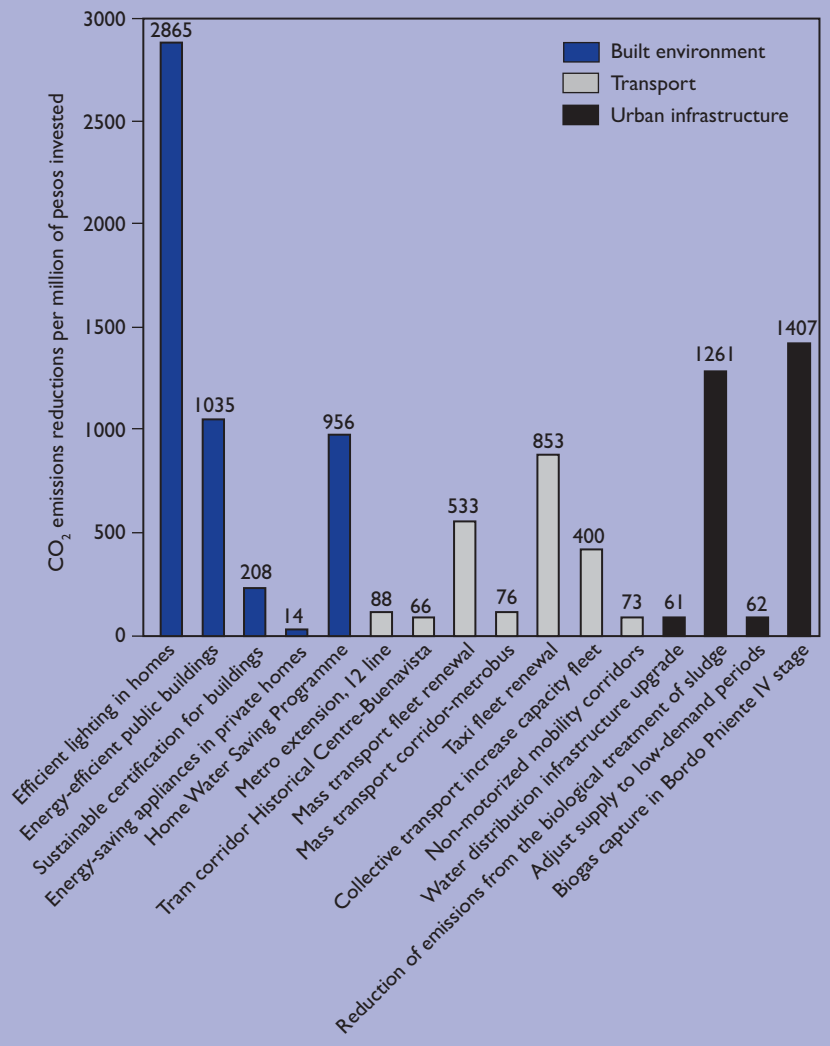
Equally, rather than a lack of financial resources, action can be impeded by the financial reporting and distribution mechanisms in place in an organization. For example, in São Paulo (Brazil), research has found that issues of financial resources, surprisingly, are not a key factor shaping the early stages of the development of climate policy and that 'institutional difficulties in reinvesting resources, rather than actual lack of resources, were reported as the main obstacle'.[200] A significant factor shaping the capacity of municipalities and other organizations to respond to climate change at the urban level is therefore the ability to establish novel mechanisms for distributing funding internally to facilitate investment in particular policy measures. This is one area in which political champions or policy entrepreneurs (explored in the section below) have been particularly important in overcoming the 'inflexible budgetary structures'[201] for which municipal authorities are usually renowned.

Box 5.17 Distribution of resources for climate change mitigation in Mexico City

In 2008 the City of Mexico presented the Climate Change Action Programme, which introduced a number of measures in the fields of energy, transport, water, waste, climate change adaptation and environmental education. Some 60 per cent of the total budget (of some 61 billion pesos) was invested in transport measures and an additional 36 per cent in infrastructure. Only 4 per cent of the budget was invested in measures for the built environment. However, while the measures in the transport and urban infrastructure sectors were expected to reduce carbon emissions by 2.1 million tonnes of CO_2eq (47 per cent of projected emission reductions) and 1.9 million tonnes of CO_2eq (42 per cent), respectively, built environment measures were projected to reduce the city's carbon emission by 0.5 million tonnes of CO_2eq (10 per cent), suggesting that the built environment measures are the most effective in reducing carbon emissions.

The analysis in the figure brings a new dimension into the discussion – namely, the disparity of efficiency of different measures in terms of reducing CO_2eq per million of pesos invested. Issues such as the 'rebound effect' that may cancel the energy efficiency gains of built environment programmes (e.g. 'efficient lighting in homes') need to be taken into consideration. Furthermore, the costs and reduction potential of each measure will be different in each city. Overall, the Mexico City approach, which targets a wide range of measures in different sectors, is likely to bring the best results.

Source: Ciudad de Mexico, 2008; see also Johnson et al, 2009



Mechanisms that have been established to leverage internal sources of funding include revolving energy funds (where financial savings from energy efficiency are reinvested in energy conservation or other climate change projects), energy performance contracting and the establishment of energy service companies (where external organizations or companies established by municipalities invest in energy efficiency measures and profit from the financial savings made).[202] In Japan, several local governments are operating local energy service companies that are achieving energy savings of more than 10 per cent.[203]

Access to external sources of funding is also a key factor shaping local capacity to address climate change. Such sources of funding may come from the EU, national governments, through partnership arrangements, or donor organizations. International municipal networks, such as ICLEI's CCP campaign and the C40, have been critical in leveraging funding for municipalities. One recent initiative in which the C40 is involved is the Carbon Finance Capacity Building Programme[204] that 'encourages the use of Carbon Finance to reduce GHG emissions in cities, in particular emerging mega cities' in developing countries.[205] National governments are also an important source of direct funding for municipal responses to climate change. In The Netherlands, the *Klimaatcovenant* is a multilevel arrangement within which cities are required to complete a performance assessment of their targets, policies and measures and are given funding according to their achievements and population or area for the implementation of climate plans.[206] In the US, many climate change mitigation measures have been associated with philanthropic activities. For example, the development of the Plaza Apartments in San Francisco by the Public Initiatives Development Corporation was supported by grants from a private utility, Pacific Gas, and a partnership between 31 financial and energy multinationals.

