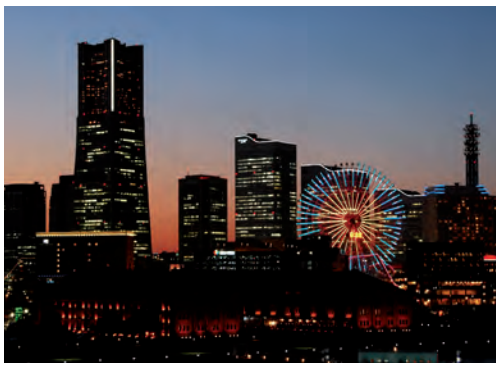
Competitive Cities and Climate Change

OECD CONFERENCE PROCEEDINGS
MILAN, ITALY
9-10 OCTOBER 2008



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ACKNOWLEDGEMENTS

This two-day event – the OECD Conference on Competitive Cities and Climate Change and the 2nd Annual Meeting of the *OECD Roundtable of Mayors and Ministers for Urban Development* -- was organised by the OECD, the Milan City Council and the Province of Milan, with the participation of the Club of Madrid and with the support of the Fondazione Eni Enrico Mattei (FEEM). The conference was hosted by ISPI (Instituto per gli Studi di Politica Internazionale).

Special thanks are given to the Mayor of Milan, Mrs. Letizia Moratti, and to President of the Province of Milan, Mr. Filippo Penati. We are also grateful to Mr. Fabrizio Grillo and Mrs. Laura Mazzini of the Milan City Council and to Mr. Giorgio Monaci of the Province of Milan.

We would like also to thank the Fondazione Eni Enrico Mattei (FEEM) for the support to the conference and in particular to Mr. Bernardo Bortolotti, Executive Director. We would also like to express our appreciation for the fruitful collaboration with the Club of Madrid, and in particular with Mr Fernando Perpina, Secretary General of the Club of Madrid, as well his colleagues Mrs. Maria Elena Aguero and Mrs. Agustina Briano.

The OECD international conference on Competitive Cities and Climate Change and the 2nd Annual Meeting of the *OECD Roundtable of Mayors and Ministers on Urban Development* is part of the OECD programme of work on urban and regional development, directed by Mario Pezzini, Deputy Director, Public Governance and Territorial Development.

The conference was co-ordinated by Lamia Kamal-Chaoui, Head of the Urban Development Programme, in collaboration with Raffaele Trapasso, Administrator and Erin Byrne, Project Co-ordinator, with the support of Suzanne Leprince, Secretary of the OECD Territorial Development Policy Committee, and Shivani Ratra, Internal Consultant.

Substantive contributions to the conference were provided by Michael Donovan, OECD Urban Development Unit and Laurie Geller, Senior Program Officer, National Academies, Board on Atmospheric Sciences and Climate, United States. The content of the conference has also benefitted from valuable suggestions from the OECD informal group on cities and climate change, including Jan Corfee-Morlot (Environment Directorate), Mary Crass (International Transport Forum), Jollands Nigel (International Energy Agency), Hiroshi Kobayashi (Regional Sustainable Development Division) and his colleague, Tetsuya Shimomura. The proceedings were edited by Victoria C. Elliott, writer/editor at the Lawrence Berkeley National Laboratory, and prepared for publication by Erin Byrne, OECD Secretariat.

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OECD INTERNATIONAL CONFERENCE

"COMPETITIVE CITIES AND CLIMATE CHANGE"

2nd Annual Meeting of the
OECD Roundtable Strategy for Urban Development

October 9-10, 2008, Milan, Italy

ISPI - Istituto per gli Studi di Politica Internazionale
Via Clerici, 5
20121 Milan

Introduction

The OECD international conference on "Competitive Cities and Climate Change" is the fifth of a series of conferences organised by the OECD to examine the challenges faced by large cities concerned with improving their economic competitiveness while providing the social and environmental conditions that are necessary to retain and attract skilled workers and investment. In a context of globalisation, previous OECD conferences addressed city competitiveness from the following perspectives: business environment, social cohesion, physical attractiveness, the role of central government. The conference in Milan addresses the environmental dimension of city competitiveness, focusing on the relationships between urbanisation and climate change, and the implications in terms of urban policy making.

As stressed by the OECD Secretary General, Angel Gurría, at the Madrid conference in March 2007:

> *"In our cities, citizens, industries and institutions must respond to the challenges of technological change and globalisation. In our cities, as elsewhere, we must deal with the social implications of change (…) Urban areas could (also) play a central role in successfully addressing global environmental challenges (…) Cities generate almost 70% of total gas emission. There is no doubt that improvements in urban design, housing stock, traffic congestion and accessibility, disaster prevention and waste management, are crucial component of a strategy to combat global warming. If cities fail to deal effectively with environmental challenges, our planet is in serious trouble".*

The conference is being organised in co-operation with the City of Milan and the Province of Milan, with the collaboration of the Club of Madrid and the support of the Fondazione Eni Enrico Mattei. As with previous OECD conferences, it will promotes policy dialogue among city mayors and national government representatives, in order to identify a common policy agenda for cities. It will bring together ministers, mayors, and regional leaders as well as eminent personalities from the Club of Madrid (former Head of States and governments), high-level representatives of international organizations, major local government networks and prominent experts.

The Milan conference will host the 2nd annual meeting of the ***OECD Roundtable Strategy for Urban Development***, which was created at the Madrid conference on 29-30 March, 2007 at the initiative of the Mayor of Madrid, Alberto Ruiz-Gallardón.

Competitive Cities and Climate Change: background and rationale

The world's urban population has multiplied ten-fold during the past century, and within the next decade, there will be nearly 500 cities of more than a million people, including several 'megacities' with populations exceeding 20 million. Meanwhile, cities have strengthened their role as drivers of innovation and entrepreneurship that account for a disproportionately strong share of a country's GDP per capita.

A series of recent OECD conferences have highlighted how cities respond to the challenges of technological change and globalization. The OECD Conference, "City Competitiveness" (Santa Cruz de Tenerife, Spain, 2005), examined policies implemented by cities and regions for fostering their competitiveness in the international marketplace, for promoting regional innovation, and for encouraging the growth of networks and partnerships with the private sector and universities. The OECD conference "Enhancing City Attractiveness for the Future" (Nagoya, Japan, 2005), offered evidence that an attractive environment and robust infrastructure are fundamental to metropolitan economic growth. The OECD Conference, "Sustainable Cities: Linking Competitiveness with Social Cohesion" (Montreal, Canada, 2005), revealed how cities often embody what is sometimes called the "urban paradox", the co-existence of high concentrations of wealth and employment alongside jarring socioeconomic disparities, distressed neighbourhoods, and criminality, which can be found in even the most dynamic metro-regions.

The ***Milan Conference*** builds upon previous debates to explore the connections between climate change and urban economic development. Cities are largely responsible for global climate change, accounting for ~70% of global greenhouse gas emissions. Cities often feel the effects of climate change more severely (*e.g.*, higher temperatures are exacerbated by air pollution and heat island effects and dense populations face elevated risks of infectious disease transmission). Mayors and regional leaders around the world are increasingly assuming leadership through a variety of innovative actions to reduce cities' 'carbon footprints', and to enhance their capacity to cope with anticipated climate change impacts.

A number of questions arise however, as to what extent these actions conflict or coincide with other objectives, especially competitiveness. Even when considering that such actions could strengthen many other aspects of cities' well-being, integrating climate change policies with economic growth and social development objectives challenges urban policy-makers. One such dilemma, for example, is how to integrate economic growth and climate change policies while organising mega-events such as the Olympic Games, International Expos, World Cups, trade fairs, cultural festivals and global summits.

Effective climate change responses at the local level require intergovernmental collaboration. The OECD conference, "Globalising Cities: Rethinking the Urban Policy Agenda" (Madrid, 2007), agreed that strong, effective urban policies that enable cities to benefit from globalising processes require flexible, multi-level forms of inter-governmental joint action. The need for a multi-level governance framework for urban development policies is particularly critical for addressing climate change. City and regional leaders are generally best suited to design strategies for addressing their own local climate change risks though not all leaders are keen to undertake such actions. Central governments can complement these efforts by assisting cities to better respond to climate change and providing scientific assessments that justify such intervention. Likewise, local governments are needed as partners to implement nation-wide climate change response policies, while at the same time designing their own policy responses that are tailored to local contexts.

The OECD Roundtable on Urban Strategy: a unique platform for addressing climate change

The OECD Roundtable on Urban Strategy of Mayors and Ministers is a unique global platform for addressing urban issues in a forum involving both national and local governments. In addition to its country delegate constituencies (comprised of high-level public officials from the 30 member countries), the OECD works directly with city and regional leaders, and international associations of local governments. Since March 2007, this process has been formalised through the creation of the *OECD Roundtable for Urban Strategy of Mayors and Ministers*, with the objective of fostering ongoing policy dialogue between local and national policy-makers responsible for urban policies.

The Roundtable on Urban Strategy also provides a valuable platform for addressing climate change issues. The OECD ***Directorate for Public Governance and Territorial Development***, has for decades worked on environment-related issues in its programmes of research on urban regions, and has implemented several projects and activities related to climate change from the viewpoint of urban policy, including a roundtable discussion on "climate change and cities" in the Working Party on Territorial Policy in Urban Areas (Rome, June 2007), a special session on climate change and cities at the OECD conference: "What Policies for Globalising Cities?" (Madrid, March 2007) and a workshop on Competitive Cities and Climate Change in the Working Party on Territorial Policy in Urban Areas (Paris, December, 2007). The Directorate also took part in the 2008 OECD Ministerial Council's meeting which was organised around the theme "Outreach, Reform and the Economics of Climate Change".

The Roundtable of Mayors and Ministers on Urban Strategy can benefit from the OECD's extensive experience in helping countries design policies that are both economically efficient and effective at achieving environmental objectives. In recent years, the organization has provided a forum for countries to discuss numerous key issues relevant to international negotiations on climate change (*e.g.*, emissions trading schemes, flexibility mechanisms, deforestation incentives, technology diffusion), and a wide range of climate change-related initiatives are underway. For instance, since 1994, the International Energy Agency and the OECD have jointly hosted the secretariat for the Annex I Expert Group on the UN Framework Convention on Climate Change (UNFCCC). Other ongoing OECD work examines the economic benefits of climate change policies implemented in different sectors and at different scales of governance; at the opportunities and barriers for diffusion of new technologies aimed at mitigating greenhouse gas emissions and sequestering carbon in the agricultural sector; and at the many dimensions of climate change mitigation and adaptation related to energy and transportation.

Objective of the conference

The objective of the Milan Conference is to engage a wide range of stakeholders, including city, regional and central government representatives, in considering a broader and holistic approach to climate change policies at the urban level. The conference sessions are designed to address this issue by:

- Examining how a city's climate change adaptation and mitigation actions affect/contribute to its efforts to remain competitive in the global economy. In particular, what are the inherent trade-offs and possible synergies between meeting climate protection goals, and the many other goals that are central to urban development (economic development, employment, social well-being, etc)?

- Identifying the bottlenecks to effective implementation of climate change policies at the city/regional level, and the existing urban governance mechanisms that allow implementation of integrative urban policy strategies;

- Assessing what are the key institutional challenges to multi-level governance on climate change, and how local and national governments and other stakeholders could work together most effectively to implement climate change policy actions at the city level;

- Providing a unique opportunity for city mayors, regional leaders and high-level national government representatives to put forward their ideas about the above mentioned issues and elaborate a common policy agenda.

In addition to Mayors, Ministers, and Regional Leaders, the OECD conference will target key international stakeholders such as local government associations (C40/Large Cities Climate Leadership Group; Clinton Climate Initiative; United Cities and Local Governments (UCLG); Local Governments for Sustainability (ICLEI)).

The ***Club of Madrid***, which consists of former Heads of State and Government, is a major partner in this event. The Club of Madrid has addressed climate change issues at the global scale through the Global Leadership for Climate Action (GLCA), a joint task force with the United Nations Foundation that engages former heads of state and government as well as leaders from business, government and civil society from more than 20 countries.

The ***Fondazione Eni Enrico Mattei*** (FEEM) has provided key support to this conference. The FEEM is an independent non-profit institution established to carry out research in the field of sustainable development. One of FEEM's principal aims is to foster the interaction between the academic, industrial, and public policy spheres in order to comprehensively address concerns about economic development and environmental degradation. The FEEM has a long-standing experience in the economic analysis of climate change, and its contribution to the Nobel Prize has been officially acknowledged by the Intergovernmental Panel on Climate Change.

The Conference will be held in the Clerici Palace on the grounds of the *Istituto per gli Studi di Politica Internazionale* (ISPI), *www.ispionline.it/it/palazzo_visita_virtuale.htm*.

Websites

- *www.oecd.org/gov/urbandevelopment/milanconference*

- *www.comune.milano.it/urbanforum2008*

ANNEX 1: AGENDA (PARTICIPANTS)

Thursday 9 October 2008

8:30- 9:00 Registration

9:00 – 10:00 Opening ceremony

- Letizia Moratti , Mayor of Milan, Italy
- Filippo Penati, President of the Province of Milan, Italy
- Odile Sallard, Director, Public Governance and Territorial Development, OECD
- Fernando Perpiñá, Secretary General, Club of Madrid
- Bernardo Bortolotti, Fondazione Eni Enrico Mattei (FEEM), Executive Director, Italy

10:00 -11:15 Plenary I: Competitive Cities and Climate Change: A Global Challenge

Moderator	Mark Drabenstott, OECD Chairman Territorial Development Policy Committee
Expert	Jan Corfee Morlot, OECD Environment Directorate, Member of the Nobel Prize winning Intergovernmental Panel on Climate Change
Panellists	• Petre Roman, Former Prime Minister of Romania. Member of the Club of Madrid • David Cadman, International President, President and Board Chair, Local Governments for Sustainability - ICLEI and City Councillor, Vancouver, Canada • Lars Reuterswärd, Director Global Division, Sustainable Development Network, Cities in Climate Change, UN Habitat

11:15 – 11:30 coffee break

11:30 -13:00–Panel Discussion I: Impacts and vulnerability of cities to climate change, costs and benefits of adaptation actions

Session I-A: "Climate-proof" urban infrastructure

Chairman : Konrad Otto-Zimmermann, Secretary General, Local Governments for Sustainability - ICLEI

Expert: Gianmarco Ottaviano, Professor of Economics, University of Bologna and Fondazione Eni Enrico Mattei (FEEM)

Session I-B: Climate Change and adaptation in the water sector

Chairman: Bernardo Bortolotti, Fondazione Eni Enrico Mattei (FEEM), Executive Director, Italy

Expert : Matthias Ruth, University of Maryland, College Park, United States

Panellists

- Wolfgang Schuster, Mayor of Stuttgart, Germany
- Rui Nuno Baleiras, Secretary of State for Regional Development, Portugal
- Marcos Perestrello, Vice Mayor of Lisbon, Portugal
- Imma Mayol, Deputy Mayor of Barcelona, Spain

Panellists

- Lajos Oláh, Deputy Minister for Environment and Water, Hungary
- Alexander Likhotal, First Vice-President of Green Cross International, Director of International and Media Relations at the Gorbachev Foundation and Advisor to the Club of Madrid
- Pierantonio Belcaro, Deputy Mayor for Environment, Venice, Italy

13:00– 14:30 Lunch

14:30 – 16:00 Panel Discussion II: Costs and benefits of mitigation actions

Session II-A: Transportation

Chairman : Adam Ostry, Chairman of the OECD Working Party on Urban Areas

Expert: Mary Crass, International Transport Forum, OECD

Panellists

- Benito Martínez-Loera, Council Member of the City of Monterrey, Mexico
- Takeshi Abe, Advisor to the Ministry of Land, Infrastructure, Transport and Tourism and Senior Executive Director, Real Estate Transaction Improvement Organization, Japan
- Rudolf Schicker, Vice Mayor of Vienna, Austria
- Bryan Glascock, Director of Environment, City of Boston, United States
- Renato Boareto, Brazilian Institute of Energy and Environment, Brazil

Session II-B: Energy Supply and Efficiency

Chairman: Fernando Perpiñá, Secretary General of the Club of Madrid

Expert : Nigel Jollands, International Energy Agency

Panellists

- Jiri Cunek, First Deputy Prime Minister and Minister for Regional Development, Czech Republic
- David Cadman, City Councillor, Vancouver, Canada
- Peter Dormand, City Energy and Resource Manager, Newcastle City Council, Australia
- Karoline Amalie Steen, Head of Finance Administration Division, City of Copenhagen, Denmark

16:00 – 16:15 Coffee break

16:15 – 17:45 – Panel Discussion III –Strategies, governance and climate change policies

Session III-A City economic development strategy and climate change

Chairman : Mario Pezzini, Deputy Director, Public Governance and Territorial Development, OECD

Expert: Joan Fitzgerald, Director of Law, Policy, Society, Northeastern University

Session III-B – Integrating climate actions with other urban governance goals

Chairman : Elisabeth Gateau, Secretary General, United Cities and Local Governments (UCLG)

Experts : Gotelind Alber, Expert in local and regional climate policy, Germany

Panellists

- Hanna Jahns, Secretary of State for Regional Development, Poland
- Kenji Kitahashi, Mayor of Kitakyusyu, Japan
- Javier Rubio de Urquia, Director General for Sustainability, Madrid City Council, Spain
- Corinne Hermant, DG Regio, Urban Unit, European Commission

Panellists

- Sara Topelson de Grinberg, Undersecretary for Urban and Regional Development, Mexico, , Mexico
- Abel Caballero Álvarez, Mayor of Vigo, President of the Network of Spanish Cities for Climate, Spain
- Wade Crowfoot, Director of Climate Protection Initiatives, Office of the Mayor, City and County of San Francisco, California, United States
- Katrina Bull, Councillor of Nottingham, United Kingdom
- Romain Diederich, Premier Councillor, Ministry of Interior, Spatial Planning, Luxembourg

Friday 10 October 2009

9:00 – 11:00

Cities and Climate Change: Civic and Business Engagement

Chairman: Joan Boer, Ambassador, Permanent Delegation of the Netherlands, OECD

Panellists

- Joost Van Iersel, Chairman of the Consultative Committee on industrial changes, European Economic and Social Committee (EESC)
- P.J. Partington, Climate Change Project Manager, Taking IT Global
- Pedro Ballesteros, DG Energy and Transport, Covenant of Mayors, European Commission
- David Lunsford, Policy Leader: Emissions Trading, International Emissions Trading Association (IETA)
- Nancy Kete, Director, EMBARQ, The WRI Center for Sustainable Transport

11:00 – 11:15 coffee break

OECD Roundtable of Mayors and Ministers on Urban Development Strategy

Chairs: OECD Secretary General, Angel Gurria and Letizia Moratti, Mayor of Milan, Italy

Mayors, Ministers and members of the Club of Madrid

Close-door meeting
Invitations only

11:15 – 13:15 Plenary II: Competitive Cities and Climate Change: Global Governance

Moderator Cristina Narbona Ruiz, Ambassador, Permanent Delegation of Spain to the OECD

Panellists

- OECD Secretary General, Mr. Angel Gurría
- David Miller, Mayor of Toronto and Chair of the C40s Large Cities Climate Leadership Group
- Ira Magaziner, Chairman of the Clinton Climate Initiative, Clinton Foundation
- Teresa Ribera, Secretary of State for Climate Change, Spain
- Wolfgang Schuster, Mayor of Stuttgart, Germany and Vice-President of United Cities and Local Governments (UCLG)

Closing remarks: Reflection on recommendations for further action and next steps for the OECD

Antonio Armellini, OECD Ambassador of Italy

ANNEX 2: AGENDA (CONTENT)

Thursday 9 October 2008

8:30- 9:00 Registration

9:00 – 9:30 Opening ceremony

Welcoming remarks and overview of conference goals from OECD Officials, local hosts.

