PART II

Chapter 4

The Urban Policy Package

While the international community has been struggling to agree on climate change targets and co-ordinated approaches to fight global warming, and many national governments have begun to act, a growing number of cities and regions have also taken initiatives to reduce their energy use and GHG emissions and to begin to adapt to climate change. Cities and regions in many OECD countries have key responsibilities in the urban sectors that can provide valuable strategies for fighting and adapting to climate change, including policies that affect transportation and the built environment. With the help of strategic planning tools, policies at the local level can establish complementary policy packages that bring together territorial strategies and sectoral policies. Chapter 4 reviews policy tools to address climate change at the local level in the sectors of land-use zoning, natural resources, transportation, building, waste and water. The question of effective urban policy packages intersects with the concept of urban spatial density, a major driver of CO_2 *and* N_2O *emissions. This chapter also assesses different characteristics of urban densification policies and their effectiveness in meeting environmental goals whilst ensuring that cities remain attractive in the long term.*

Key points

Cities have key competencies to act on climate change and can serve as policy laboratories for innovative responses to climate change

- Urban decision makers determine or influence public transportation systems, the built environment, renewable energy and energy efficiency policies and measures. They also oversee the sustainability of public service delivery. Cities and metropolitan region authorities are thus well positioned to develop policy and programmatic solutions that best meet specific geographic, climatic, economic and cultural conditions. Urban authorities are equally well placed to develop innovative policy solutions that, if successful, can be scaled up into regional or national programmes, thus acting as a testing ground for national pilot programmes on the urban level.
- Urban governments are taking serious action on climate change – even in the absence of national policies – through local regulations, urban services, programme administration, city purchasing and property management, and convening of local stakeholders. While some local and regional governments have taken action independently, others have benefited from guidance provided by networks of local governments and transnational networks. Important opportunities exist where cities are purchasers or service providers (water services system, capture of methane gas from landfills for energy…), but many city authorities could still make greater use of their regulatory authority to achieve climate goals.

Systematic, multi-sectoral strategic planning is required to exploit synergies between climate and other urban policy goals

- Effective climate policy packages seek complementarities among and within urban sectors to implement policies that enhance each other's effectiveness. For example, land-use zoning policies that allow for higher densities and greater mixing of residential and commercial uses can enhance transportation climate goals by reducing trip distances and frequency (and hence emissions associated with transportation) while strategic mass transit linkages can attract development and promote compact growth. Important opportunities also exist at the urban level to develop and exploit adaptation and mitigation win-wins.
- Successful policies for compact cities rely on strategic urban plans. While the higher residential densities targeted by these policies have the most direct effect on greenhouse gas emissions, transportation linkages – particularly between employment centres and residential zones – are crucial to ensuring that increases in density translate into reductions in personal vehicle use. Mixed land uses in urban neighbourhoods and high quality urban services and amenities, including open space, are also crucial to the long-term attractiveness and effectiveness of compact cities policies.
- Long-term strategic planning needs to take into account interaction between urban development and vulnerabilities to climate change. Cities and urban planning provide a key entry point to act on the adaptation agenda and reduce vulnerabilities. However, adaptation is made difficult by the fact that modifications to urban infrastructure and the built environment may be expensive, especially if not designed up front, as land-use and infrastructure changes occur only over decades and urban buildings typically last 50 to 100 years or longer. As a consequence, urban adaptation options often must be anticipated by at least a few decades to be effective. A risk management strategy that has both near and longer term co-benefits is likely to be most attractive given inevitable resource constraints.

Many cities and metropolitan regions in the OECD are taking action on climate change – even in the absence of national policy or commitments – not only out of recognition of cities' contributions to and risks from climate change, but also of the opportunities to achieve synergies and lower the potential tradeoffs between economic growth and environmental priorities. As primary locations of energy consumption, cities are searching for ways to lessen their impact on and prevent damage from climate change while also remaining economically competitive. Cities and regional governments – both small and large – are well positioned to tackle certain types of climate policies, particularly those relating to spatial development and the built environment, transportation, natural resources management, and urban utilities. How can urban areas maximise the impact of their climate activities while minimising abatement costs? This chapter discusses opportunities to most effectively apply urban resources to address climate change by prioritising: *i)* policies that are natural extensions of existing modes of urban governance; and *ii)* packages of complementary policies. This is followed by a consideration of the underlying impact of urban spatial development decisions on future energy demand and preparedness for climate impacts. Opportunities to apply long-term strategic planning to future GHG emissions and adaptation scenarios are then presented.

Urban governance and policy complementarities

A key indication of urban areas' increasing interest and sense of responsibility in responding to climate change is the proliferation of local climate plans, strategies and policies in recent years. Many cities across the OECD have identified opportunities for mitigation and adaptation activities and have implemented them through locally tailored and often innovative programmes. Cities have also set targets for greenhouse gas (GHG) reductions, some beyond national commitments, or in the absence of national action. They include for instance, London, which in its Climate Change Action Plan, established in March 2007, calls for a 60% reduction from 1990 to 2025; New York's "A Greener, Greater New York campaign", set up in April 2007, calling for a 30% reduction from 2005 to 2030, and Tokyo's Climate Change Strategy, established in June 2007, calling for a 25% reduction from 2000 to 2020. Through the US Mayors' Climate Protection Agreement, more than 1 000 mayors have agreed to meet or exceed Kyoto Protocol targets even though the US government has not ratified the Protocol.[1] While some local and regional governments have taken action independently, others have benefited from guidance and/or support provided by networks of local governments as well as, in some instances, from their national or regional governments (see Chapter 8). These include the Nottingham Declaration in the United Kingdom (signed by 300 local authorities)[2] and transnational networks such as ICLEI, the METREX $EUCO_2$ 80/50 project, and the EU Covenant of Mayors.[3] Urban climate action has also developed in response to national government mandates, such as Japan's Act on Promotion of Global Warming Countermeasures, which requires local governments to formulate climate change action plans.[4]

The context for urban policy making and programme implementation often involves multiple levels of governance. Cities often need to collaborate with other cities and higher levels of government – as well as private sector and non-governmental stakeholders – to gain the authority, technical expertise, community support and funding needed to establish and achieve their climate policy goals. This can require vertical co-ordination among local, regional and national governments, and horizontal co-ordination among the range of agencies engaged in climate policy within a local government, as well as among the local governments within a region (see Chapter 7). In some cases, the role of local governments is to administer national programmes or apply for and redistribute national funding. In other cases, urban areas act independently of outside programmes and may even innovate policy solutions that later get scaled up to the regional or national levels.

Urban areas in general engage in at least four modes of governance through which they can design and implement climate change policy responses. These (adapted from Kern and Alber in OECD, 2008 and Bulkeley and Kern, 2006) are:

i) **Self-governing: the municipality as consumer.** Sub-national governments can limit their own consumption and ecological footprint through municipal operations management, including such efforts as promoting the energy efficiency of municipal buildings and the greening of public transport vehicles.

ii) **Governing by provision: the municipality as provider.** Governing by provision is accomplished by influencing infrastructure development, programme administration and service delivery in the provision of urban services (*e.g.* transportation, water, electricity, public housing, natural resources management, etc.).

iii) **Governing by authority: the municipality as regulator.** Local governments may enact regulations to curb CO_2 emissions or adapt to climate change impacts if they have legal jurisdiction over relevant policy areas such as energy (*e.g.* through building codes), urban transport, land use, waste and other natural resources (*e.g.* wetlands and parklands management).

iv) **Governing through enabling: the municipality as a facilitator.** The municipality can facilitate co-ordination with private and community actors, such as by establishing public-private partnerships for the provision of services and infrastructure.

These modes of urban governance point to opportunities for local policy action on climate change in key urban sectors: land-use zoning, natural resources management, transportation, building, and to a lesser extent renewable energy and urban utilities (waste and water services). Self-governance particularly affects the GHG emissions and climate vulnerabilities of government-owned or managed infrastructure, buildings, property and natural resources. Governance through service provision shapes GHG emissions generated by mass transit networks, waste collection, water provision, and, in some cities, energy delivery, as well as these services' vulnerability to climate-related disruptions. City and regional regulations allow urban governments to meet climate policy goals by mandating, prohibiting, or attaching costs to activities related to land use and development, vehicle use, building energy efficiency, generation and use of renewable energy, and waste generation and management. Their proximity and familiarity with local business and interest groups puts urban governments in a position to inform and enable efforts by the local private sector, civil society organisations and individual residents to reduce GHG emissions and prepare for climate change impacts.

City and regional governments may more easily identify and combine complementary climate policies within and across sectors than higher levels of government, given the interconnectedness of urban policy sectors. The existence of a policy complementarity signals a benefit in the form of the return generated when one policy is enacted along with another (De Macedo and Oliveira Martins, 2006). Identifying the impact and benefits that policy sectors can have on each other is essential to designing policy packages that enhance the effectiveness of each individual policy. Some urban sectors are particularly interlinked to others, and thus can enhance or undermine the effectiveness of other sectoral policies. As Table 4.1 and Figure 4.1 present, land-use zoning, *i.e.* the decisions

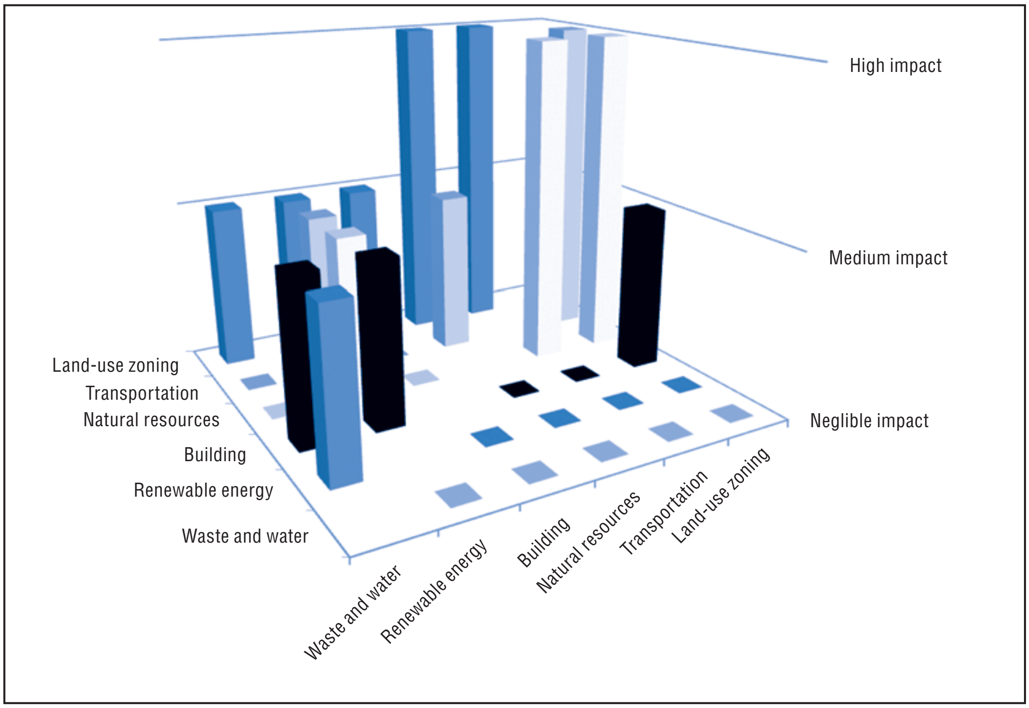
Table 4.1. **Urban sectoral interactions: Potential for climate policy complementarity and tradeoffs**

Impact → (reads horizontally)	Land-use zoning	Transportation	Natural resources	Building	Renewable energy	Waste and water
Land-use zoning *Land-use zoning determines the density, height of buildings, and proportion of undeveloped land on each property.*	–	Segregation of land uses impacts travel distances and frequency; transit-oriented development zones encourage use of mass transportation.	Zoning designates natural resource areas that may be set aside to reduce vulnerability to flooding or urban heat island effects.	Zoning impacts placement and density of buildings, which in turn impacts building energy efficiency and vulnerability to flooding and urban heat effects.	Zoning density can constrain on-site renewable energy production but can also increase efficiency of service delivery.	Zoning density can determine the efficacy of delivery of waste, recycling and composting services; and the energy required for and efficacy of delivery of water services.
Transportation *Transportation policies determine the development and extension of road and mass transportation networks.*	Transportation infrastructure policies shape demand for land and acceptance of density increases.	–	Transportation systems impact natural resource and preserved zones.		Transportation policies can require renewable energy sources for mass transportation systems.	
Natural resources *Natural resource policies determine which areas are preserved from development and what uses are acceptable on them.*	Natural resource policies determine the limits of developed land-use zones and can improve quality of high-density zones.	Natural resource policies affect the placement of road and mass transportation infrastructure.	–		Natural resources endowment makes certain renewable energies possible.	
Building *Building policies, including building codes, affect building materials, construction types, and other physical conditions.*	Building codes can increase acceptability of high-density zones by requiring design features to improve quality of high-density structures.			–	Building codes can require the on-site generation of renewable energy.	Building codes can require design and building materials that produce less construction waste and reduce water consumption in buildings.
Renewable energy *Renewable energy policies can increase on-site renewable energy production and share of energy produced by renewable sources.*					–	Renewable energy production can involve high water consumption.
Waste and water *Waste policies determine the means and extent of waste disposal. Water policies determine service extent, pricing, and water sources.*						–

Note: Policy sectors with no shading demonstrate highest impact. Policy sectors with shading demonstrate lower impact. Policy sectors with dark blue demonstrate negligible or no impact.

regarding the location and density of residential, commercial, industrial land uses, among others, has the widest influence on other sectors. Transportation policies are also interlinked with land-use zoning, natural resources management and use of renewable energy, as they affect the amount and type of energy required to travel between activities within a metropolitan region as well as the impact and vulnerability of transport infrastructure relative to the surrounding environment. Policy complementarity within

Figure 4.1. **Urban sectoral interactions: Impact on other sectors' climate policies**



StatLink http://dx.doi.org/10.1787/888932342468

each sector is also crucial, and more easily co-ordinated at the urban scale. For example, transportation polices to limit personal vehicle use are enhanced by policies to increase mass transportation options, two areas where municipal governments often have the authority and capacity to act.