Access to external sources of funding is … a key factor shaping local capacity to address climate change

One comparatively new source of funding, and one that to date has had little impact upon the development of urban mitigation efforts, is that of carbon finance. As noted in Chapter 2, there are two principal sources of carbon finance: the CDM, and that from emissions trading.[207] In São Paulo (Brazil), the use of the 'methane from the Bandeirantes landfill (one of the largest in the country) for producing electricity' was financed by the CDM, and it has been estimated that this action alone has reduced the city's

One … new source of funding … is that of carbon finance…: the CDM, and … emissions trading

emissions by 11 per cent. The resulting carbon credits were sold, raising significant finances for investments in 'social projects in the area of the landfill'.[208] Similar projects are being implemented in Mexico City, Quito (Ecuador), Lima (Peru) and Johannesburg (South Africa). As this example suggests, CDM projects may also have significant social benefits when they are targeted at low-income sectors of the population, such as is the case in the Kuyasa development project in Cape Town (South Africa),[209] although there is significant controversy over whether the 'development dividend' of the CDM will be realized in this project, or in general.[210] As noted in Chapter 2, as of December 2009, only a small percentage of the CDM projects that had been registered worldwide were located in urban areas, and more than 90 per cent of these were in the solid waste sector.[211] The main problem for city authorities in terms of making use of international funding mechanisms such as the CDM is related to the lack of an effective city-wide approach to carbon financing. In Amman (Jordan), the Amman Green Growth Programme represents an innovation in this field as the first city-wide CDM programme worldwide, focusing on waste, energy, urban transport and urban forestry sectors.[212]

The main problem for city authorities in terms of making use of international funding mechanisms … is … the lack of an effective city-wide approach to carbon financing

The lack of urban CDM projects reflects both the complexity of the processes involved in the design and verification of projects, the lack of available and consistent data, the problems of ascertaining 'additionality' where a number of factors may shape GHG emissions reductions, and the finances involved, with evidence suggesting that projects that seek to reduce demand for energy generate lower rates of financial return than large-scale energy supply or industrial projects.[213] For example, 'a transport study of Santiago, Chile … found that costs associated with a bikeway system and improved bus technology for 462 buses achieved very limited benefits as a CDM project'.[214] The following have been identified as the main barriers to expanding the use of the CDM in urban areas:

The initiation and uptake of climate change mitigation on urban agendas is usually dependent on the presence of one or more political champion or policy entrepreneur

- *Small individual projects:* typical projects in cities (except for waste management projects in large cities) are small and yield small volumes of emission reductions.
- *Repeated clearances from the same local authority for different projects:* for each project activity, developers need to seek approval, which can be time consuming and cumbersome.
- *Lack of good 'bundling' agents:* due to different budget processes and approval timelines, bundling projects across several cities is a complicated process, which is exacerbated by the fact that very few public agencies have the mandate or capacity to bring together different city governments and mobilize project activities.
- *Lack of strategic planning by the city:* piecemeal assessment of projects, proposed by developers, prevents local authorities from taking a holistic view of their development plans and opportunities to reduce GHG emissions.
- *Lack of opportunity to structurally build the capacity of local authorities to identify GHG mitigation opportunities and to monitor emission reductions:* the lack of strategic thinking results in continuation of business as usual, generally in the form of breakdown orientation (i.e. replacement only when equipment is broken beyond repair), minimum maintenance (only when reported broken) and least cost-based purchase of equipment (due to budget restraints).[215]

Political factors shaping urban governance capacity

Political factors that shape the opportunities and constraints of urban climate governance can be considered in terms of issues of leadership, questions of opportunity, the framing of the costs and benefits of acting upon climate change, and underlying structures and processes of political economy.

■ Leadership

The opportunities afforded by two different forms of leadership – at individual and organizational levels – have also been critical in shaping governance capacity to address climate change in cities (see Box 5.18). Several studies have demonstrated that individual political champions or policy entrepreneurs have been critical to the development and pursuit of policies and projects at the urban level.[216] One example can be found in London (UK) where former Mayor Ken Livingstone was a key figure in the development of ambitious policy targets and the formation of the C40. Operating both within and outside of the public eye, such individuals are critical in getting climate change on the agenda of municipal and private-sector organizations, countering opposition, forging coalitions, developing policies, and advocating particular goals and measures. Evidence suggests that the initiation and uptake of climate change mitigation on urban agendas is usually dependent on the presence of one or more political champion or policy entrepreneur. A key factor reducing urban governance capacity for addressing climate change may therefore be the lack of committed individuals. However, such individuals are not sufficient for sustaining policy action because of the barriers that they may encounter and the often temporary nature of their role within any one organization.[217] For example, in Durban (South Africa), Mexico City and São Paulo (Brazil), research has found that the effectiveness of individuals and of the coalitions that they form is constrained by the institutional and federal government contexts within which they operate.[218]

At the organizational level, leadership is … an important factor in shaping urban governance capacity

At the organizational level, leadership is also an important factor in shaping urban governance capacity. Opportunities to be at the forefront of initiatives amongst a peer group – for example, to be the first municipality to deploy a technology, adopt a certain target or achieve a particular measure – have provided the impetus for action in the urban arena. Such initiatives play on the growing importance of climate change as a means of fostering organizational reputation, both within municipalities and across the corporate sector. International networks seeking to foster urban responses to climate change have, in turn, provided various means for recognizing and rewarding such leadership, such as the Climate Alliance Climate Star award and

CCP Australia's Outstanding Council Initiative award, in turn promoting such forms of leadership. At the same time, being part of a 'leadership group' has also fostered capacity amongst both public- and private-sector actors to address climate change. The C40 is a case in point with its emphasis on being a 'climate leadership group'.[219]

Within cities, public–private partnerships or voluntary agreements amongst private-sector organizations also rely on notions of leadership and innovation. One such example is the recently launched Forward Chicago initiative, orchestrated by the Climate Group and the mayor of Chicago and intended 'to engage Chicago's leading businesses in public–private partnerships to implement selected climate initiatives'.[220] However, this emphasis on the importance of leadership can also constrain municipal capacity to respond to climate change in several important ways. First, it is clearly impossible for every municipality or private-sector actor to 'be the first' to address climate change and the danger arises that an emphasis on innovation will mean that mitigating climate change fails to be adopted as part of mainstream urban policy. Second, leadership groups are, by their very nature, exclusive, with the result that a two-tier approach to addressing climate change in urban areas could be fostered in which the 'best' cities attract resources and political support, leaving 'the rest', where the majority of GHG emissions lie, behind.

Box 5.18 Political leadership models in Los Angeles, US

The impact of leadership upon climate change action is the central feature of Los Angeles's climate change policy. This is evident in three ways. First, the political leadership of Mayor Antonio Villaraigosa and his staff has addressed climate change comprehensively and has placed it on the political agenda of the city. This high-level political support has led to the development of a climate change strategy and ambitious targets for emissions reductions for Los Angeles, bringing widespread recognition of climate change as a policy issue for the city. Motivation to do so was based on multiple drivers, including personal ambitions, and embedded in the context of the State of California, which has adopted progressive policies on climate change, such as the Global Warming Solutions Act (AB 32).

Second, Los Angeles has drawn on business and civil society leadership in the area of climate change to further support its strategies and plans. Segments of the business community have shown some leadership in terms of promoting sustainable business conferences and green business solutions. The local environmental community responded to the mayor's initial indications of prioritizing the environment by forming a coalition and offering their expertise in the process of drawing up an action plan.

Third, national and international leadership has been a key element in the Los Angeles strategy. Action is also motivated by the aspiration to become the largest green city in the US. Given the city's multicultural make-up, it sees itself as a potential model for cities around the world. Importantly, Los Angeles is collaborating internationally as part of the C40.