9:30 – 11:00 Plenary I: Competitive Cities and Climate Change: A Global Challenge

It is widely recognized that climate change is an urgent global challenge, and cities around the world must be at the front lines of meeting this challenge. As both human economic activity and population becomes increasingly concentrated in cities, urban areas are increasingly at the heart of climate change mitigation and adaptation policy. Our scientific capabilities for projecting future climatic changes and the resulting impacts is rapidly increasing. Likewise, many recent studies have helped elucidate the potentially enormous economic costs of not taking action to address climate change. There are still however, large uncertainties when it comes to 'downscaling' these projections and estimates to levels that are useful to city-level decision makers. Understanding and managing climate change risks at the urban scale requires developing a common vision among key stakeholders about likely future climate change scenarios and risks, and ensuring engagement of these stakeholders in reaching a common set of goals to manage risks. Delivering meaningful information at the local scale requires working scientific and technical experts , as well as drawing upon local knowledge and insights for exploring questions about how a city can develop in response to changing climate conditions. The challenge is not to predict the future, but to approach the future with the right tools and the right information.

- What experience do we have with assessing local-scale climate change impacts, and using this information for planning adaptation measures?

- What types of information are required and who needs to be involved in creating a vision of the "future city" and urban development in general?

- What type of science-policy interface is needed to assure that cities have access to timely, up-to-date scientific information about local-scale risks and impacts? What models for partnerships (across national and local, private and public entities) are most effective for funding and conducting the necessary assessment work?

- What role can governments play to sensitize and engage the private sector and the general public in local-scale adaptation efforts? What other local actors and knowledge resources need to be engaged?

- What is the most effective way for cities to identify highly vulnerable populations, and develop strategies to reduce their vulnerability?

11:00 – 11:15 coffee break

11:15 – 12:45 Panel Discussion I: Impacts and vulnerability of cities to climate change, costs and benefits of adaptation actions

Given the current trends in atmospheric greenhouse gas concentrations, some degree of climate change is inevitable, and indeed we are already seeing effects of a changing climate on many human, ecological, and physical systems. It is thus imperative that urban policy-makers develop proactive strategies to understand and minimize their vulnerability to climate change. This includes not only protecting existing urban areas, but also assuring that the future urban expansion is managed with the risks of climate change in mind. Specific impacts will vary widely, depending upon a city's location and geography, physical infrastructure, demographics and affluence, public health systems, and many other factors. Thus, simple 'universal' answers cannot be expected. Each city needs to develop the capacity to carry out its own vulnerability and risk assessments, and to design its own optimal adaptation strategies. Because there will always be substantial uncertainties about the specific nature and costs of future climate change impacts, a key challenge is to identify measures that strengthen a city's well-being and competitiveness, regardless of what changes occur.

Session I-A: "Climate-proof" urban infrastructure

The infrastructure for essential services such as energy, water, waste management, transportation, and communication drives a city's economic growth, supports social needs, and is closely linked to urban residents' health, well-being, and quality of life. For cities to be liveable and sustainable they must have robust and adaptable infrastructures. Disabling, and even temporarily disrupting, these critical services can have major detrimental impacts on a city's economy and competitiveness. Climate change impacts such as increased risk of severe storms and extreme heat pose serious threats to urban infrastructure. Coastal cites, in particular face threats to critical infrastructure from rising sea levels. Both the technology and management of modern urban infrastructure is built on assumptions that future climate will look very much like it has in the past; yet climate change threatens to significantly change these baseline conditions. So the goal of developing 'climate-proof' urban infrastructure is to adapt not only the relevant technologies, but also the institutions and management practices that have co-evolved with these technologies.

- What measures can be taken to make urban infrastructure (*e.g*., buildings, utilities, roads and transit systems, and in the case of port cities, sea-barriers, dikes, and drainage systems) more resilient to changing climate patterns, more extreme weather events, and sea level rise?

- How can urban planning strategies reduce a city's vulnerability to climate change by directing new development away from areas at greatest risk, and by adopting land use practices that mitigate climate change impacts (*e.g*., urban forestry and greenspaces, use of more light-reflecting urban surfaces)?

- How can low-lying coastal cities best protect themselves from the risks of sea-level rise and flooding, through risk analyses and response strategies such as land use planning and infrastructure including sea-barriers, dikes, and drainage systems?

- How can adaptive water resource management strategies help cities to prepare for climate change impacts on water quality and quantity and to avoid subsidence and exacerbation of flood risk?

- What public health protection measures do cities need to institute, to protect urban populations against the health threats posed by climate change?

Session I-B: Climate Change and adaptation in the water sector

Of the many potential impacts of climate change, effects on water resources is a centrally critical area for people's lives and for the economic stability and competitiveness of cities. Water resource issues interact with a wide range of socio-economic and environmental sectors, including health, agriculture, energy, biodiversity, industry and navigation. Indeed, there are few activities that do not in some way depend on water resources. This sector is also a particular concern because many cities around the world are already facing significant water stresses, due to competing demands (of urban/industrial, agricultural, recreational and ecological protection purposes), pollution of surface water sources, and over-exploitation of groundwater sources. Climate change is likely to greatly exacerbate this situation, as shrinking glaciers and snowpacks (a primary source of freshwater for many areas) shrink, as rising sea levels lead to salt-water intrusion that contaminates groundwater aquifers, and as more extreme cycles of precipitation and drought make it more difficult for water managers to make planning and investment decisions.

- What types of 'adaptive management' practices can urban water resource managers use to effectively cope with the uncertainties arising from changing and more extreme hydrological patterns?

- What are the most effective methods of encouraging water conservation among key players within an urban environment (households, business and industry, etc)?

- What types of improvements to urban water management infrastructure are most critical for reducing vulnerability to climate change impacts (*e.g.*, for water conservation measures, preventing saltwater intrusion, managing stormwater overflow events)?

- What feedbacks between climate change and urban water resource management may be possible (for instance, will warmer temperatures increase water demand?)

12:45– 14:30 Lunch

14:30 – 16:00 Panel Discussion II: Costs and benefits of mitigation actions

Cities need energy – lots of it. As cities consume a dominant share of global energy supply and emit a similar proportion of CO_2 emissions, they can and must lead the way in implementing bold, innovative strategies to 'de-carbonize' energy systems – including the energy used for transportation, for electricity and heating, and for industrial processes. This requires not only the development and implementation of new technologies, but also the promotion of fundamental behavioral changes on the part of individuals, businesses, and other key players in an urban environment (for instance, with regards to travel and energy conservation practices). A wide variety of programs and policies for reducing greenhouse gas emissions are being implemented in cities around the world, providing a valuable 'test-bed' for assessing the effectiveness, benefits, and costs of such actions in different settings.

Session II-A: Transportation

While mobility of people and goods is central to the life of a city, the transportation sector accounts for a large and growing share of greenhouse gas emissions, is a major source of air pollution, and in many cities, paralyzing traffic congestion is a major detriment to quality of life and economic efficiency. Municipal leaders thus have a strong motivation to advance smart, energy efficient transportation systems. This includes managing demand for private vehicle travel in cities through pricing and other means; promoting high-quality public transportation, encouraging use of non-motorized transport means (*i.e.*, cycling and walking) as well as use of energy efficient vehicles and low-carbon transport fuels – particularly in public fleets; and supporting organization of car-sharing and telecommuting programs. It also includes steps to steer land use and urban planning towards developments that minimize the need for travel. Such policy initiatives not only make a huge difference in reducing a city's carbon footprint, but also can greatly enhance a city's attractiveness, overall efficiency, and thus competitiveness in the global arena.

- What have we learned about the effectiveness of policies to discourage the use of private vehicles in urban core areas (such as congestion pricing schemes)?

- What are the biggest opportunities and the biggest challenges facing cities in their efforts to expand mass transit systems?

- What types of programs and infrastructure changes are most effective for making a city more pedestrian and bicycle friendly, and for encouraging citizens to choose these options?

- How do sprawling development patterns affect travel behavior and CO_2 emissions; and how can regional spatial planning and smart growth principles be used to minimize sprawl?

- How can city governments promote the use of low carbon emitting vehicles and fuels, for instance, through policies governing the purchase of municipal vehicle fleets and influencing the vehicle choices of city residents and local businesses and industries?

Session II-B: Energy Supply and Efficiency.

Cities have innumerable opportunities to take leadership in shaping a sustainable climate future, by promoting energy efficiency and conservation in the municipal, industrial, commercial, and household energy sectors, and by advancing clean, renewable forms of energy for heating and electricity. For instance, it is possible to significantly lower a metropolitan area's carbon intensity through the use of combined heat and power, co-generation, and district heating and cooling; through the promotion energy efficient housing and construction (including with cutting-edge 'green building' technologies and design, as well as simple measures such as solar water heating and adequate insulation); and through the promotion of decentralized, renewable energy supply systems. Local governments can also use their political influence and purchasing power to improve the economic competitiveness of renewable energy sources. Such actions not only help advance long-term goals for mitigating climate change, but also contribute to immediate goals of alleviating air pollution, and generating major cost savings.

- How can city leaders encourage energy conservation efforts among local businesses, individual households, and municipal institutions?

- What are the priority sectors that city governments should focus on to achieve cost-effective CO_2 mitigation?

- What policies are required to promote energy efficient buildings in the commercial, residential, and municipal building sectors?

- What other measures have proven to be effective for cities to promote energy conservation and efficiency (*e.g.*, in traffic and street lighting, less energy-intensive water supply and treatment systems, heat and energy co-generation systems, waste-to-energy systems)?

- How can city leaders promote broader use of renewable energy sources for meeting urban energy demand?

- What is the potential for improved urban design/land use planning to achieve CO_2 mitigation? What urban design/in land use planning tools should cities consider using?

16:00 – 16:15 Coffee break

16:15 – 17:45 – Panel Discussion III –Strategies, governance and climate change policies

As discussed in the preceeding sessions, there are a wide array of actions and policies that cities can pursue to address the goals of cutting greenhouse gas emissions and building resilience against the impacts of climate change. These sorts of actions can add up to much more than the sum of their parts, however, if they are not taken as isolated measures; but rather, are designed as part of comprehensive, integrated strategies for fostering sustainable urban development. In particular, climate change response measures can be designed to create new economic development opportunities and enhance other key urban governance goals, and to maximize the benefits of mega-events and other unique windows of opportunity for urban renewal.

Session III-A City economic development strategy and climate change

One of the main obstacles preventing political leaders from moving ahead with actions to respond to climate change is a perception that such actions force inevitable trade-offs against the goals of economic growth. Cities around the world are learning, however, that through the development of effective partnerships between municipal leaders and other key stakeholders (*e.g.*, in business, industry, financial institutions, citizens groups), cities can leverage funding and maximize opportunities for using climate actions plans to stimulate new economic development. This may include linking strategies that connect climate change response goals to business profitability and training for populations struggling with high unemployment rates; transformational strategies that use climate change goals to help 'green' existing businesses so they can remain profiutable or expand into new markets; and leapfrogging strategies that attempt to create an entirely new sector in a green technology area.

General examples include installation of solar panels and other distributed renewable energy systems, investment in energy efficient buildings and technologies, recycling and waste-to-energy systems, expansion of mass-transit, urban forestry efforts, and the creation of compact mixed-use communities in core urban areas. A more specific example is for cities to capitalize upon 'mega events' (such as Olympic games, International Expos, World Cup tournaments, policy summits) as opportunities for simultaneously advancing goals for economic development and goals for climate change mitigation and adaptation.

- What are some of the most promising examples of opportunities for linking climate protection measures to efforts to catalyze economic development goals and create new employment opportunities?

- Who are the key players within an urban community that city government leaders need to work with for identifying and taking advantage of opportunties to link climate change response strategies with economic development efforts?

- How can climate change mitigation/adaptation policies be shaped to help ensure that the resulting economic benefits remain rooted within a city's local economy (*i.e.*, that the economic developments are 'place based' and cannot be outsourced to other areas).

- In what ways might climate change adaptation/mitigation actions actually lead to trade-offs with economic development goals? In such cases, are there steps that can be taken to help align these competing goals?

- What are some ways that hosting mega-events can provide opportunities for a city to advance both economic development and climate change response goals (*e.g.*, by creating new public facilities and infrastructure for energy supply, waste management, and public transportation)?

Session III-B – Integrating climate actions with other urban governance goals

Mayors and other city leaders must address the challenges of climate change simultaneously with a host of other of urban governance challenges. This includes for instance, advancing a city's economic health and competitiveness; providing opportunities for high-quality education, training, employment; providing affordable housing, attractive communities, a clean environment, well-functioning public services, and cultural and recreational facilities; assuring protection of the public against crime, health risks, and natural disasters. The economic costs and political risks of climate adaptation and mitigation measures are minimized when they provide ancillary benefits for these other important goals of urban governance. Key to the success of such efforts is intergovernmental co-operation, with concerted efforts to build linkages across the different 'silos' of urban management (*e.g.*, departments that address economic development, environmental protection, infrastructure and urban planning, and other other key issues).

- What are some key examples of climate change response measures that can lead to benefits for other important realms of urban governance, for instance, related to housing and sanitation, health and security, economic growth and competitiveness?

- What are some key areas of potential conflict between climate change response measures and policies/programs for other core urban governance needs?

- What sorts of barriers (personal, institutional, political, legal) may impede efforts to integrate these different realms of urban governance?

- What types of management structures and mechanisms are needed to build effective working relationships among the different governmental departments that deal with climate change and those that deal with other areas of urban governance?

Friday 10 October 2008

9:00 – 11:00 – OECD Roundtable of Mayors and Ministers on Urban Development Strategy

Chairman: OECD Secretary General, Angel Gurria

Participants to the close-door meeting will include only Mayors, Regional Leaders, Ministers and Former Heads of State and Government from the Club of Madrid.

Close-door meeting -Invitations only

9:00 – 11:00 - Cities and Climate Change: Civic and Business Engagement

Local government authorities cannot effectively address the massive challenges posed by climate change without widespread, grassroots involvement of a wide variety of actors in civil society (*e.g.*, citizens groups, students, neighborhood associations) and in the private sector (*e.g.*, investors, firms, industries, business associations). These non-governmental stakeholders can play key roles in both contributing to the development of sound government policies, and in assuring that such policies are effectively implemented (for instance, through personal behavior changes, through new business invesments and practices). There are many steps that local authorties must take however, to engage and motivate these other important stakeholders. For instance, private sector interests often require clear government policies and incentives to undertake climate-related R&D and investments. In order to build a critical mass of interest and support among these other key stakeholders, political leaders need to effectively communicate about the motivations for addressing climate change and about the economic opportunities and other benefits that climate response plans can offer to the broader community.

- What are the different types of stakeholder groups and institutions that urban leaders can work with to advance climate change response policies and programs (*e.g.*, business and industry leaders, schools and universities, citizens groups and neighbourhood associations, religious and cultural organizations)?

- What are the specific roles that can be played by these various stakeholders (*i.e.*, what particular strengths/assets would these different groups "bring to the table")?

- What types of financial and policy incentives are most effective for engaging different types of small/large enterprises in public-private partnerships for addressing climate change goals?

- What sorts of communication and outreach strategies are most effective for engaging these different types of stakeholders and keeping them involved as active partners in ongoing programs?

11:00 – 11:15 coffee break

11:15 – 13:00 Plenary II: Competitive Cities and Climate Change: Global Governance

Urban-scale climate change response actions are closely intertwined with policy developments occurring at other levels of governance. National-level policy and legislative frameworks can either facilitate or hinder action at the local level. Conversely, cities can both influence national climate change and energy policies, and play major roles in putting national policy frameworks into practice.

Local-level climate change response actions are also increasingly linked to international level processes, such as those of the UNFCCC, UN-Habitat, UNEP, World Bank, the OECD and regional entities such as the European Union, the Asia Pacific Economic Co-operation Forum. There is, at the same time, a burgeoning community of 'peer-to-peer' international networks among cities. Optimizing the potential benefits of multi-level governance is an ongoing challenge for urban leaders, due to the rapidly evolving nature of this complex playing field.

- What types of the key actors and institutions are most important for facilitating effective interaction among different levels of governance on climate change and energy policy?

- How do national level policies strengthen or weaken adaptive capacity and action at local levels?

- What types of national policy frameworks and programs (for instance, for capacity building, information sharing, financing, and policy guidance) are most important for enabling action at the local level?

- How can urban-level leaders most effectively influence international-level policies for climate change mitigation and adaptation?

- How have networks that directly link city leaders from around the world helped to advance climate change response efforts, in the face of inertia at national and international levels.

13:00 -13:30 Closing ceremony:

Reflection on recommendations for further action and next steps for the OECD.

REMARKS BY OECD SECRETARY-GENERAL, ANGEL GURRÍA

Ministers, mayors, ladies and gentlemen,

It is a great pleasure to speak to you on a topic that lies at the heart of the OECD's mandate: climate change and global governance. Climate change is the global challenge par excellence, one that cannot be addressed by any country alone and one that inevitably calls for multilevel governance approaches. Cities are part of the solution.

For this reason I am very pleased that this Conference is urbanising the climate change debate. This is where climate change will mainly need to be addressed. Your attendance here from 21 cities, 17 countries, and 10 international organisations, not to mention a number of important non-governmental organisations or companies, pays tribute to the importance of multilevel mobilisation of effort around climate change.

The OECD Environmental Outlook to 2030 projected that, if we continue on a business as usual path, global greenhouse gas emissions will grow by over 50% by 2050; which will cause world temperatures to rise between 1.7 and 2.4 degrees Celsius above pre-industrial levels by 2050, and between 4 and 6 degrees Celsius or more in the long-term. This pace of change is ten times greater than that experienced since the last Ice Age.

Climate change will impact on our health, our security and our economies. The damage could be large and irreversible. This means we need to act now. Moving forward will not be cheap but doing nothing is not an option. In fact, inaction would be even more costly. The key question is thus how to find the best way to move forward. This is where the OECD's more than 20 years experience on the economics of climate change makes a difference.

Our work shows that a cost-effective strategy to tackle climate change will need to emphasise instruments that put a price on greenhouse gas emissions, covering as many countries, sectors and greenhouse gases as possible. Cap-and-trade schemes, or emission taxes are cost effective because they induce firms to look for abatement options where they are cheapest, and boost incentives to scale up climate-friendly R&D. These economic instruments need to be complemented by other policies to help address market and information failures. For example, the lack of information about energy-efficiency performance of electrical appliances and light bulbs may prevent households from optimising energy consumption. Such specific problems can be addressed through energy efficiency standards, or eco-labelling requirements. Both are areas where municipal policies can have a big impact.

Climate change is a comprehensive challenge. Addressing it successfully will need the combined partnership of national governments worldwide, local authorities -including cities -, the energy industry, other business and consumers. We are already seeing action by many of these partners, but a more co-ordinated, comprehensive and ambitious response is needed. This will also require addressing the difficult problem of how to distribute costs among the different players. The OECD is currently extending its analysis of the costs and impacts of different policy mixes to address climate change. The results of this work will be available in autumn and will feed into the UNFCCC's process leading up to the 15th Conference of the Parties in Copenhagen at the end of 2009.

We need the commitment and involvement of all countries, all regions and all cities if we are to move forward. What happens on the global scene is replicated at the local level. In many ways, the global challenge is made up of many smaller problems that are even more visible at the local level.

Two key facts can illustrate the central role of cities and metropolitan policies in addressing the challenge of climate change:

1. Urban areas make up just 2% of the world's surface but consume between 60 and 80% of commercial energy.

2. Climate change is already having a large impact on cities: hurricanes and floods have destroyed urban infrastructure, rising sea levels have altered real estate markets, and heat waves have produced power outages, harmed agriculture and most importantly put people's lives at stake.

Apart from preventing health, environment and economic losses, there is also a strong business case for taking action at the city level. Companies value clean and safe environments to do business and action on climate change can also serve to create new business opportunities, for example in the area of green buildings or clean technology. This will require a new set of policies that stimulate and enable a "green economy" to flourish.

But we will also need better tools to protect cities and their inhabitants from the effects of inevitable climate change. Today, the OECD is releasing, jointly with the Danish authorities, a new case study on Copenhagen as part of our project on Cities and Climate Change. This ongoing project assesses climate change impacts, sea level rise and storm surge risk in port cities. We found that Copenhagen's existing dikes and sea walls are able to face significant sea level rise, but they need to be upgraded. Otherwise, a storm surge with one-out-of-ten chance of occurring every year would cost Copenhagen 2.5 billion Euros. And the economic costs would be much higher in many cities worldwide, especially in developing countries, where comprehensive flood defense infrastructure and risk management plans may be weaker. We are currently carrying out another case study on Mumbai, a city which has experienced increasingly significant flood damages in recent years.

Let me now turn to the policy conclusions. What can be done in concrete terms to "urbanise" the climate change debate?