Land-use zoning policies

Land-use zoning policies have a wide-ranging, long-term and yet underlying effect on sectoral policies to address climate change. Spatial planning affects the placement of the built environment, and therefore the distances required for urban travel, the energy required to heat and cool buildings, and the vulnerability of the built environment. Urban master plans and land-use zoning policies determine the set of land uses that are allowed in a particular zone – at the most basic level these include residential, commercial, industrial, open space and mixed uses – and the degree to which land uses are separated from one another. These decisions shape the built environment and determine long-term travel patterns, building placement, access to amenities and exposure to natural hazards. This section presents the impact of land-use zoning policies on other sectoral climate change policies; the following section discusses the impact of density and "compact city" policies.

Land-use zoning policies impact transportation GHG mitigation policies by determining the degree of segregation among land uses and therefore the energy required to travel between home, work, shopping and other activities. The degree to which these uses may be segregated varies with how restrictively zones are defined. For example, German residential zoning is often more flexible than its American counterpart, as it allows for doctors' offices, hostels, small hotels, and multi-story apartment buildings to be co-located, while most residential zones in the United States are restricted to single-family dwellings (Buehler *et al.*, 2009). The establishment of mixed-use zones, which allow for the development of a combination of business and residential uses, is one way of providing alternatives to segregated zoning. However, where mixed-use zones are not the norm, such as in the United States, they are typically only applied in specially designated districts where their impact is limited (Hirt, 2007).

Land-use zones that allow for transit-oriented development can facilitate increased use of public transportation (Hankey and Marshall, 2010; Ishii *et al.*, 2010). While it may not change trip distances or frequencies, it can decrease the distances between mass transit stations and residences, places of work and retail. The City of Toronto has created policies to encourage or require mass-transit oriented development, in addition to policies to facilitate density in the urban core and mixed-use (residential and commercial) development.[5] The City of Toyoma, Japan, is pursuing transportation-oriented growth by concentrating city functions such as residential, commercial, business, and cultural facilities along a newly established light rail line, built over an underused long-distance rail line (Mori in OECD, 2009b). Arlington County, Virginia, promotes transit-oriented development around the light rail system by providing density credits that allow for higher density buildings, increasing parking requirements and improving infrastructure around transit stations. As with mixed-use zones, transit-oriented development zones are often exceptions to traditional land-use zones and therefore can be limited in their reach. Comprehensive reform may require an overhaul of residential zoning codes to systematically allow non-residential uses rather than the piecemeal designation of mixed-use zones (Hirt, 2007).

Land-use planning tools also have a fundamental impact on natural resource management. They present a primary means for cities to adapt to potential climate change impacts, including reducing vulnerability to flooding and other extreme weather events (Wilson, 2006). Local government disaster management plans are being updated to take into account potential impacts and vulnerability assessments. The Finnish cities of Espoo and Helsinki have mandated that new planned areas be 2.6 metres above sea level, and that the lowest floor level of new buildings be 3 metres above sea level (Voutilainen, 2007). Planners in the United States have introduced the concept of "rolling easements", hich could be used to discourage development of coastal areas by granting a public right-of-way to a narrow portion of coastal property, which migrates inland as the shore erodes. This prevents coastal land owners from erecting structures to block sea level rise and transfers the impact of sea level rise to the private land owner (Titus and Narayanan, 1996). The most immediate impact of the policy would be to discourage new coastal development in areas vulnerable to coastal flooding (US Global Change Research Programme, 2009). In urban areas in developing countries, the process of integrating adaptation into development policies generally involves combining two separate but linked processes: *i)* understanding the nature of local climate risks and choosing targeted adaptation options; and *ii)* formulating and implementing development policies that are beneficial to adaptation (OECD, 2009c) (Box 4.1).

Land-use policy can also support building policies that increase energy efficiency. Residential zones restricted to single-family dwellings, common for instance in the United States, can greatly restrict the availability of multi-family and row housing, both of which typically are more energy efficient per capita than detached single family dwellings. Land-use policy tools that promote multi-family or compact housing zones can also facilitate the use of district heating and cooling systems by allowing service to a greater number of customers in a given area than would be possible in a single-family residential zone. Land-use policies can also aim to reduce urban heat island effects, as the cities of

Box 4.1. **Integrating adaptation into development planning**

Donors and international agencies can support the development of climate change adaptive capacity within urban settings through the development planning process in a number of ways. They could:

i) Review sectoral priorities in light of climate change, such as drawing the attention of partner governments to the urgent need to increase funding for infrastructure, as the deficits in urban infrastructure provision and maintenance are serious constraints to adaptive capacity.

ii) Explore different options for channelling funds and stakeholder engagement to build local adaptive capacity (*e.g.* by supporting municipal infrastructure funds).

iii) Support decentralisation processes that transfer authority to elected local governments. Support for decentralisation should be coupled with efforts to enhance local government capacity to take up the responsibilities afforded by decentralisation.

iv) Increase support to civil society organisations. Because these organisations interface most directly with communities, they represent a key constituent in local-level adaptation.

Source: OECD (2009a), *Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance*, OECD, Paris.

Stuttgart, Freiburg and Mannheim, Germany have demonstrated. These policies include regional plans that provide minimum standards for open spaces, including a minimum width of 500 metres for “green corridors” and 250 metres for “green breaks”.[6]

Many metropolitan regions have used land-use planning to create “sustainable neighbourhoods” or “eco-neighbourhoods” that combine transportation, natural resource preservation, building, energy, waste and water policies to respond to climate change and reduce the urban environmental footprint. Common principles include increasing energy efficiency and renewable energy generation, using sustainable building materials, and reducing personal vehicle use. The most notable “eco-neighbourhoods”, either completed or currently under development, are located in western and northern Europe, including in Sweden (Bo01 and Augustenborg in Malmö and Hammarby Sjöstad in Stockholm); Finland (Viiki in Helsinki); Germany (Vauban and Rieselfeld in Freiburg; Kronsberg in Hanover); Denmark (Vesterbro in Copenhagen); the Netherlands (Leidsche Rijn in Utrecht); and Great Britain (BedZED in Beddington, zero-carbon communities [Box 4.2]). However, eco-cities are also under development in Korea, China and Abu Dhabi. Residential density varies among sustainable neighbourhoods projects, although most could be described as low-rise high density; towers or high-rise apartments are rare. Sustainable neighbourhoods shape development beyond residential density; cars may be restricted or prohibited (such as in Vauban) and waste collection policies that are more restrictive than elsewhere in the city may be imposed.

Transportation policies

Transportation is a key sector for reducing GHG emissions, while transportation infrastructure is also vulnerable to climate change impacts in key ways. The transport sector is a significant and growing contributor to GHG gas emissions. Transport activity is responsible for 13% of all anthropogenic emissions of GHG gases and 23% of world CO_2 emissions from fossil fuel combustion – this share rises to 30% in OECD countries. In most countries, transport CO_2 emissions are growing faster than total CO_2 emissions: CO_2 emissions from fuel

Box 4.2. **The United Kingdom Eco-Town Programme**

The United Kingdom Government's eco-town programme has been developed as a response to the challenges of climate change, the need for more sustainable living, and an acute shortage of affordable housing. The plans are for five eco-towns by 2016 and up to 10 by 2020, as part of larger plans to build three million homes by 2020. Eco-towns will be new settlements of between 5 000 and 20 000 homes, with good links to existing towns. At least 30% of the new homes will be affordable housing, and all new buildings across the developments are expected to be zero-carbon and to promote sustainable and healthy living.

In July 2009 the Government announced the locations of the first four new eco-towns. They are Rackheath (Norfolk), north-west Bicester (Oxfordshire), Whitehill Bordon (East Hampshire) and the China Clay Community near St. Austell, Cornwall. Plans at the four confirmed sites are proposed or supported by local authorities. The developments – which will include 4 000 homes on a disused airfield at Rackheath and 5 000 in the Cornwall eco-town – must still go through the planning process. Construction is expected to be underway by 2016. A second wave of at least six eco-towns is planned. The government is making up to GBP 5 million available for councils to conduct further planning work on these proposals.

Source: Thorpe in OECD (2009b), *Green Cities: New Approaches to Confronting Climate Change, OECD Workshop Proceedings*, conference held 11 June 2009, Las Palmas de Gran Canaria, Spain.

combustion in OECD countries grew 17% from 1990 to 2005, while transport CO_2 emissions grew by 30% over the same period (ITF, 2008). Transportation infrastructure is also vulnerable to climate change impacts such as flooding and high temperatures. Public transportation systems are at risk for flooding due to storms and rising sea levels, particularly in – but not limited to – coastal areas. Heat extremes can also damage roadways, bridges, and rail lines that were designed for lower maximum temperatures.

The urban transportation sector presents key opportunities for national, regional, and local governments to reduce GHG emissions and adapt to expected climate change impacts. Key transportation policies to reduce GHG emissions or adapt to climate change impacts aim to:

i) increase use of public transportation systems;

ii) decrease personal vehicle use and manage traffic demand;

iii) support non-motorised means of travel (*e.g.* pedestrian or bicycle);

iv) increase vehicle fuel efficiency and use of alternative fuels;

v) prevent disruptions to transportation system due to flooding; and

vi) prevent disruptions to transportation system due to extreme temperatures.

Local and regional governments deploy policy tools to meet these goals in their capacity as regulatory authorities, managers of public transit systems and road networks, purchasers, and enablers of local non-governmental action. National governments may deploy policy tools through local governments by regulatory mandate, funding or incentives. A key distinction should be made between policies that impact accessibility, or the ability for people in urban areas to gain access to employment, retail, services and activities, and policies that impact mobility, or the ability to travel a given distance. Policies to reduce GHG emissions from vehicles may reduce mobility by discouraging personal vehicle use and increasing mass transit use, while land-use policies to increase proximity to urban amenities and a mixture of commercial and residential land uses can improve accessibility.

Local governments can discourage personal vehicle use by using their authority to regulate vehicle circulation, parking and speed limits, but alternative transportation modes must be provided to maintain cities' competitiveness. Measures to discourage personal vehicle use include restrictions on personal vehicle use in designated zones or during certain times of day, increased parking fees or reduced parking spaces, and reduced speed limits in certain zones. These restrictions are most likely to be applied in central business districts and regional employment or retail centres (Cambridge Systematics, Inc., 2009). Restrictive policies should target zones that strongly attract employees or consumers and therefore can compete with areas that are more easily accessible by personal vehicles. Policies to discourage personal vehicles should be combined with policies to increase mass transit service, quality and multi-modal linkages to maximise both policies' effectiveness (ECMT, 1995). Local governments can also promote the co-benefits of such restrictions, which include reduced congestion, increased walkability, and increased safety, to gain support from local stakeholders for such reforms. As a self-governing entity, cities can also encourage through incentives, or in some cases require, city employees to restrict personal vehicle use.