Source: Schroeder, 2010

■ Windows of opportunity

The presence of committed individuals and an institutional framework within which acting on climate change is supported provides a basis upon which windows of opportunity can be used to further climate change policy ambitions. Such opportunities can take the form of specific climate change initiatives, triggering events that create the political and physical space for interventions in the city, or sources of funding or political support that can be diverted for climate change ends.

In terms of climate change initiatives, the participation in international and municipal networks frequently provides windows of opportunity for member municipalities. For Seoul (Republic of Korea), membership of the C40 and the hosting of the 2009 summit of that network provided a basis for galvanizing action in the city. The invitation to Luis Castañeda Lossio, mayor of Lima (Peru), to make a plenary presentation about the climate change initiatives in the city in the 2009 summit propelled the adoption of climate change mitigation measures, including the use of natural gas in city buses and the municipal fleet and the establishment of individual grants for exchanging old cars for gas-fuelled ones.

Research suggests that major urban events, such as sports competitions, can be significant triggers for actions to address climate change, providing both the political profile to what might otherwise be routine infrastructure projects, as well as the finances and motivations to undertake wholesale infrastructure replacement programmes. For example, before the 2010 FIFA World Cup, Cape Town (as well as other major cities in South Africa) was seeking to develop BRT systems[221] with the aim of achieving a 10 per cent increase in rail transport use and a 10 per cent decrease in private vehicles commuting into city centre between 2005 and 2010. The 2008 Olympic Games in Beijing (China), the 2006 Winter Olympic Games in Turin (Italy) and the 2006 FIFA World Cup in Germany have all been recognized as events triggering significant environmental action (see Box 5.19).

Major urban events, such as sports competitions, can be significant triggers for actions to address climate change

A further means through which windows of opportunity are exploited to address climate change occurs where there is a degree of commitment to action on the issue, and

Box 5.19 Trigger events in Beijing, China

The 2008 Olympic Games was a turning point for Beijing's environmental and climate policy. The city is now generally considered to be a leader, within China, in efforts to improve energy efficiency and develop cleaner urban sources of energy. The 2008 Olympic Games put pressure on the city to improve air quality and tackle other environmental problems. Beijing made great efforts to achieve a 'Green Olympics'. For example, it diversified the city's energy mix away from coal to cleaner natural gas and renewable energy. This resulted in many of the Olympic venues including solar panels and geothermal hot water systems, and investments were made in cleaner public infrastructure, such as a fleet of alternative fuel buses and taxis. Beijing also developed its clean energy resources in the form of geothermal heating and wind energy. A total of 174 new geothermal wells were constructed between 1999 and 2006, reducing CO_2 emissions by 850,000 tonnes between 2001 and 2006, and the Guanting wind farm on the southern bank of the Guanting Reservoir (Beijing's first wind power station) has the capacity to generate 100 million kWh of electricity per year.

Efforts associated with the 2008 Olympic Games increased awareness of climate change issues among both Chinese government officials and the public. Investments of US$12.2 billion to promote sustainable development had a huge impact upon reducing greenhouse gas (GHG) emissions, as city-wide activities such as energy saving, fuel switching and carbon sequestration (through tree-planting) according to some estimates generated 80 million tonnes of CO_2 reductions during the period of 2001 to 2006.

Source: Zhao, 2010

sources of additional funding can be diverted to support policies and measures. For example, in São Paulo (Brazil), the 'need [for] controlling air pollution was a window of opportunity for implementation of climate change related policies'.[222] Similarly, in Rio de Janeiro (Brazil), the federal government's commitment to build 1 million low-cost energy-saving houses in disadvantaged neighbourhoods by 2010 provided the opportunity to experiment with and implement energy-efficient construction materials.[223]

The bundling of climate change mitigation with other potential social or environmental benefits at the city level may be a potential trigger of climate change action and … may determine the long-term success of the initiatives

■ Issue framing and the realization of co-benefits

The bundling of climate change mitigation with other potential social or environmental benefits at the city level may be a potential trigger of climate change action and a factor that may determine the long-term success of the initiatives. The issues that may influence climate change mitigation actions are varied and depend largely on local conditions.[224]

The examples discussed in this chapter show that a wide range of potential co-benefits may be associated with climate change mitigation. Overall, initiatives in the built environment are often associated with energy savings or with issues of social justice, particularly when actions are associated with developments or improvements targeting low-income population sectors. Energy efficiency programmes are often linked with financial savings. This may be particularly significant for municipalities as 'local governments have come to realize the link between energy saving and climate change. They can claim credit for action on both issues even though they only take action related to energy saving; they are in essence killing two birds with one stone.'[225] Actions related to urban infrastructure may bring direct benefits in terms of improvement in access, affordability and service. In Lagos (Nigeria), climate change mitigation initiatives in the waste sector are linked to improvements in the service and reduction of pollution from waste burning. Actions in the transport sector are associated with reducing congestion and reducing air pollution, through, for example, BRT and congestion charges. Finally, carbon sequestration programmes, particularly those linked with urban tree-planting, are often associated with ideas of city beautification, such as the Greening Soweto proposal in Johannesburg. The combination of social justice and sustainable development concerns may open windows of opportunity for the advancement of climate change mitigation actions.

Energy efficiency programmes are often linked with financial savings

Carbon sequestration programmes … are often associated with … city beautification

Such strategies may be particularly important in contexts of ambiguous or overtly hostile responses to addressing climate change in cities. However, joining climate change mitigation initiatives with other co-benefits may also have downsides. For example, linking climate change with the local sustainability agenda may mean that climate change actions need to be limited to those about which consensus can be reached, while issues that require a stronger commitment may be dropped. For example, energy efficiency measures can generate consensus between government authorities, industry and civil society about their environmental and economic benefits. On the other hand, measures to control and limit the demand for energy and transport may be discouraged. Similarly, despite its achievements in creating a right of way for pedestrians, the Pedestrian Rights Charter in Porto Alegre (Brazil) was approved only when a number of considerations that restricted individual motorized transport in the city were dropped. Furthermore, the benefits of such initiatives are unlikely to be equally shared, and 'There are many examples of environmental projects in cities that have served only the narrow interests of wealthier groups, or that have included an active anti-poor political agenda.'[226] In this manner, advocating the need to address climate change may further entrench existing inequalities within cities.

In more affluent urban contexts, efforts to mitigate climate change are often in direct conflict with dominant urban political economies

■ Urban political economies: Conflicting agendas

At the most fundamental level, struggles have emerged over whether cities should or should not be addressing climate change. In many cities, the arguments 'not on my turf' and 'not in my term' are prevalent, particularly in developing countries where resources are limited and other concerns are more pressing.[227] In these cases, 'subnational governments may be overloaded with other local demands, and climate policy may be down on the list of priorities'.[228]

In more affluent urban contexts, efforts to mitigate climate change are often in direct conflict with dominant urban political economies. The very factors that are regarded as driving urban growth – including the availability of cheap land at the urban fringe, short payback periods on capital investment, increased personal mobility, and the growing consumption of energy- and resource-intensive goods and services – are also those which contribute to rising GHG emissions.[229] In this context, initiatives which seek to change patterns of production or to reduce levels of consumption may encounter significant opposition. These issues may be particularly pressing for cities in developing countries, where 'GHG mitigation has a negative connotation because of the perception that this will deny them of their basic right to growth in human services and economic activities; the prospects of "reduced growth" or "no growth" are not feasible'.[230]

Climate change mitigation can contribute to create conditions that favour sustainable development, as discussed above. However, this is not a given, particularly in those cases in which climate change mitigation (and other environmental concerns) have been used by urban elites to attack the interests of the urban poor.[231] In particular, researchers have identified two areas in which mitigation may have serious social consequences for urban populations in developing countries: when it detracts attention from adaptation[232] and when mitigation measures have impacts in particularly disadvantaged sections of the urban population.[233] For example, street-lighting programmes which promote the substitution of standard bulbs by lighting innovations such as light-emitting diodes (LEDs) – such as the one promoted by the Climate Group in Mumbai (India)[234] – may direct investments to affluent areas where lighting infrastructure is already in place, while detracting investments from developing lighting infrastructure in the wide slum areas of the city.