First and foremost, cities and nations need to collaborate better on climate change. This would ensure coherence of local and national action, while clearly acknowledging differences in the mandates of cities and national governments. City and sub-national regional leaders are generally best suited to design strategies to address their infrastructure needs, land use, geography, and economic profiles. Central governments, in turn, can set out the broad goals and frameworks to encourage action in the right areas; they can also provide needed funding or other incentives for city initiatives. Together they could work closer together to develop and exchange information about possible policy responses, to experiment with new solutions, to share experience and broaden and replicate successful initiatives.

But currently, there is no common set of urban environmental indicators that could facilitate the exchange of experiences and enable comparisons. Each city uses its own methodology to measure contamination and compliance with regulations. Here is where the OECD could contribute by joining other partners to help development and promote harmonised reporting frameworks to assess and measure progress towards carbon emission reduction across cities. The OECD can also help in pooling knowledge on the best tools for multi-level governmental collaboration in addressing climate change.

Momentum is building to mainstream policies for the “green economy” and climate smart cities. Some progressive cities are already providing financial incentives for cleaner public transportation, for green buildings, and for renewable energy.

To name just a few examples: In Pittsburgh, the city’s Urban Redevelopment Authority offers loans at lower interest rates for projects that earn green building certification. Cities throughout Italy, Japan, and Canada have distributed “smart metres” to homes, which allow citizens to adjust their energy consumption in real time rather than after receiving a bill at the end of the month. City governments, which are often the largest local employers, are also beginning to hold themselves accountable by mandating “green tendering” procedures that limit their own carbon and other environmental footprints.

Many more cities are taking path-breaking action around climate change, but more often than not their experiences fail to inform policy at the national level. A richer and more structured interaction between cities and national governments could help create improved tools to support the “green economy” and the “climate smart” urban economy.

This morning I took part in the Roundtable on Urban Strategy of Mayors and Ministers whose participants discussed many of these issues. Mayors and Ministers underscored the need for stronger partnerships between cities, national governments and international organisations to more effectively contribute to climate policy responses. They called upon the OECD to help systematise city experience, to draw out good practice and to help them measure their performance. They also asked the OECD to help them become more active in international markets to reduce emissions. We will work in partnership with our member governments and their cities to bring city level perspectives experience to bear on the climate discussions and energy frameworks for policy.

At the OECD, we will continue to support our leaders to establish cost-effective climate change policies and encourage them to involve cities as major actors in these debates. During the time of this plenary alone another ten thousand people will migrate from rural areas to cities. There they will contribute to the economy, but also consume energy, produce waste and boost GHG emissions.

How cities develop will determine our collective ability to address climate change. It will be decisive in driving world green-house gas emissions up or down and it will determine how vulnerable we are to climate change impacts. The time has come to bring the experience and the capacity of cities to deal with the development and climate change challenge to the front of the climate debate. We need to empower cities to do the right things on climate change and we need to learn from their experience.

The OECD stands ready to help in addressing this challenge of multilevel global environmental governance to tackle climate change and we look forward to working with you to make this world a better and more livable place for our children and grandchildren.

OPENING REMARKS BY THE MAYOR OF MILAN, LETIZIA MORATTI

Thank you very much, a very warm welcome to all of you to the city of Milan. I hope this will not only be an interesting meeting, but I hope you will have the opportunity to see the beauties of the city. So thank you very much. Thank you to the OECD and to the province of Milan, who are co-organizers of this event. As you have heard, we have a day and a half of intense work. So, let's start, and I will only give you an opening and short address telling you something about the experience we have as a city, and what we believe we can share among cities, and not only among cities.

Why cities? Because the world's cities account for 80% of humanity's production of greenhouse gas. So at the same time, cities are, from 2008, the places where half of the population of the world lives. So that's why cities have to commit themselves, in order to give a contribution to the climate change problems. We bring responsibility, and therefore we need to see what kind of new model we can put in place if we want to leave a better world for the future generation. Why can we give our our experience? Because cities are the natural laboratories where research is conducted, where education takes place. There is a lot of energy, a lot of resources in cities. That's why I believe that cities can really make a great contribution.

Eight years ago, in 2000, when the UN Millennium Development Goals were signed by the heads of states and governments, I have to remember that "Ensure environmental sustainability" was one of the seven goals. And we all know how far we are from reaching the goals. So I think that's for that reason, all the players have to make contributions, and interestingly enough, this last February, we had at the U.N. level, the first time at the UN General Assembly which was dedicated to climate change, mayors were there. There were two mayors, Mayor Bloomberg and myself, at the opening session to discuss the role of cities. So at the UN level, there is a new interesting trend, that is to have global cities as actors, and as new players coming at the level of a multilateral agency. So that is one of my points.

When I was speaking about the new model, I think that the new model should be to strengthen the relationship between cities, national governments, but also multilateral agencies. And just to give you a very brief idea, and I don't want to elaborate on that, we will have time during these two days, Milan was the first city to sign an agreement with the World Bank for climate change. My deputy mayor for environment is here, and I am sure he will elaborate in a panel later on the kind of agreement we have signed. But I think that this is something interesting, that the World Bank, for the first time, signed with a city an agreement on environmental problems and climate change.

Second, I think that we have a strong opportunity, which is to strengthen our network capability option and work that we can do altogether. I'm sure that all of you, or many mayors, they share participation in the most important network, the network in which we are all are represented, the USG network, the network where almost a thousand cities are represented. Interestingly enough, last week I was discussing this, again at the UN General Assembly. The Secretary General of the United Cities and Local Governments was there, and she said that it was the first time, again at UN level, that mayors had agreed to put their competences that we do have together, but try to raise the competence that we have to give a contribution at UN level. So probably, this – I'm not sure whether this was part of the final declaration of the UN, but I think that this is the sort of trend that we have to strengthen.

Talking about networks, I just mentioned another network, which has just started, although not all mayors are part of this network, but it is an interesting network where we can share not only experience, but opportunities. I'm talking about the Flint? City Network. It is a very recently formed network, at last Davos, and for the moment, it's Tokyo, New York, San Francisco, Mexico City, Teheran, London and Milan. This network has the idea of having green procurement, so let's put us altogether, and by joining forces, we can have a critical mass that will allow us to buy, for instance, hybrid vehicles at a lower price, and to convince the motor houses of production to lower the price, so we can give the assurance that cities will buy, and this will lower the price.

So this is just two, and of course there is the Covenant of Mayors European network, which is also a very interesting one, and I'm sure that many of us share not only the experience but the objective, as a city, of achieving not only the 2012 Kyoto Protocol objective but going beyond, and we have a strong idea of what we have to do from now to 2050.

So this is just, I am putting on the table some of the potential issues for discussion: I will conclude that we also have, all of us, we have what are called "flagship"events. The OECD was pointing out that for instance Milan did not have a flagship event a couple of years ago, now we do have a flagship event, which is the Expo Milan-Italy 2015. But let's use these flagship events, no matter what they are, to again make a contribution for climate change. So our Expo, so all of you who want can have more detail, we can have all the details on our Web site, or we can provide them during these couple of days, but again, Expo can be a contribution. I should just mention one point that we provided on our proposal when we were tendering for our bid: that we were prepared to give EUR 52 million for the joint implementation project to create, to give the opportunity to developing countries to have their own project and their own green credits. So not just trading green credits, but work on the joint implementation project: desertification, sea-level rise, the so-called landlocked countries, there are so many, or countries that are exposed to an earthquake or tsunami. There are so many opportunities. We are now working on 450 different scientific projects with more than 150 countries. So let's use these flagship events for a good cause.

And for that reason, the World Bank has signed an agreement with Milan Expo 2015. So we will select a project together, and they will help us on the selection of the project, and then we will match our funds. So our EUR 522 million for the developing countries are now becoming more than EUR 100 million. So this is another opportunity that we all have, and I am sure that we all share the same responsibility, and we all are committed, because I remember the last of the eight goals talks about sharing their good practices and developing together, so that's, I think, the point. I think that if we join forces, we have more energy to put for the best and the good causes. I hope for a great success for the OECD, and I again welcome you to Milan. So I will call for a great success for the OECD, for the province of Milan and for the city and for all of you, thank you.

OPENING REMARKS BY THE PRESIDENT OF THE PROVINCE OF MILAN, FILIPPO PENATI

The Province of Milan would like to thank all the ministers and government officials, the mayors and representatives of local governments, the non-governmental organisations and the international experts who have agreed to participate in this important event today.

I am sure that the combined commitment of the OECD, the municipality and the province of Milan, the Club of Madrid and the Fondazione ENI Enrico Mattei will result in a productive contribution toward redefining the agenda of national and local governments in the field of climate change and environmental issues.

I would like in particular to thank the Secretary General of the OECD, Mr. Angel Gurría, who so graciously accepted Milan's candidacy to host the fifth OECD Conference on cities' competitiveness and climate change, a most topical subject today at a time when oil prices are so high.

Climate change is a global challenge, and cities and metropolitan areas are key actors that have to be involved in formulating policy to mitigate and adapt to this phenomenon, first of all, because cities and metropolitan regions represent a large majority of the world's population, and secondly, because given their high population density, cities are a principal locus of the consumption of energy and a major contributor to climate change. Obviously, any climate change policy must be implemented at the local level, with the full support of local governments and the population.

As a focus both of scientific and of industrial activity, cities are well equipped to elaborate a strategy to face climate change. However, these sources of expertise and capability must be supported by good governance and a sharing of responsibility, particularly on the part of local governments, which need to assume a metropolitan dimension. Broader administrative jurisdiction will allow local governments to take full responsibility for new issues of importance, such as green buildings, energy and transportation, as well as to allow them to handle more effectively their other traditional competences, such as spatial planning, waste management, transportation tolls and so on.

There are already some examples in which central governments are co-ordinating with local governments to design and implement policy solutions for climate change. For instance, the Danish government, in co-operation with the city of Copenhagen, will be hosting a global forum of local governments to discuss climate change next fall. Another such example is that of the European Commission, which through its Commissioner for Energy, is involving local governments in drawing up a common strategy to optimise the consumption of energy.

Let me clarify: local governments are not asking for more public resources. They are asking to be involved in the development and implementation of key policies that will have a major impact on their citizens' lives. They are asking for participative democracy, in which decisions and responsibilities are shared across the different tiers of government.

In particular, it is crucial to re-adjust the administrative jurisdictions of local governments and to take into account the functional dimension of a metropolitan region.

In Italy, thanks to the contribution of the OECD, this has become a vital topic. The debate is particularly lively in Milan, where there is a need to redistribute responsibilities and competencies between the municipality and the province, so as to work toward improving local government's capacity to meet the citizens' need for better public services.

I look forward to our discussions at this very important conference. Thank you.

OPENING REMARKS BY THE DIRECTOR OF THE OECD PUBLIC GOVERNANCE AND TERRITORIAL DEVELOPMENT DIRECTORATE, ODILE SALLARD

I would first like to thank the City and Province of Milan for their generosity in hosting this important and timely Conference. I have been active in issues of governance at the OECD for some time and this is the first time that the OECD has organised a conference that directly explores the role of cities in fighting climate change. The time has come. I am pleased that the City and Province of Milan have assumed leadership in this area and that many Mayors, Ministers, urban experts, and representatives from nongovernmental organisations are here with us today. Though you come from many backgrounds, I hope that we can all agree that solutions will not simply involve a technological "fix" but require changes in how government perceives problems and creates solutions together with other actors.

As the Director of the OECD's Public Governance and Territorial Development Directorate, I oversee numerous research projects on urban economic development. We have done detailed profiles of 16 metropolitan regions in the world including Milan, but also Madrid, Copenhagen, Cape Town, Mexico City and many others. Our research illustrates how these regions have emerged as the key conduits of trade and innovation. We also study how cities can work with other local governments in their region, along with their central government, to formulate and implement economic policy. We have shown how pollution compromises competitiveness and how cities can provide climate solutions. We also focus on how cities can provide climate solutions and capitalise on the growing "green economy" through sustainable tourism, "clean-tech" R&D, environmental technologies, and renewable energy. Given high fuel prices and the inevitable growth of the "green economy" our studies have revealed how cities are increasingly competing for what could be called a first-mover advantage. City governments are competing to attract companies in solar technology, for example, because they know that such an industry will grow and provide green jobs. Cities are also implementing a range of programs to raise the level of their attractiveness by building parks, reducing traffic, and upgrading air and water quality. A more liveable, breatheable, and walkable city is an *environmental* asset, but also an *economic* asset.

Within government, environment departments often do not have clear channels of communication to economic development departments. This tends to divide policy discussions into two separate dialogues: one amongst environmentalists on the importance of conservation and the other amongst economists on growth strategy and innovation. Throughout this Conference, I hope that we can begin to unify these two streams.

This is all the more important given the enormous energy that cities today consume. Some large cities even consume more energy than medium-sized countries. But beyond consuming energy, some cities are large emitters of greenhouse gases and may be contributors to climate change. This is not to say that local governments are passive. On the contrary, they have actively developed an enormous amount of ecological programs through land use regulations, transportation planning, and coastal management.

Many of you come from areas that have witnessed changes in temperature, sea level and rain and now are more vulnerable to the effects of climate change. But I hope than rather be pessimistic and

apocalyptic about climate change, meaningful strategies can emerge from this Conference that could provide solutions to how cities can more effectively respond. On the ground, mayors and regional leaders around the world are already assuming leadership through a variety of innovative actions aimed to reduce their city's 'carbon footprint'. Public transportation systems are undergoing a renaissance, green building techniques are in vogue, and a number of cities have already transformed into epicentres of the "green economy" through the growth of recycling, waste prevention, and jobs in the renewable energy sector. I am excited that we have assembled such a notable panel of public officials and experts who can shed light on how cities can best adapt to climate change and look forward to discussions throughout the next two days.

Given the complexity of this topic and the many actors involved, a wide number of themes will be discussed ranging from adaptation in the water sector to energy efficiency. While today the time will be devoted to exploring these issues thematically, the Conference will culminate tomorrow in two plenaries that will thread together many of the issues into larger discussions about civic and business engagement and global governance. Tomorrow the second OECD Roundtable of Mayors and Ministers on Urban Development Strategy will also take place and bring together policymakers from around the world.

I hope that these discussions **build on** the rich dialogue and commitment that has already taken place between cities on the issue of urban sustainability. Transnational networks of mayors and local officials, such as ICLEI[1], UCLG[2], and the C40[3], have provided venues for a rich exchange. Beyond debate, resolutions like the U.S. Mayors Climate Protection Agreement (2005), the UNEP Green Cities Declaration (2005), and the Leipzig Charter on Sustainable European Cities (2007) all testify to the tremendous commitments being made. This co-operation has produced a rich exchange of information on energy efficiency, smart growth, recycling, and public transportation that can better tap CO_2 reduction potentials.

Many cities have taken this collaboration to the next level and have begun to pool their substantial purchasing power and directly negotiate with vendors of energy-efficient lighting, green building materials, and renewable technology. For example, the Clinton Climate Initiative and the C40 manage the Energy Efficiency Building Retrofit Program that bring together four of the world's largest energy service companies, five of the world's largest banks, and at least 15 of the world's largest cities to reduce energy consumption in existing buildings. Sizeable financial resources are available for these cities to improve the energy efficiency of buildings, starting with public buildings.

Second, I hope that the already rich collaboration between cities can be **extended** to include national and international actors. Far too often cities only discuss amongst themselves and nations only discuss amongst themselves—a new model is needed. Nations have much to learn from the experience of local environmental policy, where mayors and the people they represent face environmental challenges daily. Though their responsibilities are different than countries—cities, for example develop detailed land use and zoning provisions with minimal participation from national governments—central governments could provide more explicit co-operation through grants and technical capacity building. National governments could intermediate between cities and help them collectively pool their resources together both in funding resources and policy advice on climate change mitigation and adaptation. And finally, national governments could allocate more funding to support metropolitan areas that seek to be more resilient to climate change. They could also encourage cities to face climate change with a regional approach by funding institutions, such as a regional environment agency or a regional disaster preparedness commission. This already is commonplace in transportation planning where many national governments fund regional agencies that bring together many cities in one metropolitan area.

At the international level, cities could better participate in the climate change dialogue given their energy they consume and their vulnerability to climate change. Already some governments invite cities in their delegations to the UNFCCC. Though cities are observers, many have assumed leadership by agreeing to the Kyoto accords voluntarily, most notably the 800 cities in the United States that agreed to match or surpass the Kyoto accords. Synergy between different levels of government is rapidly evolving and providing new strateties to combat climate change.

We should not, however, formulate policies that are out of touch with the public who ultimately are affected by climate change. Programs need to engage citizens and be tailored to their specific needs. This city's "Spazio energia" or "Energy Space" project, which provides an information point to explain to citizens how to make houses more energy-efficient, is one good approach. Another great example is the Velib program in my hometown of Paris. This public-private partnership has a fleet of over 10,000 bicyles for the public to rent and ride. By biking instead of driving, Parisians have reduced carbon emissions and exercised at the same time.

As can be seen by these specific examples intergovernment co-operation with citizen involvement is capable of effectively responding to climate change.

On behalf of the OECD, I thank you all in advance for your participation and look forward to exploring these questions with you during the Conference.

NOTES

1. International Council for Local Environmental Initiatives/Local Governments for Sustainability.

2. United Cities and Local Governments.

3. Large Cities Group.

COMPETITIVE CITIES AND CLIMATE CHANGE: AN INTRODUCTORY PAPER

by Lamia Kamal-Chaoui

Head Urban Development Programme
Directorate for Public Governance and Territorial Development, OECD

Climate change has become one of the most pressing issues of our new century. The recent OECD *Environmental Outlook to 2030* projects that if we continue on the present trajectory, global greenhouse gas emissions will increase by more than 50% by mid-century, causing world temperatures to rise from 1.7 to 2.4 degrees Celsius above pre-industrial levels by 2050, and from 4 to 6 degrees Celsius or more in the long-term (OECD, 2008a). In his address at the Competitive Cities and Climate Change conference, the OECD's Secretary General, Angel Gurría, noted that to fight climate change, all possible expedients must be brought into play, including technological solutions; sectoral accords; prices and taxes; and the mechanisms of the Emission Trading Scheme. Similar views were expressed at the conference by Fernando Perpiñá, Secretary General of the Club of Madrid, the world's largest forum of former presidents and prime ministers. As part of its Energy and Democratic Leadership Programme, the Club of Madrid, in partnership with the UN Foundation, has launched the Global Leadership for Climate Action initiative (GLCA), composed of a high-level 25-member task force including Gro Harlem Brundtland, former prime minister of Norway; Fernando Henrique Cardoso, former president of Brazil; Ricardo Lagos, former president of Chile; the Indian economist Rajendra Pachauri; Hong-Koo Lee, former prime minister of South Korea, and James Wolfensohn, former president of the World Bank. This group of ex-politicians, experts and businessmen has recommended a comprehensive international agreement that includes all countries, all sectors, all emissions sources and sinks, to promote measures for mitigation as well as adaptation. The OECD has long focused both on urban issues and on climate change, but since positioning itself recently as the hub of globalization, it has formally recognised the importance it attaches to urban issues with the creation of the OECD Roundtable of Mayors and Ministers, the only worldwide global platform involving national and local governments at the highest levels. In any global agenda for a stable and sustainable world economy and for dealing with the challenge of climate change, cities have a key role to play, as OECD's Secretary General, Angel Gurría, noted at the conference.

Today, approximately half of the world's population lives in cities; by 2050, that proportion will probably have increased to two-thirds. As key engines of the global economy, cities are responsible for the bulk of national output, innovation and employment, and they constitute the key gateways of transnational capital flows and global supply chains (OECD, 2006). It is hence not surprising that cities consume a preponderance – between 60 to 80% – of energy production worldwide and account for a roughly equal share of global greenhouse emissions. All projections indicate that this trend will continue as urban populations grow. By 2030, according to the International Energy Agency (OECD/IEA, 2008), cities will account for 87% of the energy consumption in the United States, up from 80% in 2006. Within the European Union, projections suggest that urban energy consumption will rise from 69% to 75%, and in Australia and New Zealand, from 78 to 80%. However, the largest increase in energy use is expected in cities in emerging and developing countries in Africa and Asia, which, according to United Nations projections, will experience the fastest urban growth. In those countries, the preponderance of urban energy use is likely to shift from a CO_2-neutral energy source (biomass and waste) to CO_2-intensive energy sources, producing a significant impact on CO_2

emissions. In China, cities already account for 75% of the country's energy consumption (a figure that is projected to reach 83% by 2030), and the World Bank reports that all 30 of the 30 most polluted cities in the world are located in China (Dollar, 2008).