As providers of public transit, local and regional governments can increase the use of public transit systems by focusing on improving quality, increasing linkages with multiple modes, expanding service and increasing efficiency of operation to lower consumer costs and increase attractiveness. For example, in recent decades there has been a growing focus on better management and expansion of existing public transport networks in order to improve their quality and reliability (Poudenx, 2008). Public transit agencies can increase quality through measures such as physical improvements to make the system more attractive and feel safer, and improvements to better communicate service times and delays to customers (ECMT, 1995). For example, many local transportation agencies, including those in Stuttgart and Paris, have implemented real-time signage systems to communicate expected arrival times to mass transit customers. The City of Beijing aims to achieve a 40% share of public transport use, which would build on an increase in market share from 30% to 39% over 2005-08, by expanding public transit service, improving quality and providing linkages to other travel modes (Liu *et al.*, in OECD, 2009b). Local governments could do more to prioritise demand-side policies to improve management, regulation, information and pricing. To improve linkages between multiple modes of travel, multiple local agencies often need to co-ordinate service delivery, which requires effective regional co-ordination on transportation planning.

Improvements to the public transit system need to be carefully planned to provide attractive alternatives to personal vehicle travel and to maximise co-benefits while minimising potentially negative impacts. Increasing the use of public transit systems provides important co-benefits, but does not guarantee a reduction in personal vehicle use. Actually reducing personal vehicle use requires service expansion and improvements that present viable alternatives to personal vehicle travel. By reducing time and costs spent on travel, an expansion of public transportation systems can make areas of economic or social activities more accessible thereby increasing the market size for related goods and services; make industrial activities more productive and competitive; and connect previously isolated consumers to the public transportation market. The expansion, operation, and maintenance of transport infrastructure are also regional jobs providers (OECD, 2002). Routes must be carefully planned to target concentrations of employment, retail and social activities and residential neighbourhoods, without increasing demand for undeveloped land. Public transportation system expansion can create winners and losers, both in terms of social classes and economic activities, by making some activities more accessible but not serving others. Expanding services can also result in higher property rents in newly served areas. Noise and other potential environmental impacts, such as pollution from buses, may aggravate discrepancies in pollution and other environmental hazards depending on the location and concentration of expanded services (OECD, 2002).

Local governments can use their authority over the design and management of a city's road system to increase the share of non-motorised means of travel, particularly biking and walking. Local governments can eliminate traffic lines lanes or use "traffic calming" strategies, such as replacing intersections with traffic rotaries and enlarging sidewalks, to both discourage driving and encourage foot travel. Local governments can also make structural improvements to encourage travel by bicycle. While city-operated shared bicycle rentals, such as Paris' Vélib', Rio de Janeiro's Samba and Montreal's Bixi have been highly promoted for their potential to reduce GHG emissions, the corresponding efforts to facilitate bicycling, including the creating of protected bicycle lanes and clear signage of bicycle routes, may have a more significant impact on the attractiveness of bike travel.

In their capacity as purchasers and regulators, local governments can increase city-owned vehicle fuel efficiency, although their impact may be limited. Many cities have included policies requiring the purchase of hybrid or alternative-fuel buses and other vehicles in the local government fleet. The City of Toronto, for example, has established the Green Fleet Plan, which has already resulted in an over 10% reduction in emissions from use of the city's 4 000 vehicles.[7] While it is simpler for local governments to influence their own purchases than those of their residents, governmental fleets seldom constitute more than 1% of GHG emissions within most jurisdictions. Climate policies that focus on reducing government-owned vehicle emissions are therefore not a substitute for comprehensive approaches to urban transport emission reductions. Regulations to lower and strictly enforce speed limits and prevent engine idling, both of which increase fuel efficiency, may be more effective in reducing GHG emissions reductions than other regulatory policies such as those that discourage personal vehicle use through parking and driving restrictions (Cambridge Systematics, Inc., 2009; Ewing *et al.*, 2008). However, the average optimal speed for fuel efficiency in most cars may be higher than typical city speed limits, making it difficult for urban areas to realise GHG emissions reductions through speed restrictions. Local governments may have greater opportunities to enact policies to restrict engine idling, because these regulations are most easily incorporated into existing enforcement of parking restrictions.

Local governments can also decrease personal vehicle use by enabling alternatives through programme co-ordination and technical assistance. Cities can facilitate the use of alternatives to personal vehicle use through programmes such as the City of Toronto's Smart Commute Programme, in which the city works with large employers to develop plans that encourage their employees to utilise alternate forms of transportation.[8] Some cities have also begun to provide shared-car services through concessionaries, including the City of Hanover. While cities influence individuals indirectly when they work with employers to create employee travel plans, Cambridge Systematics, Inc. (2009) estimated that employer-based commute strategies (including vanpools, employee parking pricing and tele-work policies) can result in an up to 1.7% reduction in baseline GHG emissions, similar to their estimates for congestion pricing. The actual impact of employer-based strategies on GHG emissions depends of course on the scale at which they are implemented (Cambridge Systematics, Inc., 2009).

Cities can also take the lead on promoting use of renewable fuels for transportation and discouraging fossil fuel use by increasing the share of renewable energy used for mass transit systems (Box 4.3) and supporting the development of new technologies (see Chapter 7 example of development of the Philias low-emission public transport vehicle assisted by the Samenwerkingsverband Region in the Netherlands). Others provide funding, such as the City of Paris' programme providing EUR 400 to purchasers of electric motorcycles (City of Paris, 2009a).

Box 4.3. **Calgary's electric light rail powered by wind**

The City of Calgary's light rail transit system, the C-train, with electric drive motors powered by overhead electric wires, transports around 200 000 passengers daily. Strong westerly winds coming from the Rocky Mountains led to the development of a twelve 650 kW turbine wind farm to the south of Calgary. Changes in the regulations that govern the sale of electricity in Alberta now allow anyone to buy electricity from companies producing wind power. A partnership between the city, the local energy supply company ENMAX Power Corporation and Vision Quest Windelectric Inc. resulted in the City of Calgary announcing the Ride the Wind!TM programme in September 2001. The council took the decision to buy commercial wind power as the primary source of the C-train's electricity at an additional cost of around CAD 0.005 per passenger trip. The greenhouse gas emissions from operating the train are now effectively zero. This was the first light rail system in North America to, in effect, run on wind power. A high speed train between Calgary and Edmonton is now under evaluation and could theoretically also be powered by renewable electricity.

Source: IEA (2009), *Cities and Towns and Renewable Energy – YIMFY: Yes In My Front Yard*, © OECD/IEA, Paris, Box F, p. 92.

Reducing infrastructure vulnerability to climate change impacts poses a key challenge for local and regional transportation authorities. Preventing disruptions due to flooding is chief among these concerns. It is vital for cities to clearly assess and plan for sea-level rise, storm-surge and other storm impacts that exceed existing 100-200-year plans. Below-ground transportations systems are particularly susceptible to water damage. Effects from extreme temperatures can also disrupt mass transit systems if they exceed the heat thresholds for which roadways and public transportation systems have been designed. Currently, most transit system agencies have not yet started making improvements to infrastructure, although some cities have developed plans for protecting underground transit systems from coastal flooding. Concern about climate change impacts is also beginning to shape future infrastructure development. For this reason, nationally funded local infrastructure projects in Switzerland have to comply with climate change standards mandated by the Swiss Federal Department of the Environment, Transport, Energy and Communications.[9] While adaptation plans and taking climate change impacts into account in new infrastructure are important steps, system-wide vulnerability assessments and large-scale retrofitting are needed to respond to impacts that are expected to exceed existing worst-case infrastructure planning scenarios.

An assessment of local initiatives that aim to reduce personal vehicle use, increase use of non-motorised travel, and adapt to anticipated climate change impacts should take into consideration policy complementarity, the scale of policy impact and the opportunities for co-benefits. Policies to lower speed limits, prohibit idling and enable employer-based commute plans are easily implementable on a wide-scale on the local level and have demonstrated significant impacts on GHG emissions. Policies to increase demand for public transportation through improvements to quality, communication and linkages, and physical improvements to calm traffic and ease bike and foot travel may require additional investment but can provide important co-benefits in the form of reduced congestion, decreased pollution, increased health, and reduced time and cost associated with local or regional travel.

Transportation policies can enhance policies in other sectors as well as within the transportation sector. Transportation policies can be designed to support strategic territorial plans by prioritising service in compact and high density zones. Transportation policies also have an impact on land-use zoning policies and natural resource policies as transportation networks can increase the value of the properties they serve and can improve the perceived quality of high density developments. On the flip side, expansions in road and rail services can also lead to demand for suburban land, which can increase urban sprawl and put pressure on urban natural resources. However, these measures can provide co-benefits in the form of a wider set of sustainability objectives, such as congestion mitigation, improved air quality and better accessibility. Taking advantage of policy complementarity requires transportation decision making to become more multi-sectoral and to co-ordinate with other local and regional, and in some cases national policy makers.

Natural resources and environmental management

Local governments can accomplish climate goals in their roles as land owners and land managers of a range of infrastructure and environmental services. These include planning and managing parks and other outdoor spaces, and providing other protective natural infrastructure. Natural resource policies can be applied to reduce energy demand, absorb CO_2, and protect against climate impacts. Natural resource policies can also enhance the effectiveness of land-use zoning policies by improving the quality of high-density areas through provisions of green space. Natural resource policies, and in particular wetland protection and urban forestry programmes can also play an important role in adaptation by providing natural buffers for storms, in addition to mitigation benefits by removing CO_2 from the atmosphere.

Local governments are making use of their jurisdiction over environmental features within their boundaries to protect developed land from potential climate change impacts. For coastal cities, public investment for flooding protection is a primary adaptation tool. Examples include Venice (Box 4.4), New Orleans, Helsinki and Rotterdam. These investments are not without controversy, however, as they can lead to the destruction of ecological resources in order to protect the built environment. Parks and natural spaces can also be used as an adaptation measure, by planning new parks in areas that are most vulnerable to flooding. A number of cities and regions including the City of Dresden, Germany, and the Dolnoslaskie Region, Poland, are implementing adaptation programmes to prevent flooding, minimise and manage rain water and storm water.[10] Through national hydraulic engineering and forestry legislations, the Swiss federal government is providing funding at the canton level for protective measures against natural hazards, which is matched by funding from cantons, municipalities, and infrastructure owners.[11] Other cities are increasing their capacity to assess potential impacts. The coastal city of Shenzhen, China, has developed a network of 2 000 automatic meteorological data collection stations, to provide a monitoring range of 250 km (OECD, 2010a). Because environmental zones do not often fall within city boundaries, adaptation planning and management often requires horizontal co-ordination with multiple local governments within the same region as well as vertical co-ordination with regional and national governments.

Box 4.4. **Venice's MOSE flood protection system**

The City of Venice has undertaken massive infrastructure improvements to protect the city from rising sea levels and more extreme storm impacts, at a cost of EUR 4.272 billion. The main aim of this complex system of mobile dams and permanent works is to protect the cities of Venice and Chioggia, the lagoon's historical centres, and the broader lagoon basin from the detrimental effects of medium-to-high tides and the devastating effects of exceptional storm surge tides. MOSE is a series of projects under the broader General Work Plan for the Safeguard of Venice and the Lagoon, started by the Italian Ministry for Infrastructure in 1987 together with Venice's *Magistrato alle Acque* (the operational branch of the Ministry for the lagoon), which exemplifies the largest plan ever for the defense, recovery and re-qualification of the environment carried out by the Italian State. The MOSE includes several complementary public works to safeguard Venice, such as:

- 1 400 hectares of tidal mudflats and salt marshes and sandbars have been reinstated and protected.
- 35 km of industrial channels and five former landfills have been protected.
- 100 km of embankments have been raised.
- 45 km of beaches have been rebuilt and 10 km of wharfs have been restructured.

The MOSE's mobile dams will protect Venice and its lagoon from tides up to 3 metres high and from an increase in sea level of at least 60 cm, which could occur over the next 100 years. Even when the dams are up, the port's operations will still be ensured, thanks to the construction of a large shipping lock at the mouth of the lagoon.

Source: OECD (2010b), *OECD Territorial Reviews: Venice, Italy*, OECD, Paris; Paruzzolo in OECD (2009b), "Green Cities: New Approaches to Confronting Climate Change", *OECD Workshop Proceedings*, conference held 11 June 2009, Las Palmas de Gran Canaria, Spain.

The natural environment of the urban landscape is also often included in climate plans as a means of absorbing CO_2 and reducing overall urban GHG emissions, as well as reducing potential urban heat island effects. The City of New York's PlaNYC Climate Plan includes a goal of planting an additional one million trees by 2030, and filling all available spaces for trees. The plan sets a goal of planting 23 000 additional trees annually (City of New York, 2007). Sejong City, a new city in Korea that will be completed by 2014 with an expected population of a half million by 2030, plans to reduce average city temperatures by 2.5 °C by devoting over half of its total surface area to parks, greenbelts and waterfronts and operating a water circulation system that draws on natural water resources (Sejong City, 2009). Tokyo has initiated policies to support greening projects that include tree-lined streets and rooftop greening. In São Paulo, the development of Linear Parks along waterways has served to minimise flooding effects, reduce water pollution, and absorb CO_2 by planting of more than half a million trees in over four years (Sobrinho in OECD, 2009b).