Such tensions between dominant forms of urban growth and climate change mitigation are, however, also

discernible in cities in developed countries. In the US, for example, climate change mitigation is likely to be prioritized in those communities which are most likely to be affected by the impacts of climate change, and those with a 'liberal' political constituency.[235] In the UK, climate change initiatives in the transport sector have been undermined by the priority given to economic considerations and the stress on the need to increase the demand for travel.[236] The long-term experience with transport regulation and urban economy in Århus (Denmark), however, suggests that the focus on individual motorized transport is not always the best or the only strategy to improve the local economy.[237] That such alternatives are often overlooked may be due to the ways in which the scope for municipal action on climate change is predetermined by neo-liberal political and economic conditions. For example, research in Portland, Oregon (US), found that climate actions were confined to:

> *… elements of energy consumption that could be influenced in an acceptable way by the municipal government. Energy used in flights to and from Portland International Airport, for instance, was excluded. Also excluded were the significant amounts of energy used in importing and exporting commodities, and the energy actually embodied in commodities.*[238]

COMPARATIVE ANALYSIS

As demonstrated above, cities across the world are undertaking a range of measures to address climate change mitigation. From a handful of pioneering cities during the 1990s, the number of urban municipalities participating in climate change mitigation efforts has expanded significantly over the past two decades. Alongside a growing number of cities in developed countries, the analysis presented in this chapter suggests that climate change mitigation is becoming an increasingly important issue for cities in developing countries as well. Most urban mitigation efforts have been implemented after the adoption of the Kyoto Protocol, with many initiatives, especially in developing countries, dating from the mid 2000s. This reflects the changing international and national climate change policy context in which developing countries with growing contributions to global emissions – including China, India, Brazil, Mexico and South Africa – are becoming involved in mitigation efforts. It is also symptomatic of what has been described as an era of 'governance experimentation' emerging as a result of the fragmentation of authority for governing climate change between public and private actors, and a growing dissatisfaction with the outcomes of national policy processes and international negotiations.[239] Despite the growing profile of climate change as an urban issue, data on the strategies and measures being adopted in cities across the world are limited, especially for cities in developing countries. Equally, where the development of policy and the implementation of measures have been documented, evidence concerning the impacts and effectiveness of climate change mitigation measures is scarce. In this context, detailed comparative analysis of urban climate change mitigation efforts is not possible, though some key trends can be observed.

First, the analysis in this chapter suggests that climate change remains a marginal issue for most of the world's cities. Relatively few cities, especially in developing countries, are explicitly seeking to address climate change mitigation, and where this is the case, policy-making is largely confined to the environmental domains of municipal governments and, furthermore, the issue of climate change mitigation is one of concern primarily for urban elites. Although there are growing expectations in developed countries for action on climate change by municipal governments and other urban actors (e.g. in the UK, local authorities are required to prepare climate change mitigation (and adaptation) plans; and in the US, the Mayors Climate Protection Agreement has attracted a significant following), there is limited evidence that this is being approached in a strategic or comprehensive manner.[240] In regions where rapid industrialization and urbanization is taking place (e.g. cities in Latin America and Asia), there is a growing interest in climate change mitigation. This is, for instance, the case for cities such as São Paulo, Porto Alegre and Rio de Janeiro in Brazil; Mexico City; Beijing and Shanghai in China; and Jakarta in Indonesia, where climate change initiatives have proliferated during the last four to five years, not only in a piecemeal fashion, but also in the form of articulated and coordinated climate change action plans. It should also be noted that some developing countries, such as the Philippines,[241] have adopted national frameworks within which municipalities should address climate change mitigation. However, with limited data available, the extent to which such initiatives are taking place in other cities in developing countries is not clear.

Climate change remains a marginal issue for most of the world's cities

In regions where rapid industrialization and urbanization is taking place … there is a growing interest in climate change mitigation

Some developing countries … have adopted national frameworks within which municipalities should address climate change mitigation

Furthermore, the analysis presented in this chapter suggests that governing climate change mitigation is primarily being undertaken by municipal governments, although forms of partnerships and the involvement of private actors is increasingly becoming important. There are relatively few examples of inclusive and participatory approaches to urban climate change mitigation governance. In particular, issues of gender have received minimal attention.[242] Seeking to broaden the basis upon which climate policy is formulated and implemented is a critical challenge for cities. Women's participation in climate change decision-making at the local level may play a specific role in supporting sustainable lifestyles, developing alternative forms of engagement with the environment and challenging traditional patriarchal models of urbanization and planning.

There are relatively few examples of inclusive and participatory approaches to urban climate change mitigation governance

A *second* set of trends indicated by the analysis in this chapter concerns regional differences in terms of what cities are doing and how they are doing it. For example, urban responses to climate change are more common in developed than in developing countries. While international commitments and national policy frameworks have provided important drivers for these cities, the cases of the US and Australia – where significant action has been taken at the urban level despite the withdrawal of both countries from the Kyoto Protocol – highlight the ways in which municipal governments have also pioneered climate policy.[243]

Box 5.20 Obstacles to climate change mitigation actions in Durban, South Africa

For the municipality of Durban, responding to climate change is a major focus of the city's commitment to sustainable development. Durban was one of the first African cities to participate in Local Governments for Sustainability's (ICLEI's) Cities for Climate Protection Campaign (CCP). However, the absence of policy coordination and the existence of competing socio-economic urban policy priorities stand in the way of effectively delivering potential emissions reductions.

Early mitigation projects were landfill gas to electricity (resulting in reductions of 362,000 tonnes of CO_2eq per year, or 2 per cent of annual emissions), reduction of energy demand in municipal buildings (reductions of 914 tonnes of GHGs annually), and electricity from micro-turbines integrated within the water piping systems, making use of Durban's uneven topography. While setting municipal climate policy in motion, these initiatives did not result in significant emission reductions. A target of 27.6 per cent reductions by 2020 was proposed in the 2008 Energy Strategy, to be achieved through the use of biofuels in transportation, the creation of residential green energy tariffs, a subsidized residential solar hot water programme, encouraging industrial efficiency, and the encouragement of local energy service companies. Implementing these would demand cross-cutting action across many municipal departments, as well as private partners.