If urbanisation is contributing to the increase in CO_2 emissions, many cities are also likely to be affected by climate change in increasingly detrimental ways. The fact that they tend to be located in coastal areas increases their vulnerability to water-related calamities, increasing the risk to property, livelihoods and urban infrastructure. An OECD study on 136 port cities shows that 40 million people today are exposed to rising sea levels (OECD, 2007b). The total value of assets exposed in 2005 was estimated at USD 3 000 billion, which corresponded to around 5% of global GDP in 2005. By the 2070s, the total population exposed could grow more than threefold, to around 150 million people, and the total asset exposure will grow even more dramatically, reaching USD 35 000 billion, more than ten times the 2005 figure. This is projected to amount to roughly 9% of projected annual GDP at that time. The top ten cities in terms of exposed population include Mumbai, Guangzhou, Shanghai, Miami, Ho Chi Minh City, Kolkata, Greater New York, Osaka-Kobe, Alexandria and New Orleans. Jan Corfee-Morlot, the OECD expert on climate change, noted at the conference that if expected growth patterns continue at the pace of recent decades, two-thirds of this exposure will be driven by urban development and the remaining third by natural factors including climate change and also subsidence, which is associated with unsustainable groundwater use in many of these port cities.

The phenomenon of "heat islands", through which concrete and other impervious surfaces aggravate the effect of heat waves on built-up areas, exacerbates energy demands on urban systems. In the United States, for example, an estimated 3% to 8% of annual electricity use can be attributed to the need to offset urban heat island effects (Grimm *et al.* 2008). Climate change may also increase the intensity of hurricanes and heavy precipitation, which disrupt public service delivery, contract economic activity, damage infrastructure and, in the most extreme cases, reduce a city's population through forced relocation of "climate refugees". According to the International Federation of the Red Cross, climate change disasters are now a bigger cause of population displacement than war and persecution.[1] Estimates of the number of refugees currently displaced for reasons attributable to climate change currently range from 25 million to 50 million, compared to an official global refugee population of 20.8 million.[2] While the distribution effect is highly uneven and difficult to predict, urban infrastructure is particularly vulnerable and generally not designed to handle extreme events, particularly in cities in developing countries. In reaction to the increased risk, many insurance companies are paying particular attention to their potential exposure to the effects of climate change and are considering raising their premiums. Already Swiss Re, one of the world's largest re-insurers, requires companies to disclose their climate strategy as part of its Directors and Officers Liability insurance application. In 2008, Ernst & Young identified climate change as the top strategic risk for the industry.[3] Such burdens and other "hidden" costs – increased health care expenses, lost productivity and retrofitted infrastructure – can only compromise cities' competitiveness. Further, climate change disproportionately affects low-income populations, who have little or no savings to help them adapt or allow them to move to less vulnerable areas. Consequently, population dislocations on a massive scale may result, eroding social cohesion. In Mumbai, for instance, poor urban inhabitants of the Dharavi slums are more exposed to climate change than more affluent residents. Even in wealthy countries, the poor are hardest hit by climate disasters, as was made so clear in the case of Hurricane Katrina's impact on New Orleans' Ninth Ward.

While the international community has been struggling to agree on common objectives and targets to fight global warming, a growing number of cities and regions have taken initiatives to reduce their energy use and CO_2 emissions. Faced with the two-way relationship between climate change and urban development, cities and regions in many countries have key responsibilities in those areas, which can provide valuable strategies for fighting and adapting to climate change, including

building codes and regulation, energy provisions, public transport, waste and water management, planning and land use. Many cities have set targets for greenhouse gas (GHG) reductions, as for example in the case of London's Climate Change Action Plan, established in March 2007, which 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. Such initiatives often exceed the targets set by national governments. Within countries, joint commitments among local governments are emerging, such as the Nottingham Declaration, signed by 200 local authorities in the United Kingdom, or the U.S. Mayors' Climate Protection Agreement, under which 710 American cities adopted targets of the Kyoto Protocol, which the United States has never ratified. Cities and regions are also working together in transnational networks to strengthen their greenhouse gas reduction efforts. ICLEI, Local Governments for Sustainability, for instance, includes more than 1 074 local governments and their associations, representing more than 300 million people in 68 countries. Its international president, David Cadman, explained at the conference that more than 890 of ICLEI's members have committed to reducing their CO_2 emissions to 20% below 1990 levels within the Kyoto framework of 2010-2012.

Impacts vulnerability and adaptation to climate change at city-scale have received significantly less attention than mitigation. Yet some amount of climate change will be unavoidable, and many cities are already at risk. A few cities are leading the campaign for adaptation, including Chicago, London, Paris, Toronto and Miami. Most of them have based their impacts assessments on qualitative analysis, except for investment appraisal in transport or water supply that were in some cases based on quantitative analysis (OECD, 2007a). Adaptation and vulnerability are more of a local priority in many low- and middle-income city countries, although a main issue is the lack of capacity and funding. Carbon emissions per person in many of these cities are much lower than those of wealthy urban areas, and their vulnerability tends to be higher. For example, *per capita* emissions in Los Angeles average 15.6 tons of CO_2 equivalent, where the figure for Mexico City is one-quarter of that amount (3.6 tons) (Romero Lankao, 2006). However, as Lars Reuterswärd, director of Sustainable Development Network and the Global Division at UN Habitat, noted at the conference, the environment is not a top priority in developing countries. Meanwhile, as he pointed out, 1 billion people live in slum areas around the world at a conservative estimate, a number that is expected to rise to 1.5 billion in 20 years.

More generally, the vulnerability of cities to climate change depends to a large extent on the state of its urban infrastructure, on the types of businesses it operates and on how public services are delivered. City structure and density are defined historically, but a crucial prerequisite for the creation of climate-proof urban infrastructure is the implementation of integrated land use and transport policies that allow for compact cities to develop with clusters of high-density nodes. This requires developing an integrated urban planning framework, as land use and zoning may exacerbate or limit exposure and the vulnerability of urban dwellers and infrastructure to the growing threat of climate change. Gianmarco I.P Ottaviano, of the Fondazione Eni Enrico Mattei and Bocconi University, recalls in Chapter 3 that cities, by concentrating skills and firms, allow agglomeration economies to develop, thanks to effective urban infrastructure, knowledge spillovers, labour market pooling and input sharing, as well as demand and cost linkages. However, he cautioned, urban sprawl reduces the likelihood that such agglomeration economies will emerge, increases traffic and pollution and CO_2 emissions and also undercuts the economic and social viability of the large infrastructural investments that are needed to tackle the twin challenges of climate change and urbanisation. OECD's recent series of metropolitan reviews shows consistently that integrated planning, a crucial ingredient for limiting urban sprawl, is a challenge for cities and metropolitan areas (OECD, 2006). In Cape Town, for instance, commuter traffic extends over a radius of 100 kilometres, an area comparable to that of Los Angeles (although its population is not as numerous). The City of Cape Town's ecological footprint, at

4.28 hectares *per capita*, has become so large today that it takes a land mass equal to the size of Greece to provide its inputs and process its waste. In other words, if everyone lived as people do in Cape Town, 2.3 planets would be required, a rate that is comparable to Canada's, but less than half that of the United States (OECD, 2008b).

Sara Topelson, Mexico's undersecretary for urban and regional development, observed that Mexico is one of the most vulnerable countries associated with the phenomenon of climate change, with 87.7 million inhabitants living in high-risk areas and 70% in cities. An estimated 34.4% of its population lives in areas exposed to hurricanes and 33.2% in flood plains, and about 90 000 of its poor households live in informal, irregular settlements, many of them in vulnerable areas. Mexico's sprawling urban growth poses a challenge to local governments. In the past 20 years, it has experienced 75 geological and hydro-metereological events that have caused more than 10 000 deaths, directly affected thousands of households and resulted in severe economic stress. Hurricanes Isidore (2002), Emily (2005) and Dean (2007) cost federal and state governments about USD 316 million in housing reconstruction alone. As Topelson pointed out, cities would do well to incorporate risk maps and adaptation measures to raise public awareness about the potential disasters associated with climate change. Government authorities should recognise the value of risk maps as an additional instrument in the planning process, particularly in cities on the peninsular coasts and the Gulf of Mexico, given their high exposure to meteorological phenomena and rising sea levels.

A particular strain on urban infrastructure is related to the impact of hydrological changes on the capacity of drainage infrastructure, sewage systems and water treatment. As outlined by Matthias Ruth and Rebecca Gasper of the University of Maryland in Chapter 4, sea-level rise, combined with the increasing frequency of severe weather events, can cause sanitation problems if urban infrastructure is ill-equipped to accommodate a sudden influx of water. Drinking or recreational water can be contaminated by sewage backup, and microbial/chemical agents and biotoxins can be introduced into the water supply. Higher temperatures and more frequent drought will increase demand for household and industrial use of water in urban areas, and resources will be in short supply. In this context, the authors note, there is a need to evaluate existing infrastructure for treating and transporting water and to better understand how the existing systems can handle excess precipitation or an influx of seawater. This information is crucial for decision-making about appropriate investment options. The City of London Corporation, for example, has identified "hot spots" vulnerable to flooding, where it plans to install new sustainable drainage systems. Its plan mandates investment in the management and maintenance of these utilities, to ensure that they have enough capacity to accommodate the expected rise in the volume of precipitation.

The case of Barcelona, which experienced a major drought after two consecutive autumns of insufficient rainfall in 2006 and 2007, was presented at the conference by Vice Mayor Imma Mayol. The situation was so bad, she explained, that the city had forecast a possible interruption of the water supply to households and was forced to launch a series of emergency plans to safeguard supplies of drinking water. The city developed a water supply strategy for the period up to 2030, based on diversification of sources, including targeting consumption savings through publicity campaigns, free distribution of water-saving devices and time restrictions on some ornamental and recreational use; recovery of local aquifers, using new pollution-control technologies, to decrease dependency on river water; water purification of around 290 hectometres of water for the whole metropolitan area; plans for an extension of networks for the transport of purified water, and the opening in 2009 of a desalination plant, although Vice Mayor Mayol warned that the related technology must be used with caution, given the high energy consumption it entails. Barcelona is also extending its current network of 11 rainwater reservoirs to 17 by 2011, which will raise the city's collection capacity by 83%.

Arguing the case for mitigation policies, Nigel Jollands of the International Energy Agency (IEA), in Chapter 6, outlines the rationale for focusing on city energy use for fighting global warming and elaborates in particular on the roles cities can play in developing such policies. Many policy options for reducing energy consumption and decreasing CO_2 emissions fall under the authority of local governments, including direct energy consumption linked to the provision of public services (sanitation, water, public transport and local public buildings), capital works programmes and infrastructure development and also indirect functions related to their regulatory powers (energy efficiency requirements in building codes, land use and urban planning rules). Jolland cites some interesting examples of city energy and CO_2 savings, including the congestion fees in Seoul and London, which are estimated to have generated a reduction of between 10% to 20% of CO_2 emissions; the adoption of more stringent building specifications in Tokyo, which has led to an annual decrease of 30% of building CO_2 emissions; and the district heating system of a number of Copenhagen's municipalities, which uses waste heat from incineration plants and combined heat and power plants (CHPs) and has saved the equivalent of 665 000 tonnes of CO_2 annually. Jolland also lists four areas for energy savings where local governments can have significant policy influence: public transport; the use of integrated energy production technology, such as combined cooling, heat and power; the enforcement of energy components in building codes; and land use and urban planning measures such as low emission zones, mixed used zoning and densification.

A comprehensive approach addressing urban planning, transport, building, and water and waste management has been pursued by the city of Madrid, which managed to reduce its GHG emissions by 15% over the period 1990-2004, while Spain as whole registered a rise of 47%. Madrid's City Council, exceeding Spain's commitment, released a Plan for the Sustainable Use of Energy and the Prevention of Climate Change last year, promising a 14% reduction of GHG based on 2004 values over the period from 2008-2012. The city has developed its public transport network in recent years, pledged to make municipal transport vehicles environmentally friendly by 2011 and has actively exploited new sources of energy, including the generation of electric power through waste incineration, biogas from landfills and sludge drying. It has also embarked on the renovation of its public lighting system and encouraged a steady rise in the incorporation of solar-powered heating systems in newly constructed and renovated buildings (whose number has increased sevenfold since 2003). In collaboration with the city's economic and social stakeholders represented in the Pro Clima Madrid Forum, a platform that includes all its major private companies, Madrid is promoting biofuel supply networks and an incentive scheme for clean motor vehicles. Javier Rubio de Urquía, director general for sustainability for Madrid's City Council, noted at the conference that the city's outstanding economic growth and remarkable social integration would not have been possible without its efforts devoted to environmental sustainability.

At a supra-national level, the European Commission is supporting an integrated approach as a key element for sustainable urban development. Based on their positive experience with the URBAN Community initiatives, the member states of the European Union have decided to earmark a substantial part of their European Regional Development Fund (ERDF) allocation to support urban development in the 2007-2013 programming period. Around EUR 10 billion has been earmarked for investment in integrated urban development. For the first time in the history of European regional policy, cities are the potential beneficiaries. Climate change has also become a major objective of EU regional policy. Corinne Hermant-de Callataÿ, the representative of the EU's Urban Development Unit in the Regional Policy Directorate-General, highlighted the importance of ensuring that cities and climate change strategies are part of more holistic approaches to urban development or regeneration rather than of purely sectoral approaches, which can be detrimental to other aspects of city life. For the 2007-2013 period, EUR 16 billion has been earmarked for direct investments for climate change, while investments that impact indirectly on climate change account for another EUR 31.7 billion. This

will make it possible to measure the potential benefits of linking investment in urban development and direct or indirect investment in climate change, Hermant-de Callataÿ noted.

Transport is a major contributor to CO_2 emissions in cities and therefore should be both a national and a local priority, according to Mary Crass of the International Transport Forum (ITF). In Chapter 5, she first recalls how high the contribution of this sector is to greenhouse gas emissions: 13% of all human-related emissions and 23% of the world's CO_2 emissions from fossil fuel combustion – a figure that is 30% in OECD countries. More worrisome is the fact that transport emissions in most countries are growing even faster than total CO_2 emissions. Most indications are that emissions from transport will increase by two-thirds over the next 30 years unless alternative technologies are developed. Countries represented in the ITF generally agree that the most cost-effective policies (by cost per tonne of CO_2 abated) should be the fundamental factor determining a combined package of regulatory, pricing and technology measures designed to improve energy efficiency and limit CO_2 emissions in urban travel systems. Around 40% of CO_2 emissions in cities in the ITF/OECD can be attributed to road transport. Yet in many countries, a disconnect remains between local policy initiatives and national climate change mitigation strategies in the area of transport. In a number of cases, either the role of urban travel policies in meeting national objectives is overstated (often without quantifying the actual abatement potential of these measures) or too little importance is assigned to the CO_2 mitigation potential of local policies. Local and regional governments today have a larger role in decision-making, but the main problem, according to Mary Crass, is either incomplete or excessive decentralisation. The transfer of authority must be accompanied by a transfer of commensurate resources, and reform of fiscal and regulatory structures is required.

At the city scale, one successful example in the field of transport was put forward by Bryan Glascock, director of the Environment Department in Boston. The city's inventory of GHG emissions from transport is only 18%, compared to as much as 50% in other American cities. Boston has helped create a compact, walkable city through co-ordination with a wide range of stakeholders, from community-based groups to federal government agencies. Pedestrian advocacy groups regularly participate in development project public reviews and charrettes offered by the city's planning and development agencies, and citizens, through town meetings and other fora, help promote pedestrian accessibility and vibrant streetscapes. To curb air pollution, Boston also helped implement Federal Clean Air Act (1970) requirements by enforcing a freeze on the construction of new public parking facilities. The city is currently experimenting with new policies based on demand management, by installing parking meters whose rates vary depending on the time of day and on congestion levels. It is hoped that this pricing policy will further encourage a switch to other modes of travel, especially public transit.

In Vienna, there is general political agreement on promoting "urban friendly" transport modes and investing in their improvement, noted Rudolf Schicker, Deputy Mayor. In 1999, the city launched created an ambitious Climate Protection Programme (KLiP), which includes 36 climate protection initiatives, comprising 241 individual actions in the areas of electricity and heat generation, district heating, housing, business, administration and transport. One of the key priorities of the programme is to promote urban mobility through such targets as reducing traffic, promoting ecologically sound transport alternatives, and raising the efficiency of motor vehicles. This guiding principle of "intelligent mobility" was enshrined in the Transport Master Plan Vienna, which was adopted by the City Council in 2003. A main objective is to increase the share of public transport to 40% by 2020 and to double the proportion of cyclists from 4% to 8%. The Urban Development Plan of the city of Vienna follows the principle that new developments be concentrated along the main axes of public transport. The local government is improving improve the energy efficiency of its municipal vehicle fleet (public transport vehicles are included), and intends to launch initiatives with other stakeholders,

such as taxi operators (Vienna has more than 4 000 taxis). This strategy has been successful, Schicker argued, noting that the use of public transport has increased from 29% in 1993 to 35% and that use of private cars has decreased from 40% to 34%.

The role of the central state in promoting a more sustainable mode of urban transport has been crucial in Brazil. Renato Boareto of the Brazilian Institute of Energy and Environment explained how Brazil's creation of a specific ministry for cities at the federal level in 2003 has made it possible to structure a legal and regulatory framework and to elaborate an integrated and sustainable urban policy. Although the management of mass transit systems in Brazil is the responsibility of municipal and state governments, the Ministry of Cities establishes guidelines and makes available a series of instruments and resources for planning and management. These include adapting urban planning and developing urban mobility master plans, moderating the circulation of private vehicles, prioritising mass transit systems, and developing new energy sources. Thanks in part to the support of the Ministry's Urban Mobility Program, which finances the construction of bike lanes (*ciclovias*) in cities, space reserved for bicyclists quadrupled in Brazil from 2003 to 2007. In Japan, the central government has revised its urban traffic system comprehensively, focusing on public transport like light rail transit (LRT) and increased public transport services. At the conference, Takeshi Abe, advisor to Japan's Ministry of Land, Infrastructure, Transport and Tourism, pointed to the example of the city of Toyama, which has worked with the private sector to develop the first fully fledged LRT in the country, contributing to a significant increase in the passenger rate. Japan is also promoting mixed-use development in urban areas to address sprawl and to develop more compact cities. The central government of Japan has worked with city governments to implement this integrated approach, and has issued a revision of the City Planning Act and other related laws to introduce strict control in the construction of large shopping centres or leisure facilities in urban suburbs with more than 1 000 square metres of floor space.

Substantial energy savings can be realised with improved waste management systems. Rome's province, with financial support from the Lazio region, has began to give municipalities on its territory economic grants to encourage them to establish door-to-door selective waste collection systems and increase recycling. This will make it possible to quantify the waste produced by each household and to build fiscal incentives for recycling and reduction of waste. EUR 58 million has been made available for the period 2008-12. The president of the province of Rome, Nicola Zingaretti explained that the target of the policy is to recycle 35% of the waste stream in 2009 and 51% in 2011, with a reduction of total waste of 5% by 2015. This policy entails great job creation potential, Zingaretti said. By 2011, the province hopes to cover 79 out of 119 towns in its jurisdiction, collecting differentiated refuse from over 1 million inhabitants. In Mexico, more than half of the solid waste collected is composed of organic material, which leaves considerable potential for the reduction of emissions (estimated at between 16.6 and 18.7 million tons of CO_2 equivalent) by 2020.[4] Also in Mexico, the city of Monterrey has been active in generating electricity by harvesting methane, which makes up 10% of all greenhouse gas emissions, from landfills. The objective of the project is twofold, both reducing greenhouse gas emission from solid waste and improving solid waste management. The project was a joint venture between government and the private sector and was funded in part by a USD 5 million grant from the Global Environmental Facility.[5] A 7-megawatt plant was built that now captures and converts 214 million cubic metres of landfill gas into electricity, enough to power the city's light-rail transit system, the Metro, by day and to light city streets by night. As Sara Topelson of Mexico's Ministry of Social Development pointed out, this strategy has the advantage both of reducing atmospheric emissions and offering financial dividends if these reductions are sold to the carbon bonus market.