Building policies

Energy demand from buildings represents a significant share of cities' energy-related emissions in OECD countries; at the same time, the built environment is also vulnerable to climate change impacts. The share of energy demand from residential and commercial buildings can be much higher in cities than in worldwide figures. For example, GHG emission from buildings in the City of New York were estimated to account for 79% of the city's total emissions in 2005 (City of New York, 2007). While contributing to climate change, the built environment is also vulnerable to anticipated climate impacts, including urban heat-island effects, flooding, and related extreme weather events. Building location and design can add to the negative outcomes of urban heat-islands. The increased frequency and severity of flooding will threaten buildings that were located in areas previously believed to be at lower risk of flooding. Urban planners, architects, engineers and urban policy makers are now in the position of dealing with the dual challenges of designing and constructing urban zones that both curb energy consumption (and thus GHG emissions) and can cope with future climate change impacts.

National, regional, and local governments can deploy a range of building policies to assist local authorities, reduce GHG emissions and adapt to climate change impacts. Building policies that regularly demonstrate GHG emissions reductions aim to:

i) increase building energy efficiency through design, placement, construction materials and retrofitting with energy-saving devices; and

ii) increase local share of renewable and captured energy generation.

These measures all have the potential to reduce CO_2 emissions from building heating and cooling while simultaneously providing co-benefits in the form of reduced energy prices for energy consumers, reduced risk of blackouts during extreme heat events, and health benefits associated with reducing air pollution from unnecessary electricity and heat generation. In addition to this, building policies for adaptation aim to:

i) adapt to flooding and extreme storm events by requiring minimum ground clearances; and

ii) reduce urban heat island effects by requiring or encouraging "cool roofs".

Regional and local governments often implement these tools in their capacity as regulators of building codes, providers of building services, fiscal authorities, building and property owners, and enablers of local non-governmental action. National governments deploy these tools through local governments by regulatory mandate, subsidies, incentives and technical assistance.

As illustrated in Table 4.1, building policies impact or benefit other sectoral policies to a lesser extent than, for example, land-use zoning policies. However, they can enhance other sectoral policies in a few key ways. Design requirements, such as minimum setbacks from the street, can increase quality of residential development and therefore the acceptability of increased multi-family zones and higher residential density in land-use zoning plans. Building policies can require or encourage on-site generation of renewable energy in new developments, which can enhance renewable energy policies. Building policies can also contribute to water and waste policies by requiring or encouraging water conservation as well as designs and building materials that produce less construction waste.

Building codes are the primary means for increasing building energy efficiency in new buildings. Through building design and placement criteria, they can require reducing the demand for energy to light, heat and cool buildings. Their regulatory approach can be seen as an effective way for achieving a given goal of energy efficiency of new buildings (OECD, 2003). For example, because they are applied equally to owner-occupied and rented buildings, they can pre-empt the disincentive that owners and renters of rented buildings face in making energy efficiency investments.[12] They can also facilitate the meeting of specific targets. For example, the City of Shenzhen became in 2006 the first Chinese city to establish building energy efficiency regulations, and has since set targets of 20% energy reductions for retrofitting existing buildings and 50% reductions for new construction (OECD, 2010a). On the other hand, the effectiveness of building codes is often constrained in several ways. First, as building codes typically apply only to new construction and renovations, their benefits are only felt over the long-term (IEA, 2005). Second, while most of the OECD countries now include national energy efficiency requirements in their building codes for all new buildings, city or regional building regulations to apply more stringent efficiency standards often apply only to projects over a certain size.[13] Third, due to strong opposition of stakeholders, it is often difficult to set energy efficiency requirements strict enough to effect significant reductions in GHG emissions or real protections against climate change impacts (OECD, 2003). Fourth, building codes may discourage innovation because developers rarely have an incentive to exceed efficiency standards (IEA, 2008a). Performance-based codes, which set a total requirement for the building based on the supply of energy or the resulting environmental impact, may provide more incentives for innovation, but require a comprehensive and reliable method for calculating the energy performance of a building (IEA, 2008a). Finally, and perhaps most importantly, the effectiveness of building codes can vary significantly due to difficulties and resulting differences in compliance and enforcement (UNEP, 2007).

While some local authorities have added their own energy efficiency standards to their building codes, these can often be limited in their scale, impact and implementability, and therefore may be well suited to a package of national building codes and programmes. National building energy efficiency standards can reduce the risk of regional competition based on building codes and could potentially result in more uniformly strict standards across cities. National regulations can even take the lead in place of local policy, if ambitious goals are set. In Germany, it is now national policy for new construction of commercial buildings to attain a minimum performance of 110 kWh per m^2. Beyond codes, building-related policies afford a wide array of opportunities for collaboration among multiple levels of government (Box 4.5).

Supporting building retrofitting or the installation of energy-efficient technologies can be an effective instrument for local governments to reduce GHG emissions from existing buildings. The City of Berlin has pioneered a model for improving energy efficiency in buildings in which the city project-manages the retrofit of public and private buildings by contracting with energy service companies to implement efficiency retrofits to achieve an average of 26% reduction of CO_2 emissions (C40 Cities, 2009); the City of Toronto has provided technical support for owners of large facilities to retrofit their buildings for energy efficiency through its Better Buildings Partnership and Sustainable Energy Funds.[14] The benefits of such projects are greatest where heating and cooling loads are high. While retrofit programmes present an opportunity to have an impact on the energy demand of the built environment, governance of such programmes can be more complicated. Building

Box 4.5. **Multi-level governance building efficiency programmes**

- **The Crown Energy Efficiency Loan, in New Zealand,** is a financial instrument to assist central and local government agencies to implement energy efficiency projects. It complements the 2007 National Energy Efficiency and Conservation Strategy, which required 10% improvement in in-house energy efficiency in central and local government over five years. Local authorities and other public agencies borrow funds from the government which are repaid over five years; ideally, loan repayments are structured such that the energy cost savings exceed the cost of the loan repayments. The Crown Energy Efficiency Loans finance energy efficiency measures previously recommended by audits carried out by independent energy experts, and are allocated based on the project's cost effectiveness, projected CO_2 emissions reductions, contribution to renewable energy, potential for replication by public and private sectors, and co-benefits. As of June 2008, loans exceeding USD 23 million have been granted to 230 projects to achieve estimated cost savings of USD 60 million and reductions in CO_2 emissions of nearly 23 000 tonnes per year – the equivalent of taking 6 500 cars off New Zealand roads.
- **The Low Income Retrofitting Project, in Greece,** is an initiative of the national government in co-operation with municipalities to improve energy efficiency in homes built before the 1980s for families with incomes of less than EUR 60 000 a year. The national government works with national associations of private businesses and the local community (municipalities and directly with private business) to identify and inform low-income households about this project. The project focuses on increasing energy and cost savings through projects by increasing the energy efficiency of insulation, windows, and heating, and by installing solar collectors and cool roofs. The Ministry of Development created an agreement with national business associations to freeze the costs of these services for two years. The programme is evaluated through an "auto-verification" scheme in which the associations must evaluate whether their industry members are implementing technologies that meet the national standards – which can result in a conflict of interest.
- **Upper Austria's Regional Market for Third-Party Financing** (TPF) links municipal and private energy efficiency projects with financing in order to remove the barrier of high upfront investment costs. This programme originally linked municipalities with investors interested in financing energy efficiency renovations in public buildings, and was later expanded to link building, lighting and renewable energy projects in the public and private sectors with energy financing. TPF projects look to Energy Service Companies (ESCOs) to provide pre-financing energy-conservation schemes. ESCO guarantee that energy costs will be reduced by a certain percentage after energy improvements are made. Subsequent energy savings are then used to cover investment costs over an agreed pay-back period (typically 10 to 15 years). Out of eleven participating ESCOs, two are publicly owned; the rest are private. ESCOs are responsible for financing energy-saving measures as well as implementation, operation and maintenance. Municipalities enter TPF projects on a voluntary basis and are responsible for collecting all relevant data prior to setting up the project. Depending on the status of the owner, the regional government may fund the upfront investment costs for energy performance contracts up to 12% in the case of private owners, and up to 20% for municipalities. The upper limit in both cases is set at EUR 100 000 per project. Funding comes on top of other State (Upper Austria) subsidies. The budget comes from the broader climate change programme of Upper Austria.

Source: IEA (2009), *Innovations in Multi-level Governance for Energy Efficiency: Sharing Experience with Multi-level Governance to Enhance Energy Efficiency*, IEA, Paris, pp. 56, 103 and 114.

retrofits are less well suited to implementation through building codes; uniform performance requirements in building codes could be too burdensome for some existing buildings, and may be more appropriate for policy instruments such as public-private partnerships and grant programmes. They also require a good monitoring system and a competitive energy performance contracting industry (IEA, 2008a). Energy efficiency technical assistance programmes are a key vehicle for national assistance on the local level. Public-private partnerships can also result in the construction of buildings that are energy efficient by design, such as in the case of the Kronsberg Passive House Estate in Hannover, Germany.[15]

Building retrofitting, or the installation of energy-efficient technologies in local government-owned properties have become widely adopted into local climate action plans (Wheeler, 2008), and are often easier to implement than policies for private buildings. Depending on the scale of the intervention, self-governing and purchasing policies can have a wide impact on city building efficiencies; they can also serve as a model for privately funded energy efficiency projects. These projects can require co-ordination among multiple local government agencies. For example, cities in Japan provide matching funds to public schools that have made energy efficiency improvements, in the amount of half of the projected annual cost savings (Sugiyama and Takeuchi, 2008). Many governments have undertaken retrofitting local street lighting, including Graz, Austria, Gwalior, India and Stockholm, Sweden. While not typically subject to building policies, efficient street lighting programmes reflect the focus on improving the energy efficiency of government-owned properties. In the case of Graz, investments were pre-financed and refinanced from the energy cost savings, which are paid off over 15 years, while in Stockholm an investment in light-emitting diode (LED) traffic signals is expected to pay off within 10 years (IEA, 2008b).

Programmes to require or enable use of renewable or captured energy sources in buildings can have a large-scale effect on demand for low-emissions energy sources. Barcelona's "Solar Thermal Ordinance", which requires all new buildings and major renovations to use solar thermal collectors to supply at least 60% of the energy used to heat water, led to similar ordinances in over 60 other Spanish municipalities. In the Greater London area, building codes requiring renewable energy generation have expanded to communities across the United Kingdom (Box 4.6). District heating and cooling systems, which capture heat produced in energy generation to heat or cool water for all buildings connected to the systems, have the added benefit of being able to be applied incrementally at appropriate scales. Moreover, given that district energy systems connect to both new and existing buildings, they are an effective way of altering the energy demand of the existing building stock. One of the earliest district heating systems, in Copenhagen, provides 97% of the city's total heating needs. The cities of Stockholm, Sweden and Mannheim, Germany provide other examples of district heat generation, including through the use of biofuels. The City of Toronto, Canada, has enabled the creation of a district cooling system by establishing a corporation that has connected most of the major downtown office buildings to a deep lake water cooling system and which has resulted in a significant decrease in electricity demand for air conditioning.[16] Regulatory changes requiring buildings within a designated zone to connect to the system allow district heating and cooling projects to realise energy efficiency gains for a large number of energy consumers. For example, MVV Energie in Mannheim, Germany, makes more money selling hot water than it does electricity, due to the efficiencies of its system. However, potential price inefficiencies may exist if the projects receive significant government subsidies (Agrell and Bogetoft, 2005).

Box 4.6. **The Merton Borough initiative**

Known as the "Merton Rule" after being first introduced by the London Borough of Merton in 2003, it is a prescriptive planning policy regulation that requires developers of all new buildings in the district to plan to generate at least 10% of their predicted future total annual energy demand (for heating, cooling and electrical appliances) using renewable energy equipment that is integrated into the building design or located on site. Acceptable systems include solar PV panels, solar water heaters, ground source heat pumps (for heating and cooling space and heating water), and biomass from residues and energy crops. Energy arising from direct combustion or fermentation of domestic or industrial organic wastes is not permitted due to the possible problems of local pollution, odours, etc.

The concept was deemed to be successful and has since been taken up by the Greater London Council and many other municipalities across the United Kingdom. Each municipality can vary the details and thresholds outlined in the regulations to suit their local conditions. For example, variations in the original 10% demand level have ranged between 5% and 20%. The most commonly accepted threshold for implementation of the regulation is a development of more than 10 dwellings or non-residential developments with floor areas greater than 1 000 m^2, but other thresholds exist. The regulation also serves to encourage the energy efficient design of buildings, and to give consideration to their layout and orientation on site, since having to provide 10% energy demand from renewables is more cost-effective at lower levels of demand. In cases where the incorporation of renewable energy equipment could make a new building development unviable, for example it is not possible to mount solar panels or wind turbines on a roof, a waiver can be sought by the developer. When given sufficient grounds, the regulation may not be enforced. The energy use of the buildings is subsequently monitored to ensure the target is being met.