However, projects have been held back by questions regarding who has the resources and the jurisdiction to implement them. For instance, the municipal Department for Environmental Management has the best understanding of the issue. However, it lacks both the resources and the mandate to act upon that knowledge (their remit being primarily biodiversity protection). The entity which is perhaps best positioned to act, the energy provider, is constrained by deeply engrained procedures and relationships (traditionally the intermediary buying electricity from the national grid and selling it on to local customers, they did not see local renewable energy generation within their mandate). And the entity quickest to act, the Department for Water and Sanitation, while effective in making change in its own systems, does not have the desire or reach to coordinate broader changes. Therefore, while substantial opportunities for significant emissions reductions exist, Durban's experience shows that in the absence of integrated planning and streamlining of urban priorities, key barriers may be primarily institutional, not technical.

Source: Aylett, 2010

Nonetheless, the development of international and national policy commitments to address climate change in some developing countries – notably, China, India, Brazil, Mexico and South Africa – is also driving a growing policy interest in the issue at the urban level. The development and spread of international, national and regional municipal networks has also provided a key driver for municipal responses in developed countries, and the expansion of these networks to include cities in developing countries is one important reason for their growing participation in climate change mitigation. In developing countries, mitigation initiatives have also often been linked with adaptation responses, taking advantage of the potential synergies between both.[244]

The development and spread of international, national and regional municipal networks has … provided a key driver for municipal responses in developed countries

The differences between developing and developed countries, however, are more apparent when examining the measures and mechanisms which have been developed to address climate change mitigation. In developed countries, emphasis has been placed on the energy sector through urban design and development, the built environment and urban infrastructure systems. In developing countries, cities have focused on a more diverse range of urban infrastructure projects, including waste and water systems, as well as issues of carbon sequestration. Those schemes which have been undertaken in the urban development and design sector in cities in developing countries have tended to focus on flagship projects, which are often socially and economically exclusive, in contrast to the involvement of civil society groups and an emphasis on smaller-scale brownfield regeneration projects in developed countries. This may reflect the urban morphologies of these different cities – brownfield sites are likely to be uncommon, particularly in the rapidly industrializing cities in developing countries – as well as the availability of resources for creating 'sustainable' housing.

In developing countries, mitigation initiatives have also often been linked with adaptation responses, taking advantage of the potential synergies between both

While projects in the built environment in developed countries have tended to focus on municipal and residential buildings, in developing countries attention has been given to commercial buildings. This reflects the fact that in developed countries, the major challenges in the built environment are related to retrofitting the housing stock, as new developments are gradually incorporating more efficient designs and materials, whereas the contribution of residential dwellings to GHG emissions in developing cities is likely to be minimal for the vast majority of the housing stock. Furthermore, the focus on commercial buildings reflects the growing involvement of private-sector actors in addressing climate change mitigation in developing countries. The evidence presented in this chapter also suggests that initiatives in developed countries are often achieved through processes of self-governing and enabling, while in developing countries, modes of provision, both public and private, have been more significant. Despite these differences, there are relatively few examples of the development and use of alternative energy technologies or of explicit policies to tackle climate change in the transport sector in both developed and developing countries.[245]

However, this broad brush differentiation between developed and developing countries obscures the differences that are emerging within these regions. Urban development and design initiatives in North America, Australia and New Zealand focus on compact city principles and mixed developments to address the historical conditions of suburban development and urban sprawl. However, transport-related initiatives are relatively rare, particularly in terms of limiting and controlling the demand for individual motorized transport and the development of mass transport systems. This contrast with countries in Europe, where there is a growing proliferation of examples to promote demand

management and enhancement in transport, while developing or modernizing the public transport infrastructure. Cities in Africa and Latin America and the Caribbean have emphasized actions in urban infrastructure systems, particularly in those cases in which upgrading the infrastructure alone can lead to significant gains, such as is the case in the waste management system in Lagos (Nigeria).[246] In these regions, there is evidence that measures being undertaken in the built environment and urban development and design sectors are seeking to address issues of social equity. However, in Asia, new urban developments are emerging where high-income groups are able to create their own communities – often informed by green values in terms of nature protection and resource conservation, but with less regard for amelioration of social inequalities. Driven through partnerships of private and public agencies, large urban development projects that incorporate climate change mitigation concerns are taking place. However, concerns have been expressed about the impact and effectiveness of such schemes in climate change terms, and also because they may have important environmental justice implications for the social groups who are excluded from these partnerships.

A *third* set of trends relates to the differences in the opportunities and constraints that municipal governments and other actors face in seeking to mitigate climate change. Clearly, the resources available to act upon climate change are significantly different between cities in different regions, as well as between actors within individual cities. For many cities in developed countries a lack of resources is seen as a critical barrier to action, though these challenges are considerably higher for cities in developing countries. Analysis in this chapter also suggests that a lack of expertise, of institutional capacity and of the ability to develop and enforce policy – as well as historic issues of underinvestment in urban infrastructures, informal settlements and persistent poverty – pose significant challenges for cities in developing countries seeking to address climate change mitigation. The example of Durban (see Box 5.20) explains the interaction of multiple obstacles to climate change mitigation in a city in South Africa. In order to address these issues, linking climate change actions with their potential co-benefits appears to be crucial, particularly when these are linked with social and environmental justice objectives to improve the quality of life of the most disadvantaged sectors of the population. Examples such as the Kuyasa housing project in Cape Town (South Africa) and housing projects in Buenos Aires (Argentina) and Rio de Janeiro (Brazil) are encouraging; but their prominence is still relatively low, particularly when compared with the emphasis on the development of exclusive new urban developments. Furthermore, while international policy instruments (such as the CDM), public–private partnerships and international networks may be able to bring a degree of resource and support for climate change activities, there is, to date, mixed evidence of their impact upon fundamental issues of economic deprivation and social inequalities. In developed countries, the impacts of focusing upon co-benefits are less clear cut. While such approaches can generate political support, they could also lead to the watering down of climate change commitments or to a focus only on those initiatives that can yield economic benefits in the relatively short term, detracting attention from more fundamental issues concerning how (and by and for whom) energy is provided, the levels of personal mobility that can be sustained, and the relationship between consumption, growth and climate change.

Despite the significant constraints facing urban climate change mitigation efforts, as the evidence documented in this chapter illustrates, cities are taking important measures to address the issue. The combined effects of institutional structures, financial resources, the social and material make-up of urban infrastructure networks, and political support have created the capacity for significant advances for climate change mitigation. This capacity is not only unevenly distributed regionally and between different countries. Research also suggests that a growing divide may be emerging between cities. Municipal governments and other urban actors with initial capacity in some cities are able to capitalize on opportunities for funding, political influence, access to international organizations and international networks, and partnerships to build on their efforts, while others lack the wherewithal needed to access these resources.[247] Efforts by international networks, private-sector actors and international donor agencies to target a small number of global and megacities as arenas within which to mitigate climate change may exacerbate this divide. As a result, rather than being regionally differentiated, future urban climate change mitigation efforts may be characterized by differences between an elite group of cities with access to substantial resources, those (primarily in developed countries) who may be able to afford to undertake initiatives to pick the 'low hanging fruit', and the vast majority of cities for whom addressing climate change will remain a low priority. Furthermore, the channelling of resources in this manner may also serve to support the interests of urban elites rather than addressing broader issues of sustainable development and well-being. As discussed above, ensuring that climate change mitigation can also address issues of social and environmental justice will necessitate the participation of a broad constituency of actors and, especially in developing countries, a focus on the multiple co-benefits that such initiatives could generate.