Producing renewable energy has increasingly become part of many cities' efforts to fight climate change and improve their energy efficiency. Some of the most ambitious projects have been

implemented in Portugal, a country with few natural resources and no expertise in nuclear power. At the conference, Rui Nuno Baleiras, Secretary of State for Regional Development of Portugal, discussed his country's "clean-tech revolution", describing how renewable energy is harnessed through traditional means – wind and solar – and also from the first commercial wave-power farm in the world. Located offshore near the city of Póvoa de Varzim in northern Portugal, the Aguçadoura project converts wave energy to electricity, which is carried to the mainland via a single seabed cable. Spain also hosts some innovative renewable energy projects, such as Europe's first commercial solar thermal power plant. Located near Seville, the PS-10 is a 115-metre tower surrounded by 600 mirrors whose concentrated light converts water into steam, which in turn drives turbines that are reported to produce enough energy for 6 000 homes (Shukman, 2007).[6]

Participants at the conference agreed that the dialogue on climate change needs to directly address scepticism and demonstrate that protecting against climate change can provide an opportunity to maintain and enhance urban regions' economic competitiveness. In addition to their contribution to fighting global warming, mitigation policies at the local level offer co-benefits in other areas, including clean air, reduced pollution and better health, as well as jobs in the new green economy. At the conference, the co-benefit actions for both climate change protection and economic development were aired by Kenji Kitahashi, mayor of Kitakyushu, Japan, who explained how its city government, through the Eco-Town Plan, has helped local industries invest in innovation and technology to reduce energy dependency and pollution. During the rapid economic progress of the 1960s, Kitakyushu developed into one of the four largest industrial zones in Japan, with an economy based on heavy industry (steel, cement and chemical production). Environmental pollution, however, deteriorated to such an extent that the local Dokai Bay became known as the "Sea of Death". With the implementation of environmental policies, Kitakyushu managed to reduce its CO_2 emissions by more than 3% in the period from 1990 to 2002, while the overall rate for Japan registered an increase of more than 11%. The plan includes specific projects for recycling electric appliances, automobiles, plastic bottles and other recyclable wastes; advanced research on waste disposal and recycling technologies; and generating new industries from recycling resources and energy as city-wide activities. The opening of the special zone for recycling industries in the eco-town led to the creation of 1 000 direct jobs. Having transformed itself from a "gray" polluted city to a progressive "green" one, Kitakyushu was commended by the central government in 2008 as "the environmental model City of Japan". The key elements in this success, the city's mayor argued, were citizens' participation and partnership with various local stakeholders. His strategy is now to position his city as Asia's low-carbon centre, working in collaboration with neighbouring cities.

Another success story is Toronto, Canada's largest city, whose mayor, David Miller, argued at the conference that what is good for the environment is also good for the economy. Toronto has one of the smallest ecological footprints of large North American cities and better air quality than OECD cities of a similar size (OECD, forthcoming). The city has achieved 40% reductions in greenhouse gas emissions by capturing methane from its landfill and using it to generate electricity. Its Better Buildings Partnership programme uses green building standards and a green fleet with plug-in hybrid cars and offers small loans for new creative ideas in this field. After the city took the initial step of instituting mortgages that encouraged green building, the market responded positively by creating its own instruments. It is now routine for builders in Toronto to observe the highest environmental standards, Mayor Miller noted, although making national building codes more stringent would speed the process. A major part of Toronto's efforts have been energy retrofits on its 2000 concrete-slab apartment towers constructed during the 1960s and the 1970s. The mayor's Tower Renewal Project has lowered total energy expenditure by 5%, created better living conditions in socially disadvantaged neighbourhoods and generated new jobs in a new building retrofit industry. The demonstration effect of this strategy creates jobs and opportunities, Miller said. A similar view was proposed by Jiri Cunek, first deputy prime minister and minister for regional development of the Czech Republic, who

explained how the large-scale-dwelling renovation national policy his country has adopted will bring both environmental and economic benefits. To pay back the cost of thermal insulation can take approximately 35 to 45 years, he said, but if the investment costs of complex thermal rehabilitation can be settled in 5 years, the energy savings may help to cover 10-12% of the annual costs. The renovation and thermal insulation of apartment houses heated by their own sources can contribute to a CO_2 reduction of 0.6-0.7 tonnes per apartment per year, he said.

As for Stuttgart, its mayor, Wolfgang Schuster, argued that leadership in environmental matters has proved an excellent marketing tool for his city. With 600 000 inhabitants (and around one million for the metropolitan area), Stuttgart is a world capital of the automotive industry, the city of Mercedes, BMW and Porsche. Although manufacturing jobs have been disappearing, climate change has also affected the city in its core business, and the city government is now fully aware of the importance of coupling the imperatives of the car industry with the protection of the environment. Fostering a new culture of city development and housing, Stuttgart has reclaimed brownfields and recycled land to create communities that combine housing and employment, creating more sustainable communities. Working with the private sector, the city is now developing buses and cars that use new battery technologies with zero emissions and that need almost no fuel. The goal is to work with construction materials that are virtually 100% recyclable, Schuster said. The city has also launched many other interesting initiatives, including the establishment of a car-pool system, "Pendlernetz Stuttgart", generally recognised as the most innovative in Europe. It has also instituted green roofs in both municipal buildings and private houses, and realised further energy savings in public buildings. The city was awarded a Climate Star in 2004 by the Climate Alliance.[7]

Letizia Moratti, the mayor of Milan, noted that flagship events offer the opportunity to develop environmentally friendly urban projects. The past experience of cities that have hosted the Olympic Games, international Expos, World Cups, cultural festivals and other mega-events has shown that they provide a chance to enhance cities' economic competitiveness in the context of globalization, through high levels of tourism, media coverage and corporate sponsorship. Such events can also afford unique opportunities for large-scale renewal of blighted areas and general improvement of a city's infrastructure. At the same time, they can also entail detrimental environmental effects. Of particular concern with respect to climate change is the massive energy use involved in the construction and operation of large event facilities, and the transport of the visiting crowds. However, with careful vision and planning, cities can capitalize on the economic and social potential of mega-events, while minimizing their effects on a city's carbon footprint and advancing the goals of mitigating and adapting to climate change. The major theme of Milan's Expo 2015 is food security, but the city has engaged the global climate change agenda by instituting a rigorous environmental policy aimed at reducing greenhouse gas emissions, and by following best practices and technologies for protecting the environment as preparations get under way for the event. The city intends to reduce and offset emissions before, during and after the event, but also to model new methods, mechanisms and projects as an example for both industrialised and developing countries. At the conference, Mayor Moratti announced that in the context of the 2015 Expo, the City of Milan, in partnership with the World Bank, is underwriting a fund of EUR 2 million to finance green projects in developing countries.

David Cadman, a councillor on the Vancouver City Council, explained how his city, which is to host the 2010 Olympics, is building an Olympic Village with a novel heating system. Harnessing the city's sewage system in combination with hot water generated from the roofs of local houses by solar heat, sewage pipes will be put to use as a district heating system, conserving other sources of energy. The Olympic and Paralympics Winter Games require considerable energy for heating buildings, making snow, freezing ice sheets and sliding tracks, powering equipment and transporting people and goods, all of which generate GHG emissions. To address this challenge, the city has been working with British Columbia's electrical utility, BC Hydro, to design an innovative approach to provide the

base power-supply capacity and primary backup power for the key venues, with a lighter environmental footprint. VANOC, the Vancouver Organizing Committee, is also planning an efficient and sustainable transport system for the Games. The venue will be developed using efficient lighting and heating systems, high-quality insulation and alternative energy sources (such as the capture and reuse of waste heat) to generate less energy and emit fewer overall GHGs. The city is expecting this to result in economic benefits for host communities and regions across British Columbia and Canada, including jobs, business development opportunities, trade and infrastructure improvements. VANOC is implementing sustainable purchasing practices that allow for measuring the contributions to local economies and local suppliers. For instance, for fiscal year 2006-07, 54% of its spending went into the local economy.

In Chapter 7, Joan Fitzgerald of Northeastern University in Boston elaborates on the connection between local climate change actions and the green economy. Cities can make this link, she argues, by focusing on making existing and new buildings more energy efficient. In U.S. cities, and to a certain extent, in European ones, buildings consume 70% of electric power, 39% of all power consumed, and create 39% of CO_2 emissions. Fitzgerald describes how a group of pioneering cities have capitalised on a "first-mover" advantage and witnessed the growth of renewable energy industries and employment. Freiburg in Germany, for instance, developed a citywide strategy as early as 1986 with environmental guidelines that served as a basis for its economic specialisation in the solar energy industry. This included such policy measures as building city-owned solar projects; instituting a local ordinance requiring that 10% of the city's electricity be obtained from renewable sources by 2010; creating public subsidies; and pro-active research and economic development support. These efforts have led to the creation of about 10 000 jobs in the environmental and solar sectors. Fitzgerald also describes the analogous case of Philadelphia, itself now a centre for the solar industry. As part of a strategy to revitalise its manufacturing basis and promote job creation, and using a mix of public policy tools, including grants to companies that invest in renewable industries, energy-saving production processes and alternative energy production, and renewable portfolio standards, the city has attracted major players in the wind-power industry, such as Iberdrola in Spain and the German solar conglomerate Conergy. Investment in energy efficiency can also promote employment, creating jobs in retrofitting and stimulating demand for new energy-saving and pollution-fighting products. Fitzgerald also cites the case of Pittsburgh, a centre of the steel industry, which now ranks fifth in the United States for the number of its green buildings. Interestingly, all this green building and retrofitting has been the result not of city policies but of the work of a nonprofit organisation, the Green Building Alliance, an informal coalition of professionals that provides grants to companies, university researchers and university-industry partnerships.

At a time when the global financial crisis appears to be widening, participants in the conference commended the opportunities that the green economy offers to help cities and their inhabitants to recover. Alexander Likhotal, President and CEO of Green Cross International and director at the Gorbachev Foundation, noted that if the international community is to cure the disease rather than its symptoms, it will need to think in terms of synergies and opportunities outside the usual multiple-choice box of threats and priorities. Likhotal argued that climate change is not so much a threat to be feared, but a challenge to be met, and that it can generate opportunities to develop and sell the technologies that will be in demand in the markets of tomorrow. The underlying drivers such as drought, rising sea levels and increasingly extreme weather events, he said, are bound to fuel a new market demanding new services and products in areas such as energy efficiency, water infrastructure, modified crops, flood defences, new housing and commercial buildings. Climate change and related water challenges could become a catalyst that will anchor the runaway financial system to the basic and long-term needs of the real economy. Investment in renewable energy technologies and in the renovation of infrastructure vulnerable to climate change could serve as the backbone to a New Deal for public investment in cities. However, he said, it is still not clear how city governments can obtain

the necessary funds to engage more actively in climate change adaptation and mitigation projects. Given falling real estate values and constricting tax revenues, the economic crisis has brought an end to the era of cheap money for funding environmental projects and the beginning of an era of tough choices. In the same vein, Paris' deputy mayor, Pierre Schapira, noting that the budget for social spending in Paris has already increased considerably, observed that the crisis will seriously complicate long-term investment projects. Petre Roman, former prime minister of Romania, pointed out that many public projects in cities are likely to be halted or called off, and that in the absence of credit, cities can do little to mitigate climate change effects. He called for a carbon tax that could be used as a tool for credits for public projects.

The success of climate change policy at the urban scale depends on sub-national governments' ability to set and achieve objectives, solve problems and exercise their authority. Peter Dormand, city energy and resource manager of Newcastle, Australia, noted that without accurate measurements, it is difficult, if not impossible, to manage such objectives. With this in mind, Newcastle has created the world's first and only device, known as a greenhouse gas "speedometer" and accessible online at *climatecam.com*, that monitors and reports the city's consumption of electricity, gas, liquid fuels, waste to landfill, water consumed, trees planted and the resultant equivalent in tonnes of carbon dioxide expended. The electronic billboard includes a 500-megawatt electricity meter in the town square, updated hourly from data sourced directly from the energy providers in the 15 electrical zone substations that power the city. The device has demonstrated that if the city had continued business as usual, it would have increased its greenhouse gas emissions by 2008 to around 20% to 35% above its 2000 level. Together, the 250 council-owned and operated facilities that fuel the city have managed to reduce electricity consumption by 40% compared with 1995 levels, and water consumption by 25%, thanks to an action-based research programme and the establishment of a rating system. In the absence of large-scale national funding, the city has entered into a public-private partnership with 12 foundations (Together Today PPP). This has proved essential, Dormand said, for bringing together those who need low-carbon products and services and those who supply them.

Local governments' capacity to implement climate change policies is closely linked with their regulatory modes of urban governance. In Chapter 8, Gotelind Alber of Sustainable Energy and Climate Policy in Berlin and Kristine Kern of Söderttörn University College in Stockholm identify four modes of urban governance for implementing climate change policies. The first, "self-governing: the municipality as consumer", relates to the capacity of local governments to govern their own activities, for example, to promote the energy efficiency of municipal buildings and the greening of public transport vehicles. This is the most widespread form of local action, driven in many cases by the financial benefits of energy savings. The city of Los Angeles presents an interesting case study. In 2008, Mayor Antonio Villaraigosa publicly announced that the city had met its Kyoto targets in generating 10% of its energy from renewable sources, a figure that had increased from 2% at the time he was elected in 2005. The mayor announced in October 2008 that the city would generate 20% of its energy from renewable sources by 2010, outstripping Kyoto targets as well as those set by the state of California.[8] The mayor has also supported a program that will replace approximately 160 000 energy-intensive streetlights with energy-efficient light-emitting diode (LED) lights. These targets have been met so rapidly because the city controls a unique set of municipal assets, such as the Port of Los Angeles and the Department of Water and Power, which is the largest public utility in the United States.

A second mode of urban governance, "governing through enabling: the municipality as facilitator", refers to the different forms of co-ordination with private and community actors, such as the establishment of public-private partnerships for the provision of services and infrastructure. The authors cite the example of London, with the creation of a joint venture company between the London Climate Change Agency and EDF Energy for a decentralised energy scheme, and with the London

Energy Partnership, a consortium of private and public agencies that is developing different types of energy-related measures. The municipal energy plan of the City Council of Venice includes a series of intention protocols involving a number of joint venture projects between private companies, municipal transport companies, housing administrators' associations and associations of planners, architects and engineers. Under a third mode of urban governance, "the municipality as provider", the municipality can have a significant impact on local climate change action as the majority shareholder in the local utility companies for energy, transport, water and waste services. However, this potential for influencing the supply side of energy has been considerably eroded by the deregulation of energy markets and the privatisation of public utilities. In many countries, local governments can resort to "governing by authority: the municipality as regulator", the fourth mode or urban governance, when they have the legal power in such important areas of planning responsibilities for energy, transport and land use. Examples include Barcelona's solar thermal ordinance; the introduction of regulations to reduce the fossil fuel standard for all new buildings in Santa Barbara, California, and restrictions on the use of cars in Munich and Paris. The extent of such a mode of authoritative governance, on a voluntary basis, remains limited.

A key issue for the implementation of local climate policies and action plans is also related to the institutionalisation of such policies and strategies within local administration and their integration with other sectoral plans (such as energy, transport and land use). Alber and Kern stress that in many cases, the competence for climate change policy is generally located in the environmental policy agenda, which can raise co-ordination and integration problems if the environmental department or agency does not have the competency to implement comprehensive concepts. The city of Zurich is a promising case, where the special unit for environmental protection in charge of supervising the city's climate policy is also acting as a service agency with cross-departmental tasks within the city administration. More generally, responses to integrating climate change in urban governance include the establishment of a special unit in the mayor's office; the creation of a unit in charge of climate change policy within each climate-relevant department; a climate-policy steering group; a climate protection co-ordination group, or an over-arching unit with appropriate competences for mainstreaming climate change policy. Other obstacles to action on climate change at the local level include insufficient funding, the tension between short re-election periods and long-term infrastructural challenges, inflexible budgetary structures and the strictly voluntary nature of many agreements.

In San Francisco, the creation of a special position in the mayor's office to co-ordinate the multiple climate initiatives undertaken by several programmes demonstrates the city's commitment to remaining at the forefront of the environmental movement in the United States. Beyond advocating for climate protection inter-departmentally, San Francisco's Office of Climate Protection Initiatives lobbies for climate protection legislation at the federal level and works with local private companies to encourage the use of vehicles that run on biodiesel. Equally important, it lends political weight to climate issues, since it is located directly in the mayor's office. Progress made so far has been significant. Wade Crowfoot, director of Climate Protection Initiatives in the office of the mayor, notes that the city has a 70% recycling and composting rate (70% of all waste consumed is diverted from landfill); the strongest green building standards for new buildings in the United States; the largest local financial rebate for solar installations; a bus fleet running entirely on electricity or biofuels; a taxicab fleet 80% of whose vehicles will be green by 2012; and among the highest levels of bicycle commuting in the United States. These programs, plus the attempt to purchase clean and green energy for the city's electricity grid, has resulted in an independently verified 6% reduction of greenhouse gas emissions below 1990 levels, he said.

A lack of horizontal collaboration is also a major obstacle to action to combat climate change within metropolitan regions. In many cases, the administrative structure of governance does not fall

precisely within metro regions' actual boundaries, so that carbon-relevant functions, defined economic interchanges, flows of materials and energy, and transportation between activities and households in the city's core area and localities overlap across multiple jurisdictions. This requires that city officials engage in the sometimes challenging task of co-operation with other local governments. The lack of inter-municipal co-ordination within metropolitan areas may pose serious problems for adaptation policies, which typically need to be decided and implemented at a regional scale. Successful mitigation policies also often depend on technical infrastructure, which transcends city borders. A few experiments in metropolitan-wide co-operative arrangements have been undertaken to deal with social disparities, economic development, transport and infrastructure (OECD, 2006) and to avoid spatial mismatch and wasteful competition. Such collaborative frameworks for climate change policies and strategies are, however, the exception, not the rule. Only a few examples exist of climate change action plans at the metropolitan level. Some local governments have implemented resource-pooling strategies that have achieved significant savings through co-ordinated action, such as projects to purchase energy-efficient products for common use. For example, the Clinton Foundation has helped organise a "Purchasing Alliance" of green cities that collectively negotiates discounted pricing agreements for a range of energy-efficient products.[9] The Clinton Foundation, along with ICLEI and other groups, have also created similar networks for cities to pool know-how to reduce policy development costs and create uniform environmental monitoring frameworks.[10]

Local government authorities cannot effectively address the massive challenges posed by climate change without widespread grassroots involvement of a wide variety of actors in civil society (*e.g.*, citizens' groups, students and neighbourhood associations). These non-governmental stakeholders can play key roles in both contributing to the development of sound government policies, and in ensuring that such policies are effectively implemented. P.J. Partington, climate change project manager for TakingITGlobal, one of the most important global non-profit social networks of young people in the world, stressed the role of local governments in working more effectively with youth in dealing with climate change. He urged them to engage young people to form a core part of the solution. There are three major areas for involving youth in climate action, he said. They can play the role of messengers and catalysts for community action. Youth should be engaged and participate in policy design and delivery. They can also contribute to practical projects for adaptation and mitigation for community development. Partington stressed the importance of developing partnerships on green jobs with municipalities, including such actions like job-training initiatives or community micro-renewable programmes. An e-consultation on climate change conducted by TakingITGlobal on behalf of the OECD featured some striking results. For instance, all respondents observed that climate change was already impacting their communities in negative ways, that most adaptation policies to date had been reactive in nature, and that many mitigation initiatives in their countries have not been well followed through. What came through overwhelmingly was young people's interest in environmental education and "eco-citizenship".[11]

While cities and regions have a key role to play in mitigating and adapting to climate change, they need not do so in isolation. In Chapter 2, Jan Corfee Morlot notes that city-scale initiatives remain largely decoupled from national policy frameworks. Setting climate policy at local and national scales is likely to require working across conventional disciplinary and organisational boundaries, to bring together climate change experts and sectoral decision-makers (for example in transport, housing or water resources planning), to consider the implications for climate change of sectoral policies and development. Central governments can support two crucial activities that can help cities become more effective agents for change in the design and implementation of adaptation and mitigation policies: developing city-scale GHG inventories and supporting science-policy capacity-building and information, to help cities better assess the options for adaptation. As Corfee Morlot noted at the conference, cities today, just like the first governments collaborating on climate change policy in 1979, are striving to meet their goals, sometimes in concert, as translation initiatives indicate, but are

not yet speaking a common language. Corfee Morlot recalled the OECD's work in the 1990s to develop standard protocols for the international inventory system, which were taken over by the Intergovernmental Panel on Climate Change (IPCC) and are now used in the reporting system under the Kyoto Convention. Today, she said, the need is for a standardised greenhouse gas emission inventory and standard reporting protocols for cities. These would help cities work together to achieve their goals, as well as to measure the progress and compare the cost-effectiveness of actions at sector level. If a standard protocol existed, cities could become potential actors in the carbon market and could open the way for new sources of funding for city-scale mitigation efforts. Many city representatives at the conference said they considered funding the main obstacle for climate change actions at the city-scale.