Note: See website for more information: *www.merton.gov.uk/living/planning/planningpolicy/mertonrule.htm.*

Source: IEA (2009), *Cities and Towns and Renewable Energy – YIMFY: Yes In My Front Yard*, © OECD/IEA, Paris, Box G, p. 97.

Local governments face the challenge of revising local building regulations to address potential climate change scenarios, particularly those that expose the built environment to flooding and extreme storm events. Building codes that require minimum floor height requirements in new developments located in areas at risk for flooding and extreme storms represent an underutilised adaptation opportunity. Building codes are however not sufficient to address flood vulnerabilities because they typically only affect new construction and major renovations. They therefore must be combined with additional flood mitigation measures, such as retrofitting and infrastructure investments.

Local governments can also address the threat of increased urban heat island impacts by implementing building codes that require "cool roofs". Cool roofs may be painted white or composed of materials that allow them to reflect sunlight and minimise the amount of heat they absorb, which makes them well suited to warm climates but could work against efforts to reduce heating energy consumption in colder climates. Building codes that mitigate urban heat islands provide co-benefits by reducing the demand for energy to cool buildings. As cool roofs reduce cooling bills, they provide an economic incentive; however, like other energy efficiency measures, the upfront investment may need to be surmounted by local governments.

Renewable energy policies

Some cities and regions have undertaken the provision and production of renewable energy, in addition to pursuing goals of increasing renewable energy consumption through land-use zoning, transportation, natural resource and building policies. Local governments can develop their own sources of renewable energy by capturing and converting energy from one or more renewable energy sources that exist in many cities and towns (IEA, 2009a). A distinction can be made between distributed energy options (*e.g.* rooftop solar or solar water heaters) and centralised power production. Cities are generally better placed to incentivise distributed energy technologies, in part through zoning laws such as Barcelona's Solar Thermal Ordinance, as discussed earlier, Cities can also use their self-governing authority to purchase renewable energy for city or regional operations (IEA, 2009a).

Some cities in the OECD, such as the City of Los Angeles, own and operate power-generating facilities, which provides them with more options for increasing local use of renewable energies. The city's *GreenLA Climate Action Plan* sets targets for the Los Angeles Department of Water and Power (LADWP) to increase its renewable fuel sources to 20% by the end of 2010 and to 35% by 2020, in part by developing four new renewable energy projects. These new projects build on CO_2 reductions of 3% achieved over 2004-08, which resulted in an estimated reduction of 524 000 metric tonnes of CO_2 (City of Los Angeles, 2008). The City of Seoul, Korea, aims in its new climate change master plan to expand its renewable energy share from 1.5% in 2007 to 20% by 2030, with nearly half of this share to come from hydrogen energy (Seoul City Government, 2009). Cities and regions that are not municipal power producers can still use their regulatory authority to remove obstacles to local renewable energy production and their self-governing authority to purchase renewable energy for city or regional operations (IEA, 2009a).

Renewable energy policies can be enhanced or undermined by other sectoral policies, particularly in the areas of land-use zoning, transportation and building. Renewable energy production can also have a negative impact on adaptation activities by increasing demand for water: a range of renewable energy producers, including solar farms, biofuel refineries and cleaner coal plants, consume significant amounts of water to produce energy. For example, some local water authorities in California have denied permits for potential renewable energy developments based on their high projected water demand (Woody, 2009).

Urban utilities

Waste policies

While urban waste contributes to climate change through methane (CH_4) and to a lesser extent CO_2 released by landfills and emitted by waste incinerators, heat and energy capture from waste incineration can provide an efficient energy source. Methane, which represents the largest share of GHG emissions produced by the waste sector (IPCC, 2007), presents a key concern for local GHG emissions reduction efforts because CH_4 has a significantly greater impact on climate change than CO_2 emissions and continues to be released for decades after waste disposal. Outdoor burning of waste, more common in cities in developing countries, contributes to air pollution and poses significant health risks (IPCC, 2007). Waste processing and transfer facilities in coastal areas are also at risk from rising sea levels and more severe storm events.

Local governments can reduce GHG emissions from the waste sector through policies that aim to reduce waste quantities and increase the net energy efficiency of incinerators. Local governments can deploy these policy tools in their roles as regulators, waste service providers, and enablers of efforts to reduce waste consumption. National governments can provide technical and financial assistance for energy generation programmes and set standards for incinerators. Co-benefits to reducing waste and improving incineration technologies include reduced air pollution, resource consumption and reduced landfill impacts on water quality.

Local governments can reduce the quantity of waste that ends up in landfills by providing recycling and composting services and setting fees to discourage waste. Many cities divert waste from landfills through recycling and composting programmes. The City of San Francisco's recycling and food composting efforts have allowed it to divert from landfills 70% of all waste consumed (Kamal-Chaoui in OECD, 2008).[17] The actual amount of non-recyclable and non-compostable waste provided to collectors can be reduced through incentives in the waste collection rate structure. The City of Zurich restricts the amount of waste that residents can generate, and sets fees for additional amounts. Local governments also have opportunities to reduce waste by improving waste management systems. To meet its target of recycling 35% of the waste stream in 2009 and 51% in 2011, the province of Rome, with financial support from the Lazio region, provides economic grants to municipalities in its jurisdiction to establish waste collection systems that enable them to quantify individual household waste and thereby create fiscal incentives for waste reduction recycling (Kamal-Chaoui in OECD, 2008). Waste quantities can also be reduced through education campaigns, which are already common in many urban areas in OECD countries. In order for efforts to reduce the amount of non-recyclable and non-compostable waste through fees or information to be effective, they need to be coupled with collection services that offer recycling and composting for a wide range of consumer waste products. The EU Landfill Directive requires reductions in the volume of biodegradable municipal waste it sends to landfills.

Local government agencies that use waste as an energy source can increase the net energy efficiency of incinerators and reap economic benefits from energy savings. Even when incinerators do not generate energy, they emit a significantly smaller amount of GHG emissions than landfills. The amount of other pollutants they emit depends greatly on their cost and design; many European countries have adopted stringent emission standards for incinerators (IPCC, 2007). Cities are also capturing methane gas from landfills to be used as a source of energy. The City of Monterrey, Mexico, which has been active in generating electricity by harvesting methane, used public and private funds to construct a seven-megawatt energy plant that captures and converts enough landfill gas into electricity to power the city's light-rail transit system and its streetlights (Kamal-Chaoui in OECD, 2008). In China, the City of Guangzhou in Guangdong province has undertaken one of the largest landfill energy capture projects, which is expected to generate more than 50 GWh of electricity, or enough for 30 000 households (OECD, 2010a). Other cities investing in landfill methane gas capture include Amman, Jordan (Freire in OECD, 2009b), Christchurch, New Zealand and Nelson, New Zealand.[18]

The waste services sector provides an opportunity for local governments to reduce GHG emissions economically because they can build on services they already provide and capitalise on economic benefits. Policies to reduce waste through expanding recycling and composting services and raising the price of non-recyclable waste recycling programmes have been shown to consume less energy than disposing of the waste in landfills or by incineration, even when taking into account the potential energy that may be captured at either landfills or incinerators (Morris, 2005). It is therefore important that policies to support waste-to-energy capture do not compete with recycling programmes. Policies that support waste incineration and landfill gas capture complement recycling and composting policies by increasing the energy efficiency of disposal of non-recyclable or non-compostable waste. Incineration or landfill programmes that capture heat and energy can reduce net GHG emissions while offering economic benefits.

Water policies

While many cities do not prioritise urban water policies as part of their climate policy goals, they deserve attention because water service provision both consumes energy and is also vulnerable to climate change impacts such as increased droughts and rising sea levels. Water service provision contributes to GHG emission because of the energy demanded by water treatment, pumping and other water provision activities. For example, approximately 5% of all the electricity used in California is related to water provision, while an additional 15% is related to end uses of water, such as heating and pressurising (California Natural Resources Agency, 2008). Local governments respond to a variety of climate change impacts scenarios with four key water policy goals that aim to:

i) reduce water consumption;

ii) reduce energy demand of water delivery systems;

iii) prevent water system infiltration due to flooding; and

iv) prevent water system disruption due to drought.

Policies that encourage or require technological improvements, among others, can reduce the amount of energy required to provide water and reduce water consumption to better adapt to the risk of less available water due to climate change impacts.

Climate change requires changes in local water management to anticipate shifts in demand, and to confront the potential reduction of water availability and quality. Smart water policies that help achieve water conservation and efficiency goals include proper pricing of water to encourage waste reduction, financial incentives for low-flow appliances, proper design of subsidy and rebate programmes, new state and national efficiency standards for appliances, education and information outreach, water metering programmes, and more aggressive local efforts to promote conservation. Local and regional governments can enact regulations to increase the use of recycled water. For example, more than 40 000 homes in Melbourne, Australia, are required to use Class A recycled water, metered and delivered separately in a distinctive purple pipe, rather than potable water for toilet flushing, washing cars and watering outdoor landscaping. More could be done to drive better environmental performance in new housing through demand management. Best practices involve developing policy tools that give water efficiency equal priority to energy efficiency. This raises issues of funding and whether it is appropriate for customers to finance widespread improvements to the housing stock through water charges.

Empirical evidence emphasises that using prices to manage water demand is more cost-effective than implementing non-price conservation programmes, and they also have advantages in terms of monitoring and enforcement. Water supply managers are often reluctant to use price increases as a water conservation tool, however, and often rely instead on non-price demand management techniques, such as the adoption of specific technologies (*e.g.* low-flow fixtures) and restrictions on particular uses (*e.g.* lawn watering).

On average, in the United States, a 10% increase in the marginal price of water can be expected to diminish demand in the urban residential sector by about 3-4%. A recent study of 12 cities in the United States and Canada suggests that replacing two-day per week outdoor watering restrictions with drought pricing could achieve the same level of aggregate water savings, along with welfare gains of approximately USD 81 per household per summer drought (Mansur and Olmstead, 2007). Toronto's WaterSaver Program helps businesses that use a lot water to identify areas that may be "wasting" water and offers solutions and cash incentives. Industrial, commercial and institutional facilities that successfully reduce water use can receive a rebate (CAD 0.03 per litre of water saved). The programme allows Toronto to buy back water or sewer capacity that has been freed up by participants who have reduced water use in their operations (Raissis in OECD, 2009b).

Cities have also begun incorporating adaptation strategies into their water supply planning processes. New York City has started to adapt its water supply, drainage, and waste water systems to account for climate change and sea level rise. The City of Crisfield, United States, has incorporated sea level rise and storm surge into its comprehensive plan and is using land elevation to guide future land use planning. Many other cities are assessing vulnerabilities of water supplies. In the East of England plan (one of nine Regional Spatial Strategies in England), clear policy guidance on water planning is incorporated at the regional level to inform the next stage of the spatial planning hierarchy (Hickey in OECD, 2009b).

Adaptation and mitigation policies in the water sector are interconnected: Increased water shortages increase the energy required to provide water, as water scarcity can require greater pumping and greater travel distances from water source to consumer. Desalinisation, a possible solution for water scarce areas, requires a significant amount of energy. Policies to reduce consumption complement adaptation policies by reducing vulnerability to fluctuations in water availability and the need for energy intensive delivery methods.