A lack of expertise, of institutional capacity and of the ability to develop and enforce policy … pose significant challenges for cities in developing countries seeking to address climate change mitigation

Future urban climate change mitigation efforts may be characterized by differences between an elite group of cities with access to substantial resources …. and the vast majority of cities for whom addressing climate change will remain a low priority

CONCLUDING REMARKS AND LESSONS FOR POLICY

Mitigating climate change is an increasingly pressing urban issue. However, cities have very different starting points in terms of their GHG emissions, related to issues of geography, political economy, infrastructure provision and social practices, and the capacity of governments, private organizations and civil society actors. Historically, cities in developed countries have contributed the vast majority of GHG emissions and bear the major responsibility to act. However, as GHG emissions begin to grow in some developing countries, there is also a need to consider what appropriate and effective urban mitigation efforts might involve, and

Historically, cities in developed countries have contributed the vast majority of GHG emissions and bear the major responsibility to act

how they might be combined with the more pressing issues of urban adaptation.

This chapter suggests, in line with previous research,[248] that efforts to mitigate climate change in cities face a significant paradox. Those strategies which can be effectively implemented may have the least impact, while those with the potential for the greatest reductions in GHG emissions may be the hardest to achieve. On the one hand, the most commonly implemented and effective strategies are those which focus on reducing GHG emissions from within the municipality (self-governing) and those which aim to improve energy efficiency. As noted in Figure 5.1, the waste, transport and buildings sectors appear to be the 'low hanging fruits' of urban GHG mitigations. It should, however, be kept in mind that the cost efficiency of interventions within these sectors varies considerably (see Box 5.17). This chapter suggests that the complex challenges facing municipal governments – their partial autonomy in critical policy sectors, the splintering of urban infrastructure networks, the difficulties of meeting the basic needs of urban citizens, and the controversial politics that accompany efforts to divert from 'business as usual' – have limited the extent to which urban climate change governance has extended beyond the areas of direct municipal control. At the same time, in contexts of competing aims and conflicting agendas, focusing on energy efficiency has been a means through which urban actors have been able to address multiple agendas, including energy security, financial savings, air pollution and fuel poverty, alongside climate change.

The waste, transport and buildings sectors appear to be the 'low hanging fruits' of urban GHG mitigations

However, there has, to date, been limited assessment of the impact of such measures. While focusing on municipal GHG emissions alone will, in most cases, only account for a small proportion of urban GHG emissions, energy efficiency measures have the potential to achieve significant savings. Examples of individual buildings, new urban developments, the retrofitting of energy-efficient technologies and behavioural programmes documented in this chapter have demonstrated that energy efficiency could provide a crucial component of urban efforts for climate change mitigation. Furthermore, such initiatives have often provided the impetus for the development of comprehensive climate change strategies, as the financial savings and political influence gained within the city drive more ambitious policy goals and the development of additional measures. Nonetheless, such examples remain relatively small scale and isolated. Against a rising trend of energy consumption and GHG emissions, a critical question for future research and the development of policy is therefore the extent to which self-governing and energy efficiency initiatives can lead to widespread and sustained changes in the ways in which energy is used in cities.

On the other hand, measures which may have the greatest impact upon urban GHG emissions, including the provision of low-carbon and renewable energy infrastructure systems, the reduction in demand for personal vehicle travel, as well as enabling and mobilizing actions by communities and stakeholders, have, to date, been less common. While there are some promising signs that such initiatives are taking place – in the development of new urban transit systems in cities in developing countries, projects for urban regeneration, and the growing involvement of a range of private companies and community organizations – these remain the exception rather than the rule. Evidence suggests that such initiatives are most likely to be successful when they demonstrate a range of additional economic, social and environmental benefits, and where they attract the support of key urban actors. While this can be a progressive process, involving communities and stakeholders and addressing issues of social and environmental justice, it can also be one that serves the interests of particular urban elites and leads to a politics of exclusion.

Ensuring that mitigating climate change does not come at the expense of addressing issues of inequity and justice is a critical challenge for future policy-making

Importantly, the evidence presented in this chapter suggests that the potential for urban climate change mitigation to address issues of social and economic equity is not predetermined by the types of measure or governance mechanisms deployed. For example, projects to generate energy from landfill sites can be undertaken as technical endeavours with little regard for the impacts of such initiatives; but they can also provide new forms of employment, sources of funding for investment in poor communities, and a means of generating secure and affordable energy. Ensuring that mitigating climate change does not come at the expense of addressing issues of inequity and justice is a critical challenge for future policy-making.

NOTES

1 UNFCCC, 1992, Article 2.
2 See Chapter 2 for details.
3 IEA, 2008.
4 Kern and Bulkeley, 2009.
5 See also Chapter 2.
6 Bulkeley, 2000; Betsill, 2001; Bulkeley and Betsill, 2003; Kousky and Schneider, 2003; Yarnal et al, 2003; Allman et al, 2004; Lindseth, 2004; Davies, 2005; Mackie, 2005; Bulkeley and Kern, 2006.
7 Dhakal, 2004, 2006; Bai, 2007; Holgate, 2007; Romero Lankao, 2007b.
8 Sanchez-Rodriguez et al, 2008.
9 Betsill and Bulkeley, 2007.
10 Satterthwaite, 2008a; Dodman, 2009.
11 Harvey, 1996.
12 Monstadt, 2009, p1927.
13 Alber, 2010; Hemmati, 2008.
14 See Chapter 3.
15 See Chapters 4 and 6.
16 IEA, 2009; UN, 2010.
17 Sassen, 1991.
18 Research undertaken in preparation for this chapter draws on a database of climate change mitigation initiatives taking place in 100 cities. For further information, see www.geography.dur.ac.uk/projects/urbantransitions, last accessed 21 October 2010.
19 See section on 'Urban governance for climate change mitigation'.
20 Kern and Alber, 2008, p4; see also Jollands, 2008.
21 Kern and Alber, 2008, p3.
22 ICLEI, 2006.
23 Bulkeley and Kern, 2006; Betsill and Bulkeley, 2007; Bulkeley et al, 2009.
24 Rutland and Aylett, 2008, p636.
25 Owens, 1992; Banister et al, 1997; Capello et al, 1999; Norman et al, 2006; Lebel et al, 2007. See also discussion on urban form and density in Chapter 3.
26 UN-Habitat, 2009a.
27 UN-Habitat, 2010.
28 UN-Habitat, 2009a.
29 See UN-Habitat, 2009a.
30 City of Cape Town, 2005; City of São Paulo, 2009.
31 For the example of Stockholm (Sweden), see Holden and Norland, 2005.
32 Kolleeny, 2006 (Philadelphia); Energy Planning Knowledge Base, undated (Manchester); A101, 2006 (Moscow); BCIL, 2009 (India).
33 McGray, 2007.
34 Ying, 2009.