The respective role of national and sub-national governments was a subject of considerable debate at the conference. Cristina Narbona-Ruiz, Spain's ambassador to the OECD, declared an urgent need for the adoption of national standards and building codes in the construction and energy sectors. Wade Crowfoot of San Francisco, said national governments are well positioned to set baseline standards, for example in the case of energy efficiency in cars and appliances. Price signals can be set to reflect the true cost of carbon-based energy, so that renewable energies can become more competitive (*i.e.*, cap and trade, carbon tax). They can also provide resources for major environmental infrastructure projects (such as smart grid and transit) and for research and development to advance renewable technologies. National governments should also help cities to reduce their GHG emissions by providing them with flexible resources, taking into account their unique circumstances and with technical support (*i.e.*, standard protocols for cities to measure their carbon footprints), as well as incentives to link cities' policies and programs with others regionally, so that adjacent cities synchronise their efforts.

For the moment, the state of vertical intergovernmental co-operation in climate-change mitigation and adaptation still appears *ad hoc* and subject to rapid evolution. The role of cities and the interactions between cities and national response policies is still largely unexplored in the search for effective and efficient responses to climate change. National governments can clearly support cities through improved funding and support of a suite of energy-saving, locally administered programs in land use, transportation and utility provision. More concretely, national governments can act as *enablers* by implementing guidelines for local authorities, disseminating information on best practices, and suggesting voluntary certification schemes. As Kern and Alber show, examples include Germany's 1997 guidelines for local climate protection (*Leitfaden Kommunaler Klimaschutz*) and the involvement of the United States National Oceanic and Atmospheric Administration in drafting environmental recommendations for the Seattle metropolitan region. Second, national governments can be *providers*, by offering additional funding for local projects related to climate change, such as the Swedish Climate Investment Programme (KLIMP), which mainly funds municipal energy efficiency and transit projects. Third, and most importantly, national governments can serve as *watchdogs*, by establishing legal frameworks for local climate change action or creating national air and water quality standards, for example. But here again, success seems predicated on local planning capacity and budgetary resources. In the field of adaptation, national governments can facilitate timely and cost-effective action at the city scale, by providing mandate and incentives at the local level, financing regional climate scenarios and impact analysis to support decision-making, and raising awareness of businesses to integrate climate risks into business decisions. Regardless of the choice of models or the combination thereof, robust accountability standards will have to accompany these arrangements for public reporting. For the moment, bureaucratic processes are too unwieldy, prolonging for years tasks that could be accomplished in months, said Ira Magaziner, chairman of the Clinton Foundation.

Incentive mechanisms are essential, and the European Commission has developed an interesting approach mode of multi-level governance for climate change. Pedro Ballesteros, of DG Energy, has initiated the "Covenant of Mayors", a scheme based on voluntary agreement that includes a formal commitment from signing cities to go beyond the European "3x20%" energy and climate goals (*i.e.*, a 20% cut in emissions of greenhouse gases by 2020, compared with 1990 levels; an increase in the share of renewable energy until it reaches 20% of the energy mix; and a 20% cut in energy consumption). In the global negotiations, the EU insisted that no matter what others were doing, it would commit unconditionally to reduce emissions. It was a difficult position to strike, but Ballesteros said that thanks in part to this stand, China and India have started to accept the notion of reducing emissions. The implementation of sustainable energy action plans (SEAPs) with concrete measures should help to realize these objectives. The cities concerned must submit their Action Plans and provide periodic public reports outlining their progress. Cities have a financial incentive to join, in that it would enable them to qualify for funding through the Intelligent Energy Europe programme, and cities that do not comply with the rules will be excluded. Ballesteros noted that 160 cities have already expressed interest in this programme.

At the global scale, a degree of international co-ordination will also be central. Generally, in most countries, no direct link exists between national GHG-reduction goals derived from national climate protection programmes and international agreements on the one hand, and the implementation of these goals at the regional and local level. National and transnational networks have been crucial in sharing experience, strengthening capacity-building, developing standardised methodologies and integrating cities' opinions at national and international levels. Representatives of international networks of cities at the conference (ICLEI, UCLG, C40s) highlighted their crucial role in enhancing a learning process that resulted in the dissemination of best-practice methodologies and tools that can assist local governments to develop GHG-reduction strategies. This co-operation has produced a rich exchange of information on urban design, zoning, street patterns and public transportation that has been mirrored at the transnational level. Ira Magaziner, chair of the Clinton Foundation, said that officials in developing countries are fully tuned into the problem of climate change, but are in desperate need of technical assistance. The most effective assistance, he said, is the most practical, in the form of exchanges between those on the ground in charge of water departments and waste departments. The Clinton Foundation has proved extremely helpful in partnering with cities to develop climate change adaptation and mitigation strategies. From Seoul to Johannesburg and Houston, it helps the largest cities in the world retrofit their municipal buildings, public housing and commercial buildings. Waste management has also become a major problem, given that methane is 22 times more powerful than CO_2, and the foundation has been working with Lagos, Delhi, Mexico City and London to deal with this problem. The foundation is also promoting new energy-saving LED technology to replace conventional street lights and traffic lights that use energy 24 hours a day. The energy savings pay for themselves, Magaziner said, and the objective is to create an economic catalyst to bring the economic parties together in a common programme.

Partnership with non-public actors is also a key factor for the successful implementation of mitigation and adaptation of climate change policy at the local scale. The C40 is a partnership between the Clinton Climate Initiative and 40 of the largest cities in the world. Pledged to reduce carbon emissions and increase energy efficiency in large cities across the world, this forum brings together four of the world's largest energy service companies, some of the world's largest banks, and at least 15 of the world's largest cities, to reduce energy consumption in existing buildings. EMBARQ, the World Resources Institute Center for Sustainable Transport, is an interesting example of an international non-governmental organisation that acts as a catalyst for socially, financially and environmentally sound solutions to improve the quality of life in cities. Through the formation of public-private partnerships, EMBARQ has turned the attention of the private sector towards the needs of cities, their citizens and their environment, by providing support for the design and implementation

of sustainable urban transport strategies in the developing world. Nancy Kete, EMBARQ's director, explained at the conference how her organisation's experience with Mexico City has helped to get the press on board with reform and to gain public acceptance of the new programme. The partnership led to the launch of the Center for Sustainable Transport (CTS-Mexico) to address the problems of congestion, air pollution and transport safety in Mexico City. In June 2005, CTS and the city launched the Metrobus Bus Rapid Transit system, which runs for 14 kilometres along the Avenida de los Insurgentes, a major city thoroughfare. One year later, Metrobus had served more than 70 million passengers and cut transit time along its route from two hours to one. Today, CTS-Mexico and EMBARQ have expanded their activities into other Mexican cities, including Queretaro, León de Guanajuato and two Mexico City suburbs, Toluca and Cuautitlán.

City Networks members also pointed out the importance of engaging local governments in the global governance system. At present, local governments are sometimes invited as members of their national delegations in the United Nations' post-Kyoto process, but their role is limited to observer status. Only Parties, or signatory nation-states, are allowed to negotiate the rules of the international climate policy framework under the UN system. While observers can be quite active in many ways and clearly have indirect influence on the negotiations, they are not directly engaged in the negotiations. In their observer capacity, local and regional governments and their umbrella organisations can draw attention to their accomplishments, for example by hosting side events to highlight and share recent experience on mitigation or adaptation issues.

Beyond playing an essential role in assisting national governments to deliver on national mitigation strategies and international obligations, cities may also become active players in the emerging international carbon market. In some situations, local governments already participate in emerging carbon markets or even the Kyoto mechanisms, notably by hosting and/or developing joint implementation and Clean Development Mechanism offset projects. In some European countries (for example Italy and France), there are efforts to involve local governments in the carbon-offset market through the development of joint implementation projects. Also in the EU's Emission Trading Scheme (ETS), local governments might also be able to participate, where there is direct ownership of power stations (or district heating facilities) above the threshold size level.[12] Some EU member states also involve regional or local authorities in the administration for granting permission for installations and/or for monitoring, reporting and verification issues. In six member states (Belgium, Germany, France, Latvia, Austria and Poland) regional or local authorities are often responsible for the issuance of emission permits and/or for monitoring, reporting and verification (MRV) of emissions. In Austria, penalties are imposed by regional or local authorities.[13]

At the meeting of the Roundtable of Mayors and Ministers, Elisabeth Gateau, Secretary General of United Cities and Local Governments (UCLG) and Konrad Otto-Zimmermann, Secretary General of Local Governments for Sustainability-ICLEI, called for greater recognition of the cities in the next UN Framework Convention on Climate Change (UNFCC) framework. To this effect, the main city network associations have set up the Local Government Climate Roadmap, an international process that mirrors the UN Climate Roadmap.[14] Although most of the participants agreed on the need to further involve cities in the implementation process, they stressed that it is not clear how local governments can be involved internationally in a way that does not burden an already complex process involving 198 nations. Officials recognised the need to build consensus on urban environmental indicators and the urgency of implementing policies that harmonise national, regional, and local action to combat climate change. They endorsed continued policy dialogue and action that strengthens relationships between city competitiveness and climate change and invited the OECD to continue assisting governments by pooling and systematising knowledge around the local policy experience. This would include providing tools and monitoring to make progress in climate protection; conducting assessments of collaboration between local and national governments for climate change action; and

providing an essential sounding board for the urban dimension in current global climate change policy processes.

In the conference's closing ceremony, OECD Secretary-General Angel Gurría outlined a ground swell of local initiatives, declaring, "Momentum is building to mainstream policies for the 'green economy' and climate-smart cities. … How cities develop will determine our collective ability to address climate change. The time has come to bring the experience and the capacity of cities to deal with the development and climate change challenge to the front of the climate debate. We need to empower cities to do the right things on climate change, and we need to learn from their experience."

NOTES

1. *www.ifrc.org/what/disasters/about/factors/climate.asp.*

2. This figures exclude environmental refugees.

3. For more info:
www.ey.com/Global/assets.nsf/International/Industry_Insurance_StrategicBusinessRisk_2008/$file/Industry_Insurance_StrategicBusinessRisk_2008.pdf.

4. SEMARNAT, INE, Tercera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre Cambio Climático, México (2006).

5. The Global Environment Facility (GEF) is a global partnership among 178 countries, international institutions, non-governmental organizations (NGOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives. It provides grants for projects related to six focal areas: biodiversity, climate change, international waters, land degradation, the ozone layer and persistent organic pollutants.

6. *http://news.bbc.co.uk/2/hi/science/nature/6616651.stm.*

7. European Climate Star Award is a biannual award for showcasing its members' achievements. Stuttgart was one of about 20 municipalities awarded the Climate Star Award in 2004. Climate Alliance is an association of municipalities, regional governments, and NGOs, aiming for a reduction of greenhouse gas emissions. Since the foundation of the association in 1990, 1 400 cities, municipalities and districts have joined the association. More than 50 provinces, NGOs and further organisations have also joined as associate members.

8. Financial Times, Tuesday, 28 October 2008.

9. *www.clintonfoundation.org/what-we-do/clinton-climate-initiative/our-approach/green-technologies.*

10. *www.clintonfoundation.org/what-we-do/clinton-climate-initiative/our-approach/measuring-success.*

11. *www.oecd.org/dataoecd/51/13/40881283.pdf.*

12. This concerns public utilities (*e.g.*, hospitals and universities) owned by local governments. In France, the Urban Communities of Lille Metropole, Bordeaux and Brest own power stations whose threshold qualifies them for the French National Allocation Plan.

13. *http://reports.eea.europa.eu/technical_report_2006_2/en/technicalreport_2_2006.pdf.*

14. *www.iclei.org/climate-roadmap.*

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CHAPTER 1:

COMPETITIVE CITIES IN A CHANGING CLIMATE: AN ISSUES PAPER[1]

As the number of people and the volume and intensity of economic activities in cities grow worldwide, the influence of cities on the local and global environment is rising. The repercussions of this environmental change are felt across all sectors of cities and their hinterlands, as climate change adds to the stress on society, economy, infrastructure and environment. Climate change can affect the competitiveness of cities in the regional, national and international context, because the environmental parameters that influence a city's functioning and the broader global dynamics of production, consumption and exchange of materials, energy and people are also affected.

Cities are centres of financial activity as well as of technological, social and institutional innovation, all of which are essential to their competitiveness at the regional, national and international level. The concentration of population and economic activity lends urban areas a significant role in any national and global effort to cut emissions of greenhouse gases. As they begin to recognize their role as a contributor to global climate change, cities – through intricate changes in behaviour and the built environment – are attempting to cut emissions. But since the accumulation of emissions to date will continue to influence climate for decades, and because cities are often located in vulnerable areas, they must also begin to adapt to the impact of climate change both on the infrastructures that influence urban living and on broader, climate-induced regional, national, and global environmental and socio-economic trends. This paper will sketch the implications of climate change for cities. Section 1 will underline the relevance of cities for climate change; Section 2 will focus on the impact that climate change can have on urban functions; and Section 3 will describe the implications for urban policies. A summary and conclusions will be provided in Section 4.

1. Relevance of cities

1.1 Trends linked to urbanisation

The growing number of urban pockets with very high population densities and compact centres of leisure and economic activities rely on distant resources to remain sustainable. The global ecological footprint is expanding, and cities' competitiveness may be undermined by the depletion of resources and the accumulation of waste by-products. The world's population is projected to increase to 8.2 billion people by the year 2030. Most of the increase will be concentrated in developing nations. Population growth, migration and ageing influence lifestyle and consumption patterns, contributing to the overall strain on the environment (OECD, 2007c). In addition, population density is increasingly concentrated in urban centres, and in urban centres overall, population growth has grown fifteen-fold within the last century.

Urbanisation is linked to concentration of land use, income and economic activity…

By the year 2000, urbanisation had concentrated half of the world's population – nearly 3 billion people – on only 2.8% of the Earth's land area. In Africa and Asia in 2000, 37% of the population was

based in urban centres, and in Latin America and the Caribbean, North America, Europe and Oceania, the percentage was in many instances at or above 75% (UNDP, 2003). The average size of the world's largest 100 cities now stands at 5 million (Cohen, 2004) – a 25-fold increase over the figure for 1800.

Cities produce a significant portion of a country's GDP. For example, Budapest, Seoul, Helsinki, Brussels, Oslo, Auckland and Prague generate over one-third of their respective countries' GDP. In most instances, GDP per capita is higher in cities than the national average. Cities attract a more educated demographic. Growth in the labour force tends to be faster in urban areas than in rural areas. Although in nearly two-thirds of metropolitan regions, unemployment is lower than the national average, almost a third of urban areas are experiencing higher–than-average unemployment rates. Additionally, migration from poorer regions to more affluent cities has risen, and many cities have become home to millions of foreign immigrants. While migration generally helps to drive urban economies, its stress on local infrastructure, institutions and services can be significant (OECD, 2006).

Cities tend to concentrate high value-added, low material use and service-oriented industries. These industries and their employees, however, still require significant support from low-skill workers – most of them immigrants – to maintain, improve and expand their services. Low-skill, low-paid workers are often physically segregated in metropolitan regions (OECD, 2006b), and urban poverty levels are on the rise (UNFPA, 2007). Nonexistent or inadequate infrastructure – such as shelter, piped water, sanitation facilities, waste disposal, roads and storm water management systems – increase the vulnerability of many poor areas to local and global environmental change (UNFPA, 2007).

…as well as challenges for social cohesion and increased fossil fuel dependency

The socio-economic inequalities within urban populations contribute to a lack of social cohesion, manifested in increased exclusion, dependency, crime and poverty rates. Additionally, population concentration, as well as economic, leisure and social activities exert pressure on infrastructure, making construction and maintenance more costly and difficult. Congestion and pollution are further externalities related to densely populated areas (OECD, 2006).

Because the growth and development of cities is integrally linked to the availability of affordable energy, demand for fossil fuels in most cities has intensified. This further contributes to climate change, and regional problems such as poor air and water quality also emerge as a result. So while global climate change is a worldwide problem, abating greenhouse gas emissions will help to alleviate many local environmental issues that affect public health and well-being, such as air quality and water pollution.

Cities already concentrate human activity and exert a growing pull on surrounding ecosystems – drawing on natural resources and exporting the waste by-products (OECD, 2007d). With economic growth and the generation of wealth, direct and indirect consumption of energy and materials increase (Ruth, 2007), adding to pressure on water use, waste disposal, energy and transport (OECD, 2007c), and straining local and national budgets.

Urban areas leave a large ecological footprint

The ecological footprint[2] – the total area required to provide environmental goods and services for a specific region – is particularly severe in cities. For example, in York, England, the city's average per capita footprint is 25% higher than that of the surrounding region (Barrett *et al.,* 2002). London's footprint was found to be 125 times the size of the city and twice the land size of Great Britain (Wackernagel, 2006; London Remade, 2007), and Cardiff's footprint takes up 82% of the entire land area of Wales (Cardiff Council, 2005).