Key urban policy packages

As national, regional, and local governments seek climate change policy packages that maximise their impact on GHG emissions and reduce their vulnerability to climate change impacts, a focus on policies that fit best with urban modes of governance and that enhance other climate policies is warranted (Table 4.2). City and regional regulatory authority is an important governance mode for implementing mitigation and adaptation policy tools across urban sectors, particularly as relates to the goals of reducing travel distances, discouraging personal vehicle use, increasing building energy efficiency and reducing vulnerability to storm, flooding and extreme heat impacts. Many cities display however a reluctance to make full use of their regulatory authority in the face of potential political, private sector and public opposition. Notable exceptions include Barcelona's Solar Thermal Ordinance and San Francisco's recent introduction of mandatory recycling (Kern and Alber in OECD, 2008; Partin, 2009). Service provision is another key means of implementing climate change policy goals, particularly those related to increasing mass transit use, providing renewable energy, district heating/cooling and waste-to-heat initiatives, and managing the urban environment to reduce the risk of flooding and other climate impacts. The impact of policies implemented through self-governance tend to be more limited in scope, but environmental management policy tools for adaptation and installation of energy efficiency technologies in city-owned buildings can have a large impact when

Table 4.2. **Policy tools for local-level action on climate change**

Policy goals	Policy tools	Policy sector	Purpose	Mode of governance	Complementary with policy tools that
Reduce trip lengths	Restructure land value tax to increase value of land closer to urban core, jobs, or services.	Land-use zoning.	Mitigation.	Regulatory.	Increase mass transit use.[1]
	Mixed-use zoning to shorten trip distances.	Land-use zoning.	Mitigation.	Regulatory.	Discourage vehicle use.[1] Support non-motorised means of travel.
Increase mass transit use	Transit-oriented development zones.	Land-use zoning.	Mitigation.	Regulatory.	Increase mass transit use.[1] Discourage vehicle use.[1]
	Restructure land value tax to increase value of land served by public transportation.	Land-use zoning.	Mitigation.	Regulatory.	Increase mass transit use.[1]
	Tax-incentives to developers near public transportation.	Land-use zoning.	Mitigation.	Regulatory.	Increase mass transit use.[1]
	Improve quality of public transportation.	Transportation.	Mitigation.	Service provision.	Discourage vehicle use.[1]
	Provide linkages with multiple modes of travel.	Transportation.	Mitigation.	Service provision.	Discourage vehicle use.[1] Support non-motorised means of travel.[1]
	Expand mass transit service.	Transportation.	Mitigation.	Service provision.	Discourage vehicle use.[1]
	Employee transport plans.	Transportation.	Mitigation.	Facilitative.	Improve quality of public transportation. Provide linkages with multiple modes of travel. Expand mass transit service.
Discourage vehicle use	Traffic calming (*e.g.* reducing lane width) to discourage driving.	Land-use zoning.	Mitigation.	Regulatory/service provision.	Improve quality of public transportation. Provide linkages with multiple modes of travel. Expand mass transit service.
	Driving and parking restrictions in certain zones.	Transportation.	Mitigation.	Regulatory.	Improve quality of public transportation. Provide linkages with multiple modes of travel. Expand mass transit service.
Support non-motorised means of travel	Traffic calming and increasing bike lanes.	Transportation.	Mitigation.	Regulatory/service provision.	Discourage vehicle use.[1]
Increase vehicle efficiency and alternative fuels use	Special parking privileges for alternative fuel or hybrid vehicles.	Transportation.	Mitigation.	Regulatory.	Driving and parking restrictions in certain zones.
	Purchase of fuel-efficient, hybrid, or alternative fuel vehicles for city fleet.	Transportation.	Mitigation.	Self-governance.	–
Increase building energy efficiency	Zoning regulation to promote multi-family and connected residential housing.	Land-use zoning.	Mitigation.	Regulatory.	Increase attractiveness of higher density developments through policies tools that: ● Increase neighbourhood open space. ● Improve quality of public transportation. ● Provide linkages with multiple modes of travel. ● Expand mass transit service. Tree-planting programmes.
	Energy efficiency requirements in building codes.	Building.	Mitigation.	Regulatory.	Co-ordination of public-private retrofitting programmes. Stringent enforcement policies. National building codes.
	Co-ordination of public-private retrofitting programmes.	Building.	Mitigation.	Facilitative.	Energy efficiency requirements in building codes.
Increase local share of renewable and captured energy generation	Building codes requiring a minimum share of renewable energy.	Building.	Mitigation.	Regulatory.	Technical support to developers and property owners.
	District heating and cooling projects.	Building.	Mitigation.	Regulatory/service provision.	Remove regulatory barriers to requiring connection to district heating/cooling system.
	Waste-to-energy programmes.	Waste.	Mitigation.	Service provision.	Strictly regulate incinerator emissions. Remove recyclables from waste stream.

Table 4.2. **Policy tools for local-level action on climate change** *(cont.)*

Policy goals	Policy tools	Policy sector	Purpose	Mode of governance	Complementary with policy tools that
Reduce vulnerability to flooding and increased storm events	Zoning regulation to create more open space.	Land-use zoning.	Adaptation	Regulatory.	Zoning regulation to promote multi-family and connected residential housing.
	Retrofitting and improvements to mass transit systems to reduce potential damage from flooding.	Transportation.	Adaptation.	Service provision.	Improve quality of public transportation. Provide linkages with multiple modes of travel. Expand mass transit service.
	Designation of open space as buffer zones for flooding.	Natural resources.	Adaptation.	Regulatory.	Zoning regulation to create more open space. Zoning regulation to promote multi-family and connected residential housing. Building codes requiring minimum ground clearance.
	Building codes requiring minimum ground clearance.	Building.	Adaptation.	Regulatory.	Designation of open space as buffer zones for flooding.
Reduce urban heat-island effect and vulnerability to extreme heat	Retrofitting and improvements to mass transit systems to reduce potential damage from extreme temperatures.	Transportation.	Adaptation.	Service provision.	Improve quality of public transportation. Provide linkages with multiple modes of travel. Expand mass transit service.
	Tree-planting programmes.	Natural resources.	Mitigation and adaptation.	Self-governance.	Increase attractiveness of higher density developments through policies tools that: ● Increase neighbourhood open space. ● Improve quality of public transportation. ● Provide linkages with multiple modes of travel. ● Expand mass transit service.
	Building codes requiring design materials that reduce heat-island effects.	Building.	Mitigation and adaptation.	Regulatory.	Energy efficiency requirements in building codes.
	Building codes requiring "green roofs" with vegetation or white surfaces.	Building.	Mitigation and adaptation.	Regulatory.	Energy efficiency requirements in building codes.

1. Denotes complementarity with all policy tools listed under a policy goal.

applied widely. Public information campaigns can enhance a number of other policy tools, including those that can benefit most from targeted climate-related information. However, as the impact of urban facilitative activities is diffuse, it is hard to measure.

Policies that enhance each other when applied concurrently should also be considered as top priority policies. Land-use zoning policies that allow for higher densities and greater mixing of residential and commercial uses can enhance transportation climate goals by reducing trip distances and frequency, protect natural areas that act as buffer zones against climate impacts, decrease building energy demand, and increase efficiency of urban services delivery. Other sectors, in turn, can enhance the quality of densification policies and lessen their potentially negative impact on adaptation measures. The expansion of mass transportation and non-motorised travel options can provide benefits that outweigh the disadvantages of high residential density, while natural resource policies can enhance the quality and availability of open spaces within densely developed areas. Building design policies can enhance the quality of the densely built environment while reducing climate vulnerability through minimum ground clearances and design features to reduce urban heat island impacts.

Policy complementary within sectors is also important for enhancing policy effectiveness. Transportation policies to increase the quality and availability of public transportation, bicycle, and foot travel make policies to discourage or restrict vehicle travel and circulation more politically feasible. For example, congestion fees for driving during peak hours worked well in

London because they were combined with improvements in management of the road network and substantial enhancements in bus service. In the building sector, local government co-ordination of public-private partnerships to provide energy efficiency retrofitting programmes complement energy efficiency codes that affect only new development and major renovations. Waste policies to promote both waste-to-energy incineration and the collection of recyclables can enhance rather than undermine the economic viability of recycling programmes while diverting waste from landfills. Policies to reduce water consumption can increase local resilience to drought while lowering energy demand for water service provision and the development of energy-intensive water sources in response to water scarcity.

Density and spatial urban form in combating climate change

The urban policies discussed above intersect with the question of urban density. Many cities have begun pursuing policies to increase the density of residential neighbourhoods and favour concentration at the centre of the urban agglomeration as a means to facilitate the mitigation and adaptation measures discussed above. The questions of whether to densify development and which spatial development patterns to pursue have come to the forefront of local long-term planning concerns. Compact cities and sustainable neighbourhoods have been presented as models of development patterns that can address climate challenges and long-term resource, economic, and social sustainability. However, questions remain about the effectiveness of these spatial urban forms in meeting environmental goals and in attracting residents over the long term.

In determining whether and how to incorporate climate policies into spatial urban form and density decisions, city and metropolitan governments face a number of questions:

i) How to define density in order to set priorities for compact development?

ii) Which spatial development patterns best contribute to GHG emissions reductions, climate change adaptation, and efficient resource use?

iii) How can spatial planning reduce the energy required to travel between home, jobs, and activities?

iv) What impact does compact development have on economic growth?

v) How can challenges to urban quality of life, housing affordability, and urban attractiveness be overcome?

These questions require consideration of the potential impact on GHG emissions and climate change vulnerability, but also on economic growth, long-term resource sustainability, affordability, and urban quality of life.

The concept of the "compact city" as a spatial development strategy has become popular in many OECD countries, particularly in Europe and Japan. The European Commission encourages European cities to move towards more compactness, on the basis of environmental and quality of life objectives (Commission of the European Communities, 1990). The British government has made urban compactness a central element of its sustainable development policy (United Kingdom Department of the Environment, 1994) and the Dutch government has taken similar action (Sorensen *et al.*, 2004). Most recently, the Japanese government has introduced the concept of "Eco-Compact City" as one of its top-priority urban policies (Ministry of Land, Infrastructure, Transport and Tourism, 2009). The compact city strategy aims to intensify urban land use through a combination of higher residential densities and centralisation, mixed land uses, and development limits outside of a designated area (Churchman, 1999). Compact cities also typically involve concentrations of urban services and transportation options and high degrees of land-use planning controls (Table 4.3) (Neuman, 2005).

Table 4.3. **Compact city characteristics**

• High residential and employment densities.
• Mixture of land uses.
• Fine grain of land uses (proximity of varied uses and small relative size of land parcels).
• Increased social and economic interactions.
• Contiguous development (some parcels or structures may be vacant or abandoned or surface parking).
• Contained urban development, demarcated by legible limits.
• Efficient urban infrastructure, especially sewerage and water mains.
• Multi-modal transportation.
• High degree of accessibility: local/regional.
• High degree of street connectivity (internal/external), including sidewalks and bicycle lanes.
• High degree of impervious surface coverage.
• Low open-space ratio.
• Unitary control of planning of land development, or closely co-ordinated control.
• Sufficient government fiscal capacity to finance urban facilities and infrastructure..

Source: Neuman, M. (2005), "The Compact City Fallacy", *Journal of Planning Education and Research*, Vol. 25, No. 1, Sage, London, pp. 11-26.

While some associate compact cities with high-density development, the concepts are distinct. Compact development prioritises development close to and radiating from an urban core, where the definition of high-density development is based primarily on the concentration of dwelling units, regardless of proximity to an urban core or urban amenities. In some metropolitan regions, compact development may apply to polycentric development, where two or more cities in a region share complementary functions (Nordregio, 2005), in which case compact development strategies radiate from each urban core.

Impact on urban amenities and services

As illustrated in Chapter 1, dense and compact development emerges as a crucial strategy to reduce GHG emissions. Policies to increase residential density in urban areas, whether or not they are part of a compact cities or sustainable neighbourhoods strategy, have been credited with providing benefits such as reduced GHG emissions from travel, increased efficiency and reduced costs of public services provision, and increased protection of agricultural land and open spaces (Churchman, 1999). Higher residential densities may also facilitate many of the urban policies to reduce GHG emissions and adapt to climate change impacts. For example, dwellings that are adjacent rather than stand alone are more insulated and therefore require less energy for heating and cooling. Mass transport networks and public utilities benefit from economies of scale in denser areas, which can facilitate expansion of mass transit and reduction of personal vehicle use. Compact development can provide the economies of scale required to make district heating and cooling projects economically viable, and reduce the energy required to provide water, wastewater, and waste services. Higher-density development can also result in the preservation of key open spaces critical for climate change adaptation, such as flood plains or buffer zones for coastal flooding. Estimates of the effect of compact growth scenarios on US national GHG levels range from 1% (US National Research Council, 2009) to 10% (Ewing *et al.*, 2008), but further research is needed to understand the impact of a range of spatial development scenarios on future greenhouse gas emissions.

The impact of density on urban economic and social priorities is even more diverse and complex. On one hand, high-density residential areas have been associated with a more economically efficient use of high-priced land and a greater mix of housing types, which may facilitate a more diverse mix of residents than areas dominated by single-family housing (Churchman, 1999). On the other hand, policies to promote high-density residential development have also attracted criticism, in particular for their potential impact on residents' quality of life, access to open space, housing prices, and responsiveness to market demand. High residential densities can lead to increased traffic congestion and pollution, which can be exacerbated by a lack of trees or vegetation. The value of land may also rise significantly as a result of high-density developments, which can discourage the preservation of open space and limit residents' access in high-density areas (Churchman, 2003). The increase in land values also can result in the exodus of low-income and even middle-class residents from high-density areas with valuable amenities such as proximity to the urban core, open space, and mass transit. If increases in urban density are accompanied by efforts to reduce pollution or otherwise improve the urban environment, wealthier households may move in, driving up rents and benefiting landlords at the expense of existing tenants, as demonstrated in a study of California cities (Banzar and Walsh, 2006). Higher housing prices and smaller dwelling sizes, both associated with high-density areas, may lead families with children to leave for areas with lower prices, larger dwellings, or opportunities for outdoor space. This can lead, in turn, to economically and socially homogenous high-density areas. Further research is needed to clarify the relationship between high residential densities and neighbourhood demographics.