35 Moore, 2008.
36 Schifferes, 2007.
37 For example, the backing down from implementing a planned ban on motorized private vehicles on the islands.
38 Pearce, 2009.
39 See also Box 2.7.
40 BSHF Database (available at www.worldhabitatarwards.org) (Boston and San Francisco); WHEDco, 1997 (New York).
41 Alber, 2010.
42 Bulkeley et al, 2009, p43.
43 Akinbami and Lawal, 2009; Bulkeley et al, 2009.
44 Foresight, 2008.
45 Hemmati, 2008; Alber, 2010.
46 Bulkeley et al, 2009, p44.
47 This is discussed in more detail in the section on 'Urban governance for climate change mitigation'.
48 See note 18.
49 US Department of Energy, 2008.
50 Pauzner, 2009.
51 Boardman, 2007. For some interesting examples of how to deal with existing building stock, see also http://thezero-prize.com, last accessed 18 October 2010.
52 For example, innovation in the use of traditional building materials in conventional housing in Bangalore (India) has been led by the pioneering experience and skills development promoted by architect Chitra Viswanath (see www.inika.com/chitra, last accessed 18 October 2010).
53 City of Cape Town, 2005; Ciudad de Mexico, 2008.
54 Bulkeley et al, 2009.
55 Agencianova, 2009. This project follows previous experiences in sustainable building, such as those led by the architect Carlos Levinton from the Special Centre of Production and the University of Buenos Aires to create energy-efficient building materials from recycled products (see Sotello, 2007).
56 Barry, 1943.
57 Zhao and Michaelowa, 2006.
58 Hemmati, 2008.
59 Gender is a critical issue in terms of behavioural patterns relating to climate change. Although commentators have suggested that women may emit less GHGs emissions than men, the evidence is limited by the lack of disaggregation of data about consumption patterns within the household. A study of consumption patterns in single-person households in different European countries supported the hypothesis that women emit less GHG emissions than men (see Alber, 2010); but doubts exist over whether such findings could be extended over the whole life of individuals or could be applied more generally in different types of households and different countries. On the other hand, women across the world tend to have lower incomes and greater participation in the informal labour market. Even women who are not living in poverty will tend to be less affluent and financially secure than men; hence, they will have more modest consumption associated with lower carbon footprints (Haigh and Vallely, 2010).
60 OECD, 2008.
61 Hemmati, 2008; Haigh and Vallely, 2010.
62 See also Aylett, 2010.
63 Greene et al, 1999.
64 Satterthwaite, 2008b, p11.
65 Hemmati, 2008.
66 UN-Habitat, 2008b.
67 Graham and Marvin, 2001.
68 See Chapter 2.
69 See Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (undated).
70 Bulkeley et al. 2009.
71 City of Cape Town, 2005.
72 Greenpeace, 2008; Wu and Zhang, 2008.
73 Greenpeace, 2008.
74 Solar America Cities, 2009.
75 See www.cleanenergy fuels.com/main.html, last accessed 18 October 2010.
76 The scheme was funded by the Department for Environment, Food and Rural Affairs and the Waste Resources Action Programme.
77 Silver, 2010.
78 See also see the sub-section on 'Modes of public–private collaboration in urban climate governance' below.
79 See also Bulkeley et al, 2009; Aylett, 2010.
80 Oresanya, 2009.
81 Ciudad de Mexico, 2008.
82 Aylett, 2010.
83 Ciudad de Mexico, 2008.
84 Short et al, 2008; Bertaud et al, 2009. See also Chapter 3.
85 Karekezi et al, 2003.
86 World Bank, 2009c.
87 Sari, 2007, p129.
88 Sari, 2007, p137.
89 Johnsson-Latham, 2007.
90 Haigh and Vallely, 2010.
91 Johnsson-Latham, 2007.
92 Skutsch, 2002.
93 Alber, 2010.
94 See note 18.
95 Wagner, 2009.
96 See www.transmilenio.gov.co/WebSite/English_Default.aspx, last accessed 18 October 2010.
97 See www.cdm-egypt.org/, last accessed 18 October 2010.
98 The partnership is partly funded by the German federal government's Fuel Cell and Hydrogen Innovation Programme, and the partners include Daimler, Shell, Total and Vattenfall Europe.
99 Note that this measure is frequently associated with improving the air pollution of the city (e.g. Alam and Rabbani, 2007).
100 Bertaud et al, 2009.
101 Bertaud et al, 2009.
102 See discussion in the sub-section on 'Urban infrastructures' above.
103 Dlamini, 2006. The programme was implemented with financial assistance of the governments of Norway and Denmark and the World Conservation Union (IUCN).
104 Lagos State Government, 2010. Updates about the tree-felling programme can be found at www.lagosstate.gov.ng, last accessed 18 October 2010.
105 Concejo de Bogotá, 2008.
106 See Box 2.7.
107 ICLEI Australia, 2008.
108 This project is a collaboration between the Clinton Climate Initiative, Microsoft Corporation, Autodesk and ICLEI (Clinton Foundation, undated b).
109 See, for example, Bai, 2007; Dhakal, 2009.
110 UNEP et al, 2010. See also Box 2.4.
111 Bulkeley and Kern, 2006.
112 UN-Habitat, 2009a, p73.
113 UN-Habitat, 2009a, p73.
114 Bulkeley and Kern, 2006; Kern and Alber, 2008; Bulkeley et al, 2009.
115 Hammer, 2009.
116 This trend is also reflected in other arenas of climate change governance (see Biermann and Pattberg, 2008; Bulkeley and Newell, 2010).
117 Jessop, 2002, p241; Sørensen and Torfing, 2007, 2009.
118 Bulkeley and Kern, 2006; Gore et al, 2009.
119 Martinot et al, 2009.
120 Gore et al, 2009, p10.
121 See the sub-section on 'Public–private provision' below.
122 Bulkeley et al, 2009.
123 State of São Paulo, 2008.
124 GLA, 2008.
125 Bulkeley and Schroeder, 2008; www.nabers.com.au, last accessed 22 October 2010.
126 Bulkeley et al, 2009.
127 Bulkeley and Kern, 2006; Bulkeley et al, 2009; Gore et al, 2009; Hammer, 2009.
128 Bulkeley et al, 2009.
129 Funded by the Danish International Development Agency.
130 Aylett, 2010.
131 See note 18.
132 UNEP, 2007, p44.
133 In the eastern US, for example, local planning regulations have slowed the establishment of hydrogen refuelling stations.
134 Bulkeley et al, 2009.
135 Aylett, 2010.
136 UN-Habitat, 2009a, p74.
137 UNEP, 2007, p46.
138 See the sub-section on 'Modes of governing climate change mitigation'.
139 UN-Habitat, 2007, p106.
140 Satterthwaite et al, 2009b, p24.
141 Bulkeley and Newell, 2010.
142 See www.carbon rationing.org.uk, last accessed 18 October 2010.
143 Peak oil is the point in time when the maximum rate of global petroleum extraction is reached, after which the rate of production enters terminal decline.
144 See www.transition network.org, last accessed 18 October 2010.
145 Pers comm, 2010.
146 See the sub-section on 'Provision' above.
147 See the sub-section on 'Urban infrastructures' above.
148 The London Energy Service Company is a 'private limited company with shareholdings jointly owned by the London Climate Change Agency Ltd (with a 19 per cent shareholding) and EDF Energy (Projects) Ltd (with an 81 per cent shareholding)' (LCCA, 2007, pp5–6).
149 Clinton Foundation, undated b.
150 See Chapter 2.
151 The Climate Group is an international non-profit organization whose members include national, regional and local governments, as well as private corporations (see www.theclimategroup.org/about-us/, last accessed 18 October 2010).
152 Bulkeley and Betsill, 2003; Romero Lankao, 2007b; Biermann and Pattberg, 2008; Rutland and Aylett, 2008.
153 Kern and Alber, 2008.
154 Betsill and Bulkeley, 2007; Bulkeley et al, 2009; Romero Lankao, 2008.
155 Deangelo and Harvey, 1998; Bulkeley et al, 2009; Hammer, 2009.
156 Granberg and Elander, 2007, p545.
157 Qi et al, 2008, pp397–398.
158 Hammer, 2009.
159 Betsill and Bulkeley, 2007; Bulkeley et al, 2009; Puppim de Oliveira, 2009.
160 Bai, 2007; see also Bulkeley and Kern, 2006; Granberg and Elander, 2007.
161 Collier, 1997; Lebel et al, 2007; Jollands, 2008; Schreurs, 2008; Sugiyama and Takeuchi, 2008; Setzer, 2009.
162 GLA, 2007, p19.
163 Monni and Raes, 2008, p753.
164 Sugiyama and Takeuchi, 2008, p429.
165 Satterthwaite, 2008b, p9.
166 See the sub-section on 'Self-governing' above.
167 Romero Lankao, 2007b, p529.