Figure 1. Progression of ecological unsustainability from 1961 to 2001: footprint and biocapacity

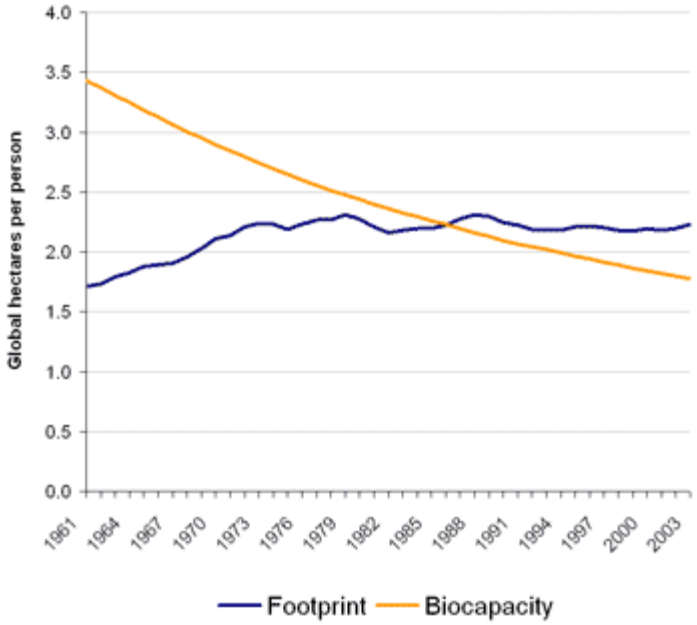


Figure 2. Geographical distribution of the ecological footprint from 1961 to 2001

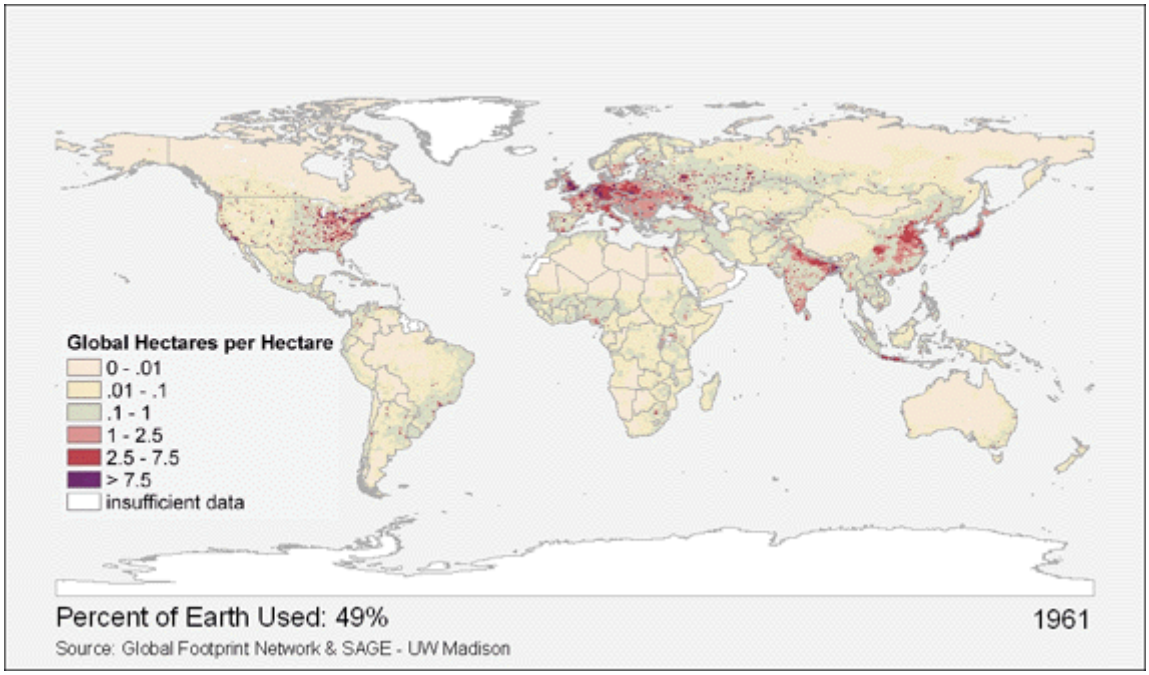
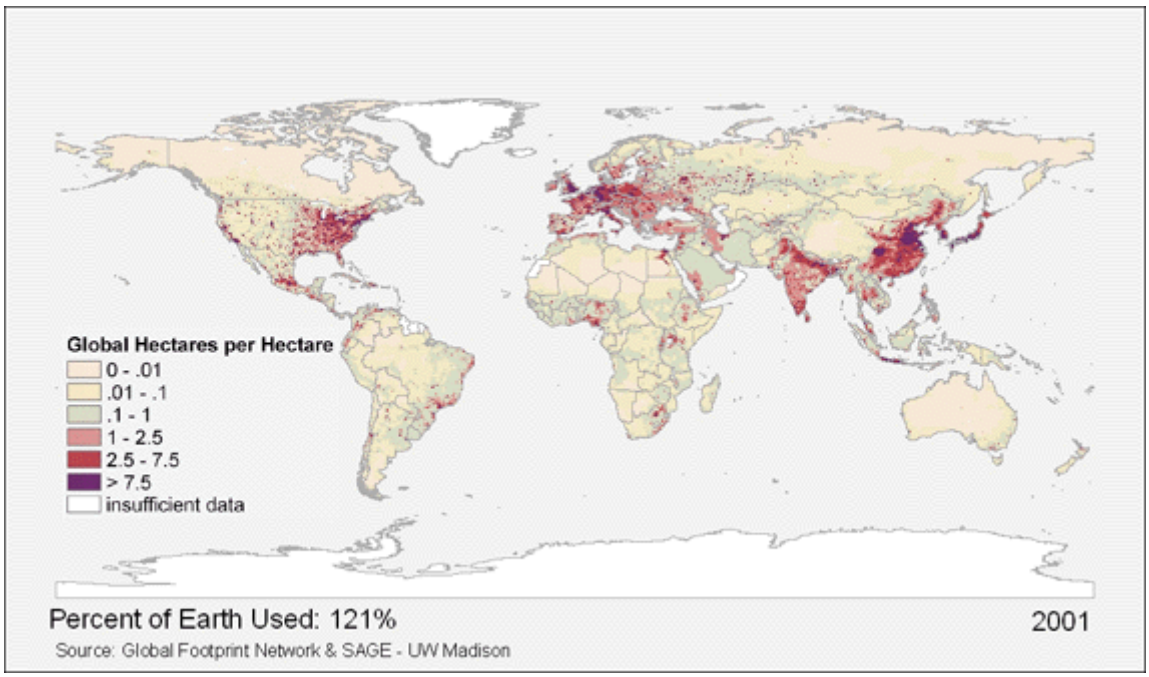


Figure 2. Geographical distribution of the ecological footprint from 1961 to 2001 (*cont.*)



Source: www.footprintstandards.org.

Urbanisation is associated with higher ecological footprints per capita, primarily because of the high levels of industrial commodity production and the concentration of key consumer markets in urban regions (Jorgensen, 2003). Growth in GDP per capita is similarly associated with increases in global ecological footprint (see Figure 3).

Figure 3. Relationship between urbanisation and GDP per capita with the size of global ecological footprint

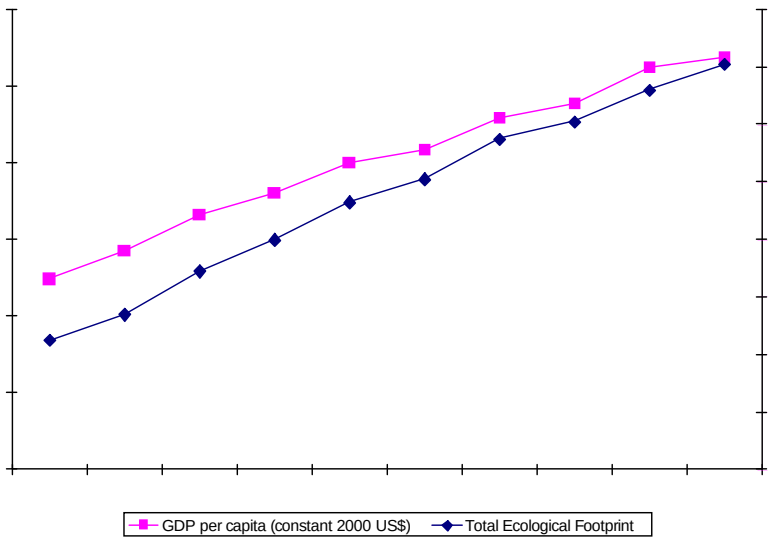
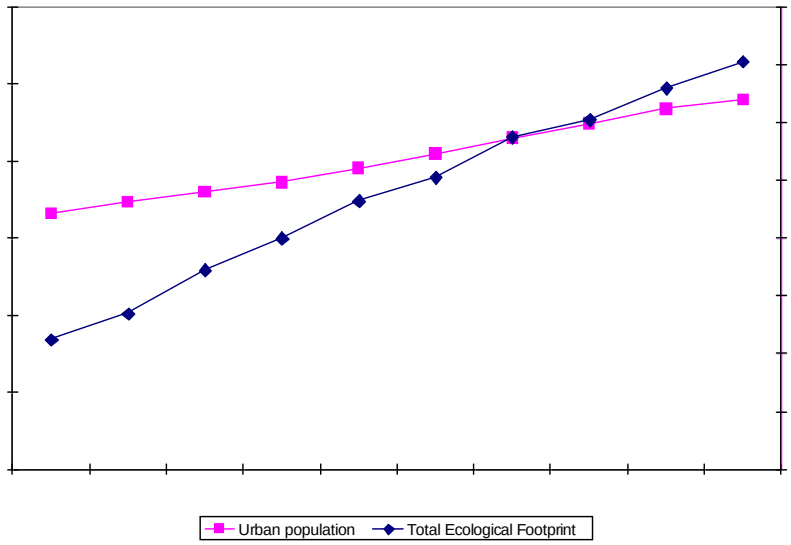


Figure 3. Relationship between urbanisation and GDP per capita with the size of global ecological footprint (*cont*.)



Source: World Development Indicators Online (2007), The World Bank Group, University of Maryland Library, College Park, Maryland, and Loh, J. and M. Wackernagel (eds.) (2004), *Living Planet Report 2004*, World-Wide Fund for Nature International (WWF), Global Footprint Network, UNEP World Conservation Monitoring Centre, Gland, Switzerland.

The density of demographic and economic parameters in cities, and the corresponding density of physical and intellectual resources, greatly contribute to the continuation of climate change, but also provide an opportunity for an efficient policy response to the challenges of climate change. Local policy makers can take advantage of the factors that drive cities' competitiveness to prepare for the effects of climate change. The concentration in cities of infrastructure, labour, services, buyers and sellers can facilitate "knowledge spillovers" and innovation (World Bank, 2005b).

1.2 Cities as engines of growth

Cities are engines for national growth…

Many cities not only produce a large portion of their country's GDP, as was described in the previous section, but can also act as engines of regional and international growth through effective development and enhancing competition. High productivity, a well-developed infrastructure and supporting industries, social cohesion and investments in human capital, as well as policies designed to reinforce all these elements, are necessary components of city competitiveness.

Studies of GDP per capita in cities within the OECD identify three factors that explain variations in GDP. The most powerful factor, accounting for almost all the variation, is labour productivity, which is GDP per employee. The activity rate (the percentage of the population that is in the labour force) is also correlated with GDP per capita. For cities with low GDP per capita, the employment rate (employees as a percentage of the labour force) has some additional explanatory power (OECD, 2006).

…because they have higher productivity…

The remainder of this section explores factors that contribute to high productivity. Most cities of high productivity within the OECD specialize in high value-added, low-material-use industries, including information technology, financial services, logistics, analytics and biotechnology. They also usually include a thriving sector of specialized consumer goods, such as fashion, arts and marketing. For such activities, the concentration of people and businesses in a large urban area offers many advantages, enhanced by global communications and transportation networks (OECD, 2006). Transportation in particular is vulnerable to climate change, as we discuss later.

…in which transportation, R&D and human capital play a central role

Transportation plays a vital role for cities. The population of urban areas far exceeds what the natural resources within their borders can support. In order to survive at all, cities borrow both the material products of natural systems and ecosystem services from surrounding areas. Some of these items are traded in the market, while others are not, and are the economic externalities stemming from the functioning of the city. For market items such as food or clothing, urban areas borrow ecosystem productivity from all over the globe. This means that they must rely on transportation for very basic functions.

High value-added industries rely on the concentration of research and development activities within the urban area. This, in turn, requires a variety of supporting factors. For instance, the presence of university research centres focused on such industries is critical. Such centres entail a concentration of both physical capital (for example, laboratory space and scientific instruments), as well as the human capital of their highly trained workforces. A diverse manufacturing base is also important for R&D (OECD, 2006). Additionally, many service businesses, such as call centres or IT support from across the globe, have relocated close to pools of cheap, educated labour in developing countries. Many low-wage countries produce large numbers of trained, English-speaking college graduates (Agrawal, 2003). This outsourcing attracts an influx of financial capital from outside the country and often boosts the local economy (Baily, 2004).

Competitive cities need human capital. The economic performance of a city depends on the skills and productivity of its low-skilled workers, as well as on its social cohesion. While investment in human capital raises the skill level of workers, contributing to economic performance, the presence of a large informal economy typically reduces investment in workers' skills, and can reduce a city's competitiveness (OECD, 2006a). Social cohesion and the rule of law, in so far as they limit the informal economy, can be characterized as elements of social capital that aid the competitiveness of a city.

Many factors that contribute to city competitiveness – high productivity, adequate infrastructure (especially of transportation), underlying supportive industries, and social cohesion and human capital investments – are described above. On a basic policy level, increasing such competitiveness requires co-ordinated policy actions designed to provide services at an optimal level, the collection of adequate funding, a mix of tax types, sufficient local autonomy, and limiting urban-made externalities on the rest of the region (OECD, 2006).

1.3 Urban infrastructure and institutions

Although urban infrastructure is an essential element in city competitiveness, cities in many parts of the world are struggling to meet the basic needs of their populations. To plan for and provide the

necessary infrastructure, governments need extensive institutional capability and inter-party co-operation.

Functioning urban infrastructure and a healthy environment not only provide the urban population with the necessary structure for carrying out economic and social activities, but are also prerequisites for ensuring the competitiveness of a city. Disruptions in infrastructure systems create inefficiencies and slow down economic progress, imposing costs on the local and national economy. Cities' stability and prosperity rely on vast networks of provisional infrastructure – solid waste disposal; wastewater treatment; transportation; water, energy and sanitary provisional systems. Urban infrastructure is grossly deficient in many developing countries. As much as 50% of the urban population in Asia and Africa lacks adequate provision of water and sanitary services (Ruth, 2007). Furthermore, if urban growth trends in sub-Saharan Africa follow their projected rates and increase at least 50% between 2000 and 2015, 60% more water will be required to meet the additional demand (Muller, 2007).

Around the world, many urban areas are struggling with deteriorating infrastructure, insufficient public budgets and inefficiencies in privately run services. The underlying causes of inadequate infrastructure are often complex. Government, planning agencies and sometimes non-governmental organisations must assess the adequacy of existing infrastructure. Institutional aptitude and co-operation are particularly necessary in cities to anticipate and respond to environmentally driven challenges, given cities' spatial, functional and economic interconnectedness. Institutions must often struggle to secure adequate funds, correct inequitable access, commit to expensive and irreversible infrastructure investments, and deal with the uncertainty and risk inherent in investment decision-making (Ruth, 2007). In metropolitan regions with overlapping legislative and jurisdictional boundaries, these challenges become ever more difficult.

Investment drivers

Typically, a national government has the authority to make large-scale decisions over infrastructure, although private/government and purely private investments can account for a significant portion of overall infrastructure availability and accessibility. Each of these agents has different investment goals, strategies and tactics. Private/public partnerships often help diversify investment portfolios and spread risk across multiple players, facilitating the provision of infrastructure that is potentially more efficient (Ruth, 2007).

Examples of public-private partnerships abound. Many health care services – for example, through hospitals, mental health care centers and health initiatives (the Global Alliance for Vaccines and Immunisation, the World Health Organization, the TB Alliance, etc.) – are financed and run by public/private partnerships. Transportation networks, including tunnels, roads, motorways, railway stations, bus and rail transit, and bridges are often a co-operative public/private effort. Education, water and energy distributional services, and information technology have also been provided through such collaborations (IP3, 2007).

Ideally, such arrangements combine the advantages of the private sector – capacity for and flexibility in innovation, access to finance, technological competence, and managerial efficiency – with the public sector's mandate to provide services in a socially and environmentally responsible manner (Kumar, 2004). Often, involvement from the private side has been limited to private debt contracts with a select few institutional investors or multilateral banks. Particularly in emerging markets, the public and private sectors wrangled over public control versus investor profits and entitlements; public access to the built infrastructure; inconvenient political realities of privatisation without public input; and sometimes the legal incompatibility of the financing scheme employed. New

partnerships are emerging that rely on local domestic capital spreading risk and benefits among local governments, development banks, international aid agencies and local users. This diversification may deal with some of the concerns outlined above (Streeter, 2004). Regardless of the form infrastructural investment takes – public or private/public partnerships – the presence of an effective and efficient public sector base is vital to a successful outcome.

Obstacles

Governments face several difficulties in planning for and constructing infrastructure. One concern is that rapid population growth and expansion of economic activity quickly makes infrastructural investments inadequate or obsolete. There are several considerations related to the expense, life span, and size and functionality of infrastructure systems. The need for large amounts of financial capital can make infrastructure decisions politically cumbersome. Once investments are made, infrastructure systems become locked in, stalling technological advancement and perpetuating inefficiencies. The relatively long lifespan of most infrastructure introduces investment risks and uncertainties. Furthermore, most infrastructure systems, such as water supply, transportation networks or flood management systems, are large and involve multiple components that must work in co-ordination. Damage to one element can render the entire system dysfunctional. This usually makes investment in redundancy and complementary systems essential, increasing the total cost of a project. In light of these considerations and the projected stress on infrastructure networks stemming from the combination of local influences and global climate change, it is prudent to retrofit current infrastructure and to design systems capable of withstanding the predicted impacts (Ruth, 2007).

Additionally, differentiating and co-ordinating the roles of several tiers of government (local, regional, state and national) can be a daunting task, with their distinctive structures and existing private partnerships. Investment-making involving multiple agencies can be time-consuming and complicated. Another complicating factor in providing adequate infrastructure for local governments is the fact that the essential natural services, such as water aquifers, do not necessarily map onto human-made jurisdictional borders. Many municipalities may rely on a single aquifer – as is the case with the world's largest rivers and lakes. Competing uses of water from the Nile in Egypt and Sudan, the Danube in Europe, the Ganges in India and Bangladesh, and the Colorado River in North America, as well as the Great Lakes in Africa and in North America, illustrate the need for international co-operation and raise questions about the effects of climate change on international relations.

2. The challenges of climate impacts on cities

2.1 Climate variability and change

Some effects of climate change are reasonably predictable (*e.g.*, melting of glaciers, changes in global temperature regimes), while others are not (*e.g.*, frequency and magnitude of extreme weather events). In addition, some are relatively uniform across the globe (sea level rise) while some vary widely from place to place (*e.g.*, heat waves, droughts, spread of alien species and disease). In general, those that show high regional variation are particularly difficult to predict.

Rising sea levels are critical for coastal cities…

Higher global average temperatures and sea level rise are the most widespread and predictable effects. In the twentieth century, the global average temperature has risen 0.6 degrees Centigrade, and even given aggressive measures to curb greenhouse gas emissions, scientists expect an estimated 2.2°C additional rise by 2100, with temperatures continuing to rise for centuries thereafter.[3] This can

have a direct effect on human health and energy use (IPCC, 2001c), particularly in urban areas, where it is exacerbated by the heat island effect.

Mean sea level has risen 10-20 centimetres in the 20th century, due to glacial melting and the expansion of sea water as it warms. While the specific amount of melting is difficult to predict, the IPCC expects 30-50 centimetres of sea level rise by 2100[4] (IPCC, 2001c). This is a critical issue for major cities, which tend to be clustered near coasts, particularly in developing countries. Even in Europe, 70% of the largest cities have areas that are less than 10 meters above sea level (McGranahan, 2007).

Table 1. Cities are highly concentrated in coastal zones

Share of urban settlements whose land area intersects the Low Elevation Coastal Zone (LECZ), by urban settlement size, 2000					
Region	<100K (%)	100–500K (%)	500K–1M (%)	1–5M (%)	5M+ (%)
Africa	9	23	39	50	40
Asia	12	24	37	45	70
Europe	17	22	37	41	58
Latin America	11	25	43	38	50
Australia and New Zealand	44	77	100	100	N/A
North America	9	19	29	25	80
Small island states	51	61	67	100	N/A
World	13	24	38	44	65

Source: McGranahan, G., D. Balk, and B. Anderson (2007), "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones", *Environment and Urbanization*, Vol. 19, International Institute for Environment and Development, London, p. 17.

… and urban infrastructure must be able to handle more extreme weather conditions

Climate variability and extreme weather events are also predicted to increase worldwide. Climate models predict more droughts and more floods, as well as more heat waves and strong wind storms (IPCC, 2001c). While the exact distribution of such effects is highly uneven and very difficult to predict, infrastructures must generally be designed to handle the extremes rather than the average, making cities particularly vulnerable to increasing variability. Much of climate change's damage to ecosystems will be from increasing variability in weather and increasing severity of extreme events (Jones, 2004), and this is likely to be true for human systems as well.

Aside from extreme storms, changes in precipitation patterns will be critical for many regions. Scientists expect a general trend of increased precipitation in middle latitudes and decreasing precipitation near the Equator, but the effects will be highly variable on a local scale, and the technology to predict them accurately does not yet exist (IPCC, 2001c). Changes in the availability of water are more likely to be dominated by the effect of growing populations and economies, but since current water management systems are designed for historical weather patterns, some adjustment will probably be required in most places (Hitz, 2004).

Events that are the least likely to be predicted may also be the most catastrophic, as for example the stalling of the North Atlantic Oscillation or the sudden collapse of ice sheets. Given their unpredictability and relatively sudden and widespread effect, adaptation to such events would require

large investments, all the while running a strong risk of being unnecessary (Jones, 2004). Mitigation measures that reduce the stabilisation level of greenhouse gases will reduce the risk of such events and are the best protection against them.

2.2 Urban climate impacts and vulnerabilities

Section 1.2 discussed factors that contribute to and factors that limit city competitiveness. This section will highlight those factors that are likely to be affected by climate change. Many of the dangers of climate change can be mitigated by folding the expectation of a new climate into existing infrastructure development, although this is complicated by the dense interconnections among the infrastructures on which cities rely (Ruth 2006, Ruth et al. 2006). Where climate change interacts with persistent social problems, adaptation will be even more challenging (Ruth and Ibarraran, in press).