Building design and availability of neighbourhood amenities affect residents' perceptions of high-density developments' advantages and disadvantages. In determining urban quality of life, residents' perceptions of density, or perceived density, may be as important as real measures of residential density (Churchman, 1999). For example, in the Netherlands, 10 dwelling units per net hectare is considered low density and 100 units per hectare high density, while in Israel, 20 to 40 dwelling units per net hectare is considered low density, and 290 units per hectare is considered high density. While high-density developments are often associated with high-rise towers, low-rise buildings can also achieve relatively high densities. For example, a study of Toronto, Canada, identified net densities of 120-230 dwelling units per hectare in areas of buildings up to five stories (Churchman, 2003). Urban amenities, such as open space, mass transit service, shopping areas and cultural activities, can all serve to lessen the potential impacts of high-density developments on quality of life. For example, a study of neighbourhood satisfaction in central Dublin found that density itself was less important to perceived quality of life than management of the physical environment (*e.g.* litter, pollution, greenery), noise and traffic congestion, and access to open space, children's facilities, quality food stores and secure parking (Howley *et al.*, 2009). However, while building design and amenities may increase high-density areas' attractiveness, they do not address the issue of potentially rising housing prices.

Spatial policy tools for low-carbon development

A focus on spatial compactness or density to increase urban growth's responsiveness to climate change and sustainability may be limiting if it does not take into account the climate impact of urban activities (Neuman, 2005). Metropolitan regions must be able to respond to rapid growth and demand for undeveloped land. To effectively reduce GHG emissions, it is critical for spatial policy tools to reduce distances between residential, employment, shopping, and leisure activities, which is not necessarily achieved by increasing residential densities alone. As was discussed in the section on land-use policies, Transportation and resource efficiency, and open space preservation can be facilitated by spatial development that is planned to maximise transportation linkages, prioritise areas adjacent to public utilities services, and preserve open space. The Île-de-France region provides a key example of combining these elements in a long-term master plan (Box 4.7).

Box 4.7. **Île-de-France's regional master plan to become the first "Eco-Region"**

Where and at what density future construction should take place in Paris and the surrounding Île-de-France region, and how this will impact climate change goals, are key questions for the revision of the Île-de-France Regional Master Plan.

The new SDRIF (Master Plan for the Île-de-France region) continues past practices of targeting polycentric development in the region, but also emphasises the importance of a compact region and places new attention on the historically dense urban core of the agglomeration. With the goals of limiting traffic and curbing urban sprawl, the SDRIF encourages higher density in existing urban spaces and prioritises development in areas served by public transportation. As a prescriptive land-use document in particular, it reworks the map of constructible land, seeks minimum densities for new urbanisation, and places conditions on the urbanisation of certain areas.

As density is only sustainable if it translates into urban spaces with a high quality of life, the revision of the SDRIF aims for urban "intensity", or the linking of dense neighbourhoods to quality public transportation, parks and open spaces, services, and jobs. To maximise opportunities for quality densification:

- The general map of the SDRIF, which must be respected by local plans, identifies preferential sites for densification, often to optimise planned public transport links.
- The rules expressed in the SDRIF's text make it compulsory for all municipalities to increase their local average densities.
- Other elements of the SDRIF set expectations for densification of districts around existing and planned public transport stations (express railway, metro, tram).
- To balance plans to reduce the expansion of urbanised land, the SDRIF requires new districts to meet higher minimal housing densities than currently in practice.

The counterpart of this *ville compacte* is the plan's strong effort to preserve and mobilise the region's open spaces, whose various economic, environmental, and public uses are now better acknowledged. This includes the strengthening of a network of green spaces that runs through the central agglomeration and the creation of "biological corridors" in the outer areas of the region.

Box 4.7. **Île-de-France's regional master plan to become the first "Eco-Region"** *(cont.)*

Finally, the new SDRIF continues longstanding efforts to develop the metropolitan area around a network of strong, structured urban centres. The plan's transportation programme plays a key role in this effort as it will help structure the region's urban core and give a boost to the new dense neighbourhoods called for in the SDRIF. In addition to reinforcing the region's historically "radial" transportation system, which spans outward from Paris, the new SDRIF calls for a number of new high-capacity lines running around the Parisian centre.

Source: Fouchier in OECD (2009b), *Green Cities: New Approaches to Confronting Climate Change, OECD Workshop Proceedings*, conference held 11 June 2009, Las Palmas de Gran Canaria, Spain.

A number of policy tools exist to facilitate compact development, through mixing land-uses, improving mass transit services and providing urban amenities. These include reducing existing regulatory barriers to more compact development, including barriers to mixed-use, transit-oriented and brownfields development, accompanied by fiscal reform that internalises environmental and public services costs incurred by new development and concentrates urban amenities and services in priority growth areas. A primary strategy for promoting more compact urban development is to reform land-use policies that restrict opportunities for high-density development. Zoning and other land-use controls impose an "implied zoning tax" that discourages new housing construction (Glaeser and Gyourko, 2003). Floor-area-ratio restrictions, restrictions on units per acre, and height restrictions all can restrict compactness policies. Zoning reform and incentives to increase mixed-use developments, which combine residential and non-residential land uses, can reduce the length and frequency of personal vehicle trips. Mass transit use is facilitated not only by increasing density but also by ensuring service to key employment centres, even those located away from residential neighbourhoods or on the urban periphery. Transit-oriented developments, which often include mixed-use elements, and mass transit connections to key employment and residential areas are needed to reduce personal vehicle use and can function even in the absence of high-density policies.

Many policy instruments to reduce urban sprawl, which is characterised by low density, segregated land uses whose outward expansion is unchecked and may "leap" over undeveloped land (Burchell *et al.*, 2002) may result in higher residential densities within the urban area, but also achieve goals related to increasing the use of mass transit, improving accessibility of the urban environment, and increasing urban amenities such as nearby open space (Table 4.4). Land-use policies such as urban growth boundaries and development incentives can actively promote denser urban development. However, while more compact development is achieved, negative impacts on property values can have perverse effects on the value of land outside urban growth boundaries. Less restrictive approaches also exist. In Germany, for example, new development is restricted to land immediately adjacent to already developed land (Buehler *et al.*, 2009). Local governments can also promote densification by allowing developers to exceed zoning regulations if they meet other climate policy goals. Given the tendency for higher housing prices closer to urban cores, it can often be relevant to keep some land for future infrastructure, including through tools such as land banks for affordable housing, urban amenities, and infrastructure.

Table 4.4. **Policy instruments to manage urban sprawl**

Policies for managing urban growth	Policies for protecting open space
Public acquisition Public ownership of parks, recreation areas, forests, environmentally sensitive areas, etc.	**Public acquisition** Public ownership of parks, recreation areas, forests, environmentally sensitive areas, etc.
Regulation Development moratoria, interim development regulations. Rate of growth controls (such as building permit caps), growth-phasing regulations. Adequate public facility ordinances. Up-zoning or small-lot zoning, minimum density zoning. Mixed-use zoning. Transportation-oriented zoning. Greenbelts. Urban growth boundaries. Urban service boundaries. Comprehensive planning mandates (master plans).	**Regulation** Subdivision exactions. Cluster zoning (incentives often provided). Down-zoning or large-lot zoning. Exclusive agricultural or forestry zoning. Mitigation ordinances and banking. Non-transitional zoning. Concentrating rural development.
Incentives and fiscal policies Development impact fees. Real estate transfer tax. Split-rate property tax. Infill and redevelopment incentives. Brownfield redevelopment. Historic rehabilitation tax credits. Location efficient mortgages. Priority funding for infrastructure in city centre.	**Incentives and fiscal policies** Right-to-farm laws. Agricultural districts. Transfer of development rights. Purchase of development rights, conservation easements. Use-value tax assessment. Circuit breaker tax relief credits. Capital gains tax on land sales.

Source: OECD adaptation based on Bengston, D.N. *et al.* (2004), "Public Policies for Managing Urban Growth and Protecting Open Space: Policy Instruments and Lessons Learned in the United States", *Landscape and Urban Planning*, Vol. 69, pp. 271-286.

Strategic urban planning for climate change

Long-term strategic planning needs to take into account urban areas' contributions and vulnerabilities to climate change. As urban areas have shifted towards the concept of urban governance, which involves managing and co-ordinating public and private interests, future growth and development decisions are no longer made solely by a central authority. Strategic planning – determining future action, identifying implementing roles, and monitoring and evaluating the outcomes (see Steiss, 1986) – has been increasingly used to co-ordinate diverse priorities and contributions from multiple levels of government, non-governmental stakeholders and the private sector. The basic principles of strategic urban planning are to observe urban dynamics, land and house prices and understand the reasons why key stakeholders intervene in urban development processes; establish a consensual long-term vision and translate it into specific goals, define and prioritise required actions to achieve those goals given local capacity to act and power structures; and manage linkages among sectoral policies and uncertainty. The tools for flexible and strategic public intervention that can be used to incorporate climate change responses into long-term growth plans typically include:

i) analyse urban emissions drivers and urban vulnerabilities;

ii) identify local capacity to act;

iii) model long-term implications of policy options; and

iv) assess costs and benefits and cost-effectiveness.

To plan long-term reductions of urban areas' contributions to climate change, it is critical to inventory sources of GHG emissions. Scenarios to predict future GHG emissions are needed to identify policy priorities and choose among policy options. Analysing the drivers of GHG emissions involves identifying energy-consuming activities, the modes through which those activities take place, the energy intensity of the activities and the GHG emissions intensity of the energy sources consumed. Many cities have begun to inventory their emissions sources, however, the need exists for harmonisation of tools.

Climate change impacts are often localised, thus effective responses require region-specific assessments of local vulnerabilities. Vulnerability assessments model potential local damage in scenarios of flooding, rising sea levels, heat extremes, and other expected climate change impacts. Many urban areas are beginning to undertake these assessments, including the Washington DC/Northern Virginia region (Box 4.8). However, they are costly and require scientific expertise that may not be readily available to urban governments. This points to a role for national governments to foster science-policy capacity building and information to improve local understanding about how climate change will affect cities.

Box 4.8. **The Sustainable Shoreline Community Management in Northern Virginia project**

To support the development of a regional climate change adaptation plan for Northern Virginia, United States, the Northern Virginia Regional Commission embarked on a three-year effort to develop a plan for sustainable shoreline and near-shore restoration, protection, revitalisation and community development along the region's tidal waters. Through the Sustainable Shoreline Community Management in Northern Virginia project, the local governments in Northern Virginia are able to addresses coastal hazards and sea level rise preparation in a collaborative manner.