168 Kern and Alber, 2008.
169 Bulkeley et al, 2009, p23.
170 Holgate, 2007.
171 OECD, 2008, p24; see also Bai, 2007; Crass, 2008; Kern and Alber, 2008.
172 Kern and Alber, 2008, p4.
173 Betsill and Bulkeley, 2007, p450.
174 Akinbami and Lawal, 2009, p12.
175 Schwaiger and Kopets, 2009.
176 UNEP, 2007.
177 Bulkeley et al, 2009, p49.
178 Sari, 2007, p141.
179 Satterthwaite, 2008b, p12.
180 Sippel and Michaelowa, 2009.
181 See www.cdmgold standard.org/, last accessed 18 October 2010.
182 GLA, 2007, p19.
183 Arup, 2008.
184 See Chapter 3.
185 Newcastle City Council, 2008.
186 Allman et al, 2004; Lebel et al, 2007; Sugiyama and Takeuchi, 2008, p432.
187 Aylett, 2010.
188 Akinbami and Lawal, 2009.
189 Akin to previous definitions of large technical systems; see Hughes, 1989.
190 Bertaud et al, 2009, p23.
191 Bertaud et al, 2009.
192 Schwaiger and Kopets, 2009, p3.
193 Akinbami and Lawal, 2009, p10.
194 Monni and Raes, 2008, p749.
195 Hodson and Marvin, 2007.
196 See www.climate-change.ir/en/, last accessed 17 May 2010.
197 Satterthwaite, 2008a, p11.
198 Castán Broto et al, 2007, 2009.
199 Kern and Bulkeley, 2009.
200 Setzer, 2009, p8.
201 Jollands, 2008, p5.
202 Bulkeley and Kern, 2006.
203 Sugiyama and Takeuchi, 2008, p430.
204 The Carbon Finance Capacity Building Programme is an initiative of the World Bank, ECOS, C40, the Swiss Government (SECO) and the Canton of Basel City.
205 See www.lowcarboncities.info/home.html, last accessed 18 October 2010.
206 Kern and Alber, 2008; Jollands, 2008.
207 To date, there is little evidence of the role of the voluntary carbon market in urban climate change governance and this analysis focuses on the CDM.
208 Puppim de Oliveira, 2009, p257. See also Box 3.3.
209 See City of Cape Town, 2005.
210 For an overview of this debate, see Bumpus and Liverman, 2008.
211 World Bank, 2010a.
212 World Bank, 2010c.
213 Sippel and Michaelowa, 2009; Roberts et al, 2009, p13; ICLEI, 2010; Clapp et al, 2010.
214 Roberts et al, 2009, p14.
215 World Bank, 2010a.
216 'Policy entrepreneurs', individuals involved in the innovation of policies or schemes, are defined by 'their willingness to invest their resources – time, energy, reputation, and sometimes money – in the hope of a future return ... in the form of policies of which they approve, satisfaction from participation, or even personal aggrandizement in the form of job security or career promotion' (Kingdon, 1984, p122). 'Political champions' are individuals who advocate the importance of responding to climate change and who may back particular policies, projects or schemes. See Bulkeley and Betsill, 2003; Bulkeley and Kern, 2006; Qi et al, 2008; Schreurs, 2008.
217 Bulkeley and Kern, 2006, p2253.
218 Romero Lankao, 2007b; Setzer, 2009; Aylett, 2010.
219 See www.c40cities.org/, last accessed 18 October 2010.
220 See www.theclimategroup.org/our-news/news/2009/2/24/the-climate-group-launches-forward-chicago/, last accessed 22 October 2010.
221 City of Cape Town, 2006.
222 Puppim de Oliveira, 2009, p254.
223 Frayssinet, 2009.
224 Bai, 2007; Gore et al, 2009; Betsill and Bulkeley, 2007.
225 Qi et al, 2008, p393.
226 Bartlett et al, 2009, p22; see also McGranahan and Satterthwaite, 2000.
227 Bai, 2007.
228 Puppim de Oliveira, 2009, p25; see also Bai, 2007; Romero Lankao, 2007b; Jollands, 2008.
229 See Chapter 3.
230 Lasco et al, 2007, p84.
231 Bartlett et al, 2009.
232 See Chapter 6.
233 Bartlett et al, 2009.
234 Urvashi Devidayal, the Climate Group, pers comm, 2010.
235 Zahran et al, 2008.
236 Bulkeley and Betsill, 2003.
237 Flyvbjerg, 2002.
238 Rutland and Aylett 2008, p636.
239 Hoffman, 2011.
240 See the sub-section on 'Municipal policy approaches' above.
241 The Philippines adopted a National Framework Strategy on Climate Change in April 2010 (www.climatechangecommission.gov.ph/link/downloads/nfscc/index.php, last accessed 10 August 2010.
242 Demetriades and Esplen, 2008; Alber, 2010.
243 See the sub-section on 'Multi-level governance' above.
244 See Chapter 6.
245 See note 18.
246 Oresanya, 2009.
247 Granberg and Elander, 2007; Kern and Bulkeley, 2009.
248 For example, Bulkeley and Betsill, 2003; Bulkeley and Kern, 2006; Bai, 2007; Betsill and Bulkeley, 2007; Rutland and Aylett, 2008; Bulkeley et al, 2009; Gore et al, 2009.