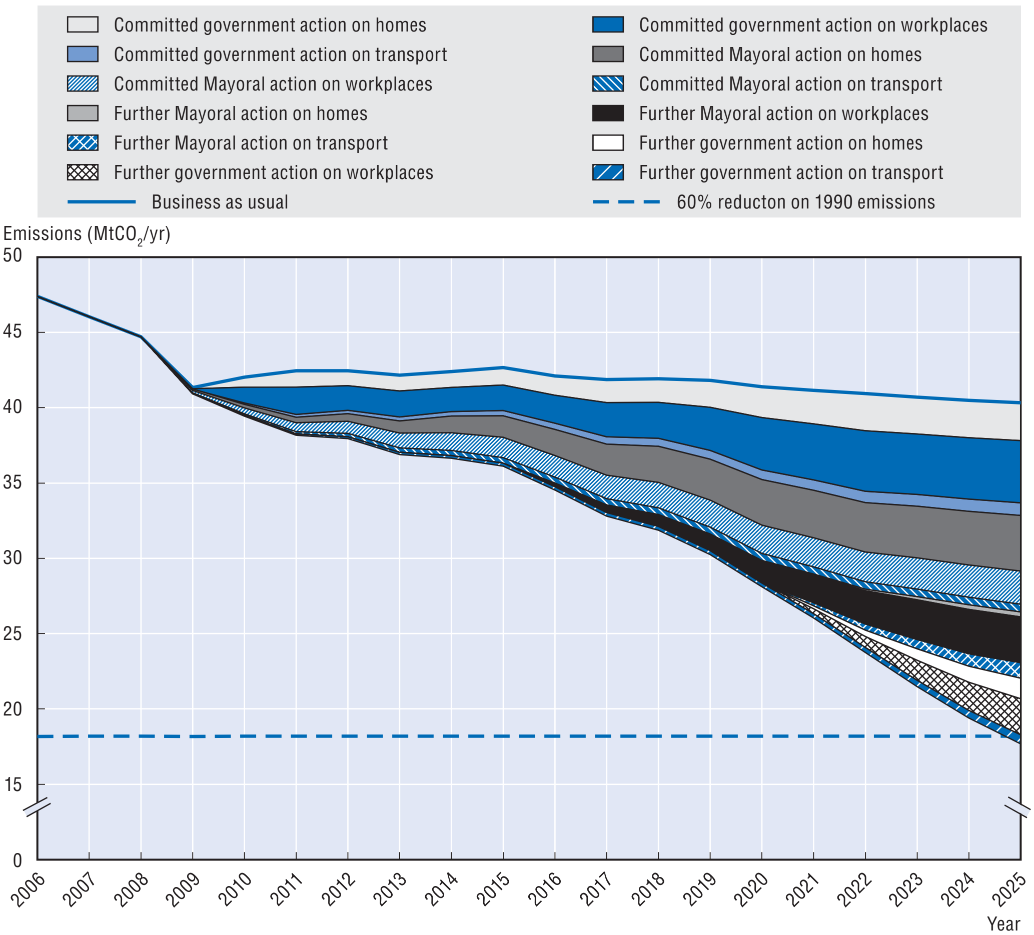
This plan focuses specifically on impacts due to sea level rise and storm surge and is funded in part by the Virginia Coastal Zone Management Programme through a grant sponsored by the National Oceanic and Atmospheric Administration. Phase I, of this three-year, three-phase project, includes an inventory of existing data resources and policies to determine the natural and man-made resources at risk, identify data gaps, and understand current local shoreline management regulations. A workgroup consisting of representatives from local, state, and federal governments, colleges and universities, and other stakeholders assists in highlighting and collecting relevant data including policies, land use, and natural resource information. Phase II will focus on filling data gaps, identified through Phase I of this project, and producing a report and maps of areas at risk of sea level rise and other climate change impacts.

Source: Grape in OECD (2009b), *Green Cities: New Approaches to Confronting Climate Change*, OECD Workshop *Proceedings*, conference held 11 June 2009, Las Palmas de Gran Canaria, Spain.

An assessment of local capacity to respond to urban contributions and vulnerabilities to climate change is critical to planning future responses. Understanding local capacity allows local authorities to identify what they are capable of accomplishing alone and what may require the involvement of other levels of government or of non-governmental stakeholders. For instance, a city may have direct control of the local electric or gas utility, and therefore a say in pricing policies or the fuels used to generate power, but may have much more limited control over another sector such as public transport planning. Assessing capacity to act can be challenging, but some cities are forging ahead. Wedge analysis and stakeholder mapping are two types of tools to assess local capacity to act. For instance, the Greater London Authority has assigned responsibility for different initiatives proposed in its climate action plan to Mayoral and governmental authority (Figure 4.2), as well as the contribution to greenhouse gas targets of different types of energy reductions (Figure 4.3). To understand GLA's ability to influence the emissions associated with buildings around London, the mayor's team also developed an influence "hierarchy" examining different factors that could potentially affect buildings-related emissions, and the mayor's influence over these factors (Lefèvre & Wemaere, 2009).

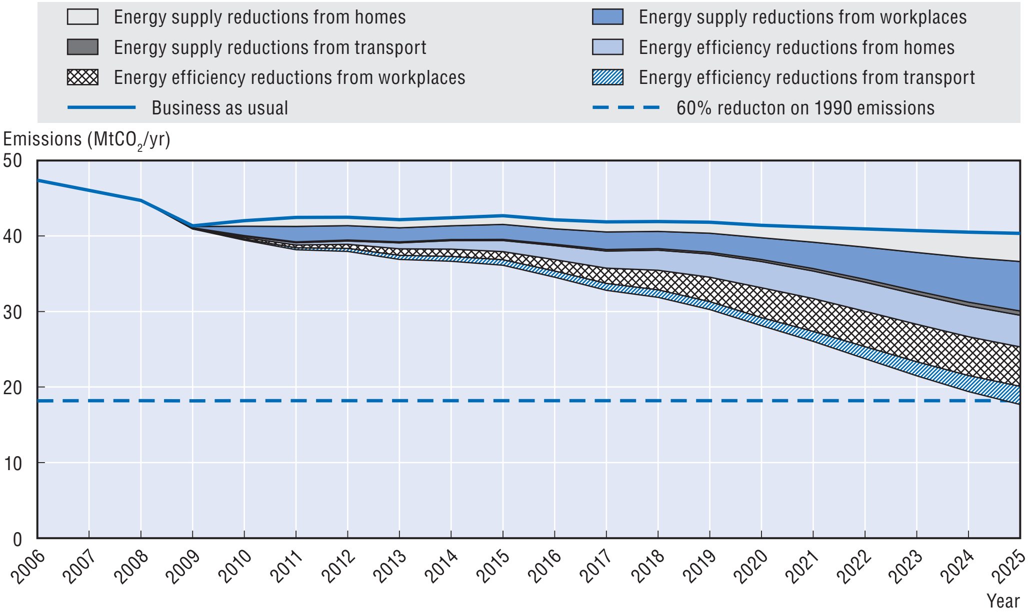
Modelling the impact of policy options on future GHG emissions and climate vulnerabilities is a key step in understanding policy opportunities and tradeoffs. Because of the complexity of the interrelations between the drivers of spatial organisation processes within a city, the empirical prediction of the multiple impacts of various combinations of urban policies is a difficult task. Given the various trade-offs that sustainability requires, it is necessary to also find a way to quantitatively assess the impacts of policy on the welfare of different population categories, productivity, energy consumption, and GHG emissions. Strategic planning processes can be significantly facilitated by long-term prospective methods that are able to forecast the effects of urban policy alternatives on urban spatial

Figure 4.2. **Projected CO_2 emissions reductions in London (2008-2025)**



Source: Greater London Authority (2010), "The Mayor's Climate Change Mitigation and Energy Strategy (Public Consultation Draft)", GLA, London.

Figure 4.3. **Breakdown of projected reductions in London's CO_2 emissions by energy efficiency and energy supply savings (2008-2025)**



Source: Greater London Authority (2010), "The Mayor's Climate Change Mitigation and Energy Strategy (Public Consultation Draft)", GLA, London.

organisation. Current models are driven mainly by transport scenarios and estimate through quantitative assessment their consequences on various sustainable parameters, such as different population categories, congestion, energy consumption, GHG emissions, etc. One example, the TRANUS model, which integrates transport and land-use scenarios, has been implemented both in northern cities (Baltimore, Sacramento, Osaka, Brussels, etc.) and southern cities (São Paulo, Mexico City, Caracas, Bogotá, etc.). Models that go beyond transportation-based scenarios, and which also take climate change impacts into account, are needed to better inform policy options.

Tools to assess costs and benefits and inform cost-effectiveness planning also play a key role in strategic planning. Policies, plans, and projects tend to be assessed on short-term financial returns, or on an economic valuation based narrowly on a structured cost-benefit analysis, from the perspective of a limited range of stakeholders or project objectives. Few cities worldwide have a real understanding of the impact of new development on their long-term fiscal condition. Decisions are dominated by immediate capital costs, despite the fact that often over 90% of lifecycle costs for typical infrastructure are expended during operational maintenance and rehabilitation. At the same time, most government budgets do not account for ecological assets, the services they provide, and the economic and social consequences of their depletion and destruction. Introducing qualitative assessment in cost-benefit analyses can be challenging; one example is the performance-based planning approach in use in the San Francisco Bay Area, United States, to help the Metropolitan Transportation Commission focus on sustainable measurable outcomes of potential investments and the degree to which they support stated policies (Chapter 7, Box 7.4).

While the requirement for cost-effectiveness should probably be proportional to the environmental ambitions (similarly for social initiatives), the economic dimension of the problem is rarely seriously considered. For instance, few local climate action plans are currently based on a serious economic analysis of the possibilities and constraints of the proposed measures. The cities of London and New York are exceptions. Energy-economy or sectoral energy models have made it possible to simulate different policies and especially to build sets of Marginal Abatement Cost Curves (MACCs).[19] These mechanisms are highly efficient tools for analysing different aspects of climate policies, particularly by seeking to reduce the global cost through levelling, to a certain degree, the marginal costs of sectoral initiatives. These mechanisms can provide the required support to develop a methodology for defining and prioritising actions to be initiated, based on technical-economic criteria. The different actions required can then be organised to build a cost-effective programme (Lefèvre and Wemaere, 2009).

Notes

1. As of August 2010, 1 044 US mayors have signed the agreement. See *www.usmayors.org/climateprotection/list.asp*.
2. See *www.energysavingtrust.org.uk/nottingham*, accessed 18 November 2009.
3. ICLEI's Cities for Climate Protection was one of the first networks established, and counts over 680 cities as members from over 30 countries worldwide (*www.iclei.org/climate-roadmap*). The EU CO_2 80/50 project, organised by METREX: The Network of European Metropolitan Regions and Areas, targets a reduction in GHG emissions by its member cities of 80% below 1990 levels by 2050 (*www.eurometrex.org/ENT1/EN/Activities/activities.asp?SubCat1=EUCO2*). The Covenant of Mayors is a commitment by signatory towns and cities to exceed EU CO_2 emissions reduction targets (*www.eumayors.eu/*).
4. From response to the OECD "National-Local Climate Change Governance Practices Questionnaire" by Naoto Nakagawa, Japanese Ministry of Foreign Affairs, 10 August 2009.
5. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009.
6. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Klaus Elliger, City of Mannheim, Germany, 12 August 2009.
7. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009.
8. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009.
9. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Barbara Jeanneret, Swiss Federal Statistical Office, 17 August 2009.
10. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Wolfgang Socher, City of Dresden, Department of Urban Ecology, 26 August 2009, and by Maciej Zathej, Dolnoslaskie Region, Poland, Regional Bureau of Spatial Planning, 28 August 2009.
11. From response to the OECD "National-Local Climate Change Governance Practices Questionnaire" by Barbara Jeanneret, Swiss Federal Statistical Office, 17 August 2009.
12. Known as a "principal-agent" problem, owners of rented buildings have little incentive to make investment because they usually do not have to pay the energy bills, and renters do not have incentive, either, because they are not likely to benefit from the investment over the long term. Under such circumstances, economic instruments and information tools may not function effectively (OECD, 2003).
13. For example, the City of Boston approved a green building zoning code in January 2007 that requires all construction projects exceeding 50 000 square feet to be designed and planned to meet the US Green Building Council's (USGBC) LEED "certified" level standards (City of Boston Redevelopment Authority). The Flemish Climate Policy Plan for 2006-2012 sets out comprehensive requirements for new or significant additions to dwellings, schools and offices, as well as major renovations of schools and offices exceeding 3 000 m^3 (Flemish Ministry of Public Works, Energy, Environment and Nature, 2006).
14. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009.

15. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Astrid Hoffmann-Kallen, Ute Heda and Rainer Konerding, City of Hannover, Climate Protection Unit, 1 September 2009. See also *www.passivhaustagung.de/zehnte/englisch/texte/PEP-Info1_Passive_Houses_Kronsberg.pdf*.
16. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009.
17. The South Waikato Region, New Zealand; Christchurch, New Zealand; Dolnoslaskie Region, Poland; Darmstadt, Germany; and Toronto, Canada, also provide examples of composting (responses to the OECD "Local Climate Change Governance Practices Questionnaire" by James Piddock, South Waikato District Council, New Zealand, 29 July 2009; by Tony Moore, Christchurch City Council, New Zealand, 3 September 2009; by Maciej Zathej, Dolnoslaskie Region, Regional Bureau of Spatial Planning, 28 August 2009; by Günther Bachmann, City of Darmstadt, Department of Economy and Urban Development, 21 August 2009; and by Mark Bekkering, City of Toronto, Environment Department, 11 August 2009).
18. From response to the OECD "Local Climate Change Governance Practices Questionnaire" by Tony Moore, Christchurch City Council, New Zealand, 3 September 2009; and by Debra Bradley, Nelson City Council, New Zealand, 3 September 2009.
19. "Marginal Abatement Cost Curves (MACCs) provide an assessment of the level of emissions reduction which a range of measures could deliver at a given point in time, against a projected baseline level of emissions. They show how much CO_2 each measure could save (the level of abatement potential) and the associated cost per tonne of CO_2" (United Kingdom Committee on Climate Change, 2009).

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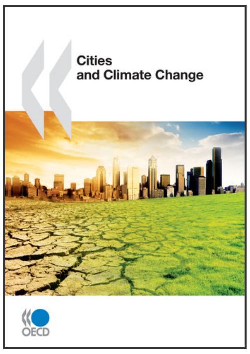

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