Transportation infrastructure is vulnerable to flooding

Transportation infrastructures are critical to cities for their very survival, as well as for competitiveness. Transportation networks are vulnerable to climate change because they are vulnerable to flooding (see Box 1). There is little question that transportation and flood control infrastructure can be built to withstand a wide range of extreme weather events. However, since such infrastructure generally lasts decades, it will be important to take into account predictions for the climate in the future when designing and building the structures. Since these structures will be part of a changing economic and social system as well (and lay the footprint for future development), it will also be imperative to assess them within the longer-term trajectories of socio-economic changes that may occur in response to climate change. In the long view, the best adaptation strategies may turn out to not be technical but socio-economic and institutional in nature.

Box 1. Climate change, transportation and flood risk

New York's airports, as well as many of its power plants and waste transfer facilities, are at sea level and/or on waterfront sites. The subway system and subterranean water and sewer systems were designed for current sea levels. A Category III hurricane would flood all the tunnels out of New York, as well as the city's airports, requiring the evacuation of up to 3 million people (City of New York, 2007).

The Thames Barrier, which protects London from high seas, was raised only three times in its first six years of operation, but was been raised 56 times between 2001 and 2007. Flash floods caused approximately 600 flooding incidents in the London Underground between 1992 and 2003. A single 2002 flooding incident in the Borough of Camden caused traffic disruptions amounting to losses of at least £100,000 per hour's delay on each main road affected, even without including infrastructure damage. A recent report concluded that significant changes to current drainage systems would be needed to maintain current service levels with even a small increase in storm rainfall. (Mayor of London, 2007).

Energy prices will rise, effects on demand are ambiguous

This section summarizes the most vulnerable systems that cities must rely on, both for their existence and in order to compete effectively. It is notable that most of the systems that are not treated here as particularly vulnerable must rely on the continued availability of cheap energy. For instance, as rainfall and temperatures shift, some foods may need to be grown elsewhere. As long as transportation

is relatively cheap, market economies will adjust to this without specific planning or intervention. However, there are several reasons to expect the price of energy to rise.

The largest factor by far is increasing *per capita* energy use in populous developing countries, and increase in population worldwide (Hitz, 2004). There is also evidence that the peak of world petroleum production is approaching, and that additional sources, such as oil shales or tar sands, will be more expensive to exploit (Deffeyes, 2006). In addition, climate change may directly affect the cost of fossil fuel production, as demonstrated graphically by the damage to petroleum platforms in the Gulf of Mexico during the 2005 hurricane season. Hurricane Katrina alone caused nearly USD 11 billion in damages to oil platforms and pipelines (CIER, 2007).

Changing climate may also drive changes in energy demand, which will in turn affect its price. It is not clear whether moderate global warming will increase energy demand or decrease it. As winters warm, less coal, oil and natural gas will be needed for heating. The infrastructure to deliver heating fuels is largely in place and will only be minimally affected by lower utilisation. Cooling requirements, in contrast, are likely to increase considerably, making large-scale investments in cooling efficiency and electricity capacity imperative. Those will, no doubt, have economic implications that far exceed any savings from a reduction in heating costs.

Climate change mitigation measures are likely to impose a cost on emissions from energy use and/or production. This will stimulate efficiency improvement, which will tend to lower demand. The overall effect on energy prices is unclear (see Box 2).

Box 2. Technology

To reduce energy-related carbon dioxide emissions, technological improvements are necessary in the following arenas: reducing the amount of energy required by processes in all sectors; switching energy procurement from coal to oil to gas to renewable energies; increasing efficiency in converting and using energy; and sequestering carbon dioxide (OECD, 2003a).

Establishing a price on greenhouse gases through the market will stimulate behavioral and technological conversion. Optimal timing for mitigation policy should consider the long-term commitments inherent in expensive technological investments. Acting too soon may encourage the development of less than optimal technology, while prolonged inaction will lock society further into high-emitting technologies (OECD, 2003a). Policy options for technology transfer include taxes and other economic instruments that provide incentives for technological efficiency and for research and development investment, voluntary measures and standards, bilateral and regional co-operative efforts on climate change, partnerships with the private sector, and programmes designed to train and educate (OECD, 2003a).

Climate change may put additional strain on social cohesion in cities…

As noted in Section 1.2, social cohesion contributes to city competitiveness. To the extent that the impacts of climate change, or of adaptation to it, are unequally distributed, they may put additional strain on social cohesion. Worldwide, vulnerability to climate increases with population density and poverty (OECD, 2003a; OECD, 2007a). Where a country's low level of development does not allow for expensive infrastructure investments or institutional capacity that can protect the population adequately, a vicious cycle of vulnerability and poverty may result (Ibarraran and Ruth, 2006).

Within countries, studies show that the poor endure higher mortality rates after an environmental disaster. This is primarily because assets and income form the basis of social stability, and secondly, because the poor consistently lack access to credit markets, and government officials and institutions. Furthermore, since the poor generally have little or no savings, their ability to adapt or to move to less vulnerable areas may be limited. To the extent that poverty is correlated with reliance on a single income source, natural disaster will probably undermine livelihoods (Ibarraran and Ruth, 2006). Consequently, as employment opportunities within cities become increasingly specialized, vulnerability may increase. While the distribution of climate change impacts within cities are not well established, it is clear that less well-off residents will have fewer resources for adaptation.

Aside from the distributional inequalities of costs and benefits associated with climate change, mitigation and adaptation policies may also produce imbalances. If a rich developed country chooses to ignore mitigation and pursue only adaptation policies, the costs of mitigation will be shifted to poorer nations and worsen the distributional impacts of climate change (Schneider, 2004). Within metropolitan regions as well, residents with the lowest greenhouse gas emissions per capita are likely to have the fewest resources for coping with climate change. Given their role as social, economic and technological innovators, as well as their particular vulnerabilities, cities will have a key role and responsibility – nationally and internationally – to promote a combination of adaptation and mitigation efforts that help minimize adverse distributional impacts.

…and may intensify competition for water

Since cities rely heavily on ecosystem services outside their boundaries, they are vulnerable to impacts in surrounding regions. For instance, cities generally rely on their immediate surroundings for water. While the effect of climate change on the water resources of a particular city cannot be predicted at present, the competition for water can be expected to intensify in the areas that become dryer than they are now. Areas most likely to be affected include those that rely on snow melt for water over the course of the summer, since winter snow packs in most places will decline (IPCC, 2001a). This will exacerbate the pressure on water resources caused by rising population and affluence (AAAS, 2006).

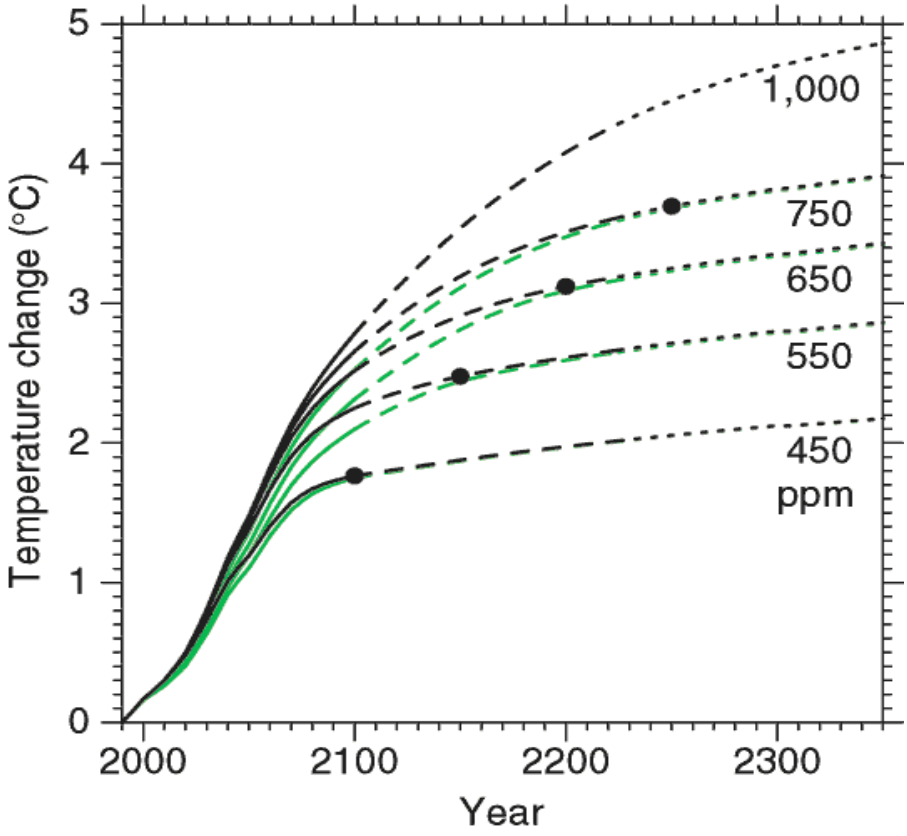
2.3 Mitigation and adaptation measures

Adaptation to climate change and mitigation of climate change are complementary strategies: the investment now of relatively small amounts will avoid larger costs later (see Box 3). Adaptation focuses on expanding the ability to cope with changes in climate,[5] whereas mitigation focuses on reducing the amount of change through reducing emissions or removing greenhouse gases from the atmosphere through sequestration. Frequently, adaptation and mitigation can go hand in hand, for example when developing a decentralized energy system based on locally available energy sources. Here, greenhouse gas emissions may be lower, as may be the vulnerability to large-area outages from severe weather impacts. The effects of climate change will vary locally, but the causes are global. This means that it is advisable to plan adaptation measures with a bottom-up approach that emphasises local stakeholders and priorities, and mitigation measures with a top-down approach focused on global agreement (Jones, 2004).

Box 3. Mitigation and adaptation are complementary strategies

The more the climate changes, the larger investments cities must make for adaptation. The higher the concentration of greenhouse gases in the atmosphere, the more climate change we can expect. As greenhouse gas release slows and sequestration increases, the world will eventually reach a point at which the concentration of greenhouse gases (GHG) stops rising. The GHG concentration at that point, called the stabilisation level, will determine our new climate. Thus, effective investments in mitigation will reduce the amount we need to invest in adaptation. (Figure from IPCC, 2001b).

Figure 4. Stabilisation scenarios for greenhouse gas emissions



Adaptation implies taking climate change into account in policy making

In many cases, the appropriate measures for adaptation consist of taking climate change into account in building codes, land-use planning and in the planning of new infrastructure or renovating existing infrastructure (Mayor of London, 2007). Transportation and flood control infrastructures, for instance, are usually planned on the basis of historical data that establish the likelihood that a flood of a given size will occur within a certain period. Cities then decide how much to invest in handling a 50-year, 100-year or 500-year flood. However, as climate changes and extreme weather events increase, the incidence of floods of a given size will increase. Infrastructure designed on the basis of historical data may prove insufficient.[6] For instance, metropolitan Boston may experience what used

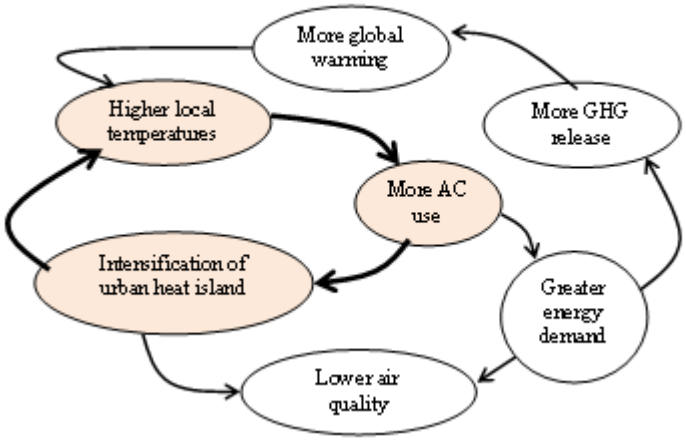
to be 100-year floods as often as every four years by 2100 (Kirshen, 2004). A similar argument can be made for updating building codes to protect against increased extreme weather events.

In choosing a portfolio of mitigation and adaptation measures, it may be necessary to make investment trade-offs between them. However, some policy choices will encourage both mitigation and adaptation. For instance, building codes can also enforce measures for mitigation through lower building energy use, which activates a virtuous cycle of mitigation and adaptation (see Box 4).

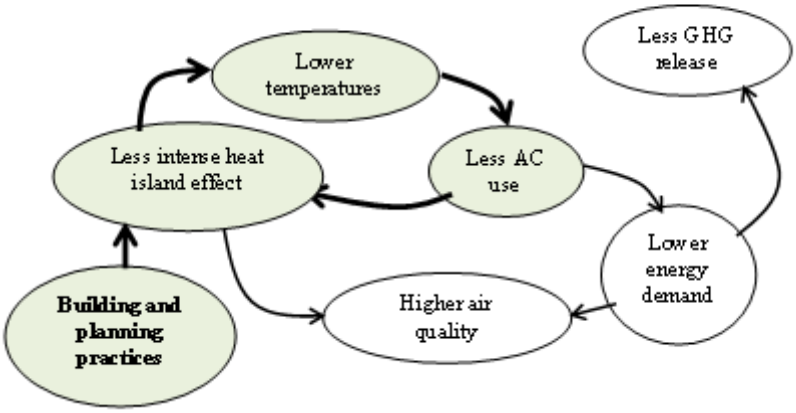
Box 4. The urban heat island effect

The built environment that makes up cities reflects less sunlight, absorbs more heat and retains it longer than vegetation does. In addition, the concentration of energy use leads to a concentration of waste heat. Because of this, cities are consistently several degrees warmer than their surroundings, particularly at night. This exacerbates higher temperatures due to global warming, and participates in several feedback cycles with it.

The vicious cycle of business as usual:



The virtuous cycle of mitigation and adaptation is activated by policies that limit the urban heat island effect, such as green roofs, tree cover and permeable and light-colored surfaces.



Mitigation of climate change might also improve urban liveability and health

Many of the measures that mitigate climate change and that help handle its effects also make cities more liveable and therefore potentially more competitive. For instance, cities can reclaim land in flood plains for open space, including wetlands. This provides an amenity to residents, removes buildings and other infrastructure from flood plains, reduces the urban heat island effect, helps control downstream flooding, provides habitat for animals, and limits water pollution by slowing storm water runoff into large bodies of water. In some cases, this may be integrated into redeveloping abandoned industrial sites.

Mitigating greenhouse gas emissions provides additional public health benefits by reducing many dangerous air pollutants and protecting natural ecosystem services. Often tactics to mitigate greenhouse gases improve national security through reducing dependency on foreign energy sources and by reducing the risks involved in transporting highly combustible fossil fuels around the world (Schellnhuber, 2004).

The problem of infrastructure and climate change is very different for cities in the developed and in the developing world. Highly developed cities have many advantages in institutional and infrastructural capacity for adaptation, from the rule of law to general electrification. On the other hand, it is always easier to change the design of infrastructure for mitigation and adaptation in the planning stage than to alter it once it is in place. In highly built cities, the design of any new infrastructure is constrained by the need to work with what is already in place, making both mitigation and adaptation harder.

3. Implications of climate change for urban policy-making

3.1 Urban climate policy goals

As global, regional, and local environmental challenges grow in size and range, many government environmental agencies have shifted their role from environmental protection providers to environmental policy developers and facilitators (OECD, 2007b). Their exact roles and goals in mediating climate change policy in light of the potential obstacles have to be clearly defined, and the scope of policy determined.

Policies should mitigate climate change and adapt to its irreversible effects…

To comprehensively respond to climate change, policies should be designed to achieve two main objectives – mitigation (through abating existing emissions of greenhouse gases and sequestering atmospheric carbon) and adaptation to irreversible effects of climate change (Schellnhuber, 2004). The inherent uncertainty of climate change scenarios and their impact on policy setting can be dealt with by assessing and assigning probabilities to detrimental impacts; by evaluating critical thresholds; by acting on priority measures that are well-established; and by aggressively mitigating greenhouse gases to avoid the worst effects (Jones, 2004). Not the least, forward-looking cities should embrace the challenge of dealing with climate change. Cities must focus on development of human capital and alleviation of socio-economic vulnerabilities and move away from reliance on competition through material extraction, use and depletion. Development, not growth, is the only truly sustainable way to maintain competitiveness in a world that has finite material resources but infinite intellectual and technological potential.

Just as most policy measures aim to maximize net social benefits, net benefits of adaptation can be determined by comparing adaptation benefits and costs, as well as the unavoidable damages of

climate change, the cost of precaution (if adaptation actions are taken and the climate does not change as predicted) and the cost of caution (if adaptation actions are not taken and the climate does change) (Callaway, 2003). Incorporating the risk of an irreversible catastrophic climate change episode increases the economically optimal level of near-term investments in mitigation and abatement (Corfee-Morlot, 2004). It has in fact been shown that mitigation policy strategies can significantly decrease the possibility of an anthropogenic large-scale climate disturbance (Schneider, 2004). Once the optimal level of action is determined, policy makers can begin to evaluate a programme of policy options necessary to accomplish the goal. Setting a policy agenda that is united across jurisdictions, municipalities and tiers of government is crucial for minimizing negative policy externalities, particularly since many costs and benefits of mitigation policies will probably be decoupled – with costs and benefits distributed unevenly between populations and regions (Corfee-Morlot, 2004).

…despite structural challenges

The ability of policy makers to respond to climate change challenges is often restricted by the existing structural and systematic paradigms. For example, the response of natural resource managers may be constrained by a variety of factors, including limited mobility of resources, the homogeneous, undiversified nature of most natural resource economic sectors, restricted technological possibilities, the high price of environmentally friendly substitutes, inadequate distribution and marketing systems that contribute to deficient domestic markets for a natural resource, and inadequate integration into international product markets. Counteracting these trends may be a prerequisite for implementing a successful climate change policy response in the natural resource sector (Callaway, 2003). More generally, every individual policy arena is operating under an existing paradigm, which may obstruct the successful implementation of climate change policies. This needs to be assessed and acknowledged.

Public authorities at city level often have the necessary jurisdiction (*i.e.*, governmental control, legislative mandate and institutional hierarchy) over the baseline issues underlying many major environmental problems – land-use planning, transport and traffic, building codes and waste management. The combination of these powers can be utilized to institute serious policy actions for sustainability, although implementation is often restricted by funding shortages or inadequate institutional capacity (OECD, 2006).

3.2 Implications for governance paradigms

As city governments move to implement climate change policies, existing relationships with certain economic sectors and other partners will need to be redefined. Governments will need to make decisions on every aspect of policy – from deciding whether to institute top-down or bottom-up controls to the exact nature of the policy tools. Involving the affected parties, the general public, and a mix of policy tools, including market-based solutions, may ease the transitional period.

Because of the likelihood that some industries (particularly fossil fuel-based energy sectors) will incur a financial cost as a result of policy implementations, certain environmental policy reforms will face stiff resistance. Policy tools such as taxes, emissions trading or regulatory standards are often perceived to undermine industries' competitiveness, especially if similar regulations are not required of their international competitors. Impact assessments of new policies that include measuring the potential damages of inaction can help advance a fuller understanding of the urgency and need for action. Additionally, stakeholder involvement and a transparent phasing-in process will be necessary to secure participation and commitment to the policy (OECD, 2007f).

There should be international co-ordination…

However, the most salient response to the concerns of the affected parties is a co-ordinated international effort to ensure fair competition, to buttress a more equitable market system by eliminating market imperfections. Overall, providing better information, paying close attention to policy implementation timing, broad international harmonisation of policy, establishing compensation mechanisms for affected sectors and increasing public awareness must be the foundation of government decision-making and policy implementation. It should be remembered, however, that while some climate policies will introduce new inequalities, the no-policy approach and resultant damages from climate impacts will also affect sectors and individuals unequally.

To implement policy standards on climate change effectively, governments need to consider the level at which to institute these policies. They can be designed to extend top-down or bottom-up – focused on control-and-command policies or voluntary participation; to consist of a single department or be spread across multiple agencies; to be written into legislation; to be tied to budgets; to be open to stakeholders; and to be connected to national, regional, and local policies (OECD, 2007f). City governments face special considerations with regard to their exact jurisdictional authority, available capacity for implementation and enforcement, and co-ordination with the private sector and other affected parties.

…and agreement about targets

Quantified objectives for climate change mitigation involve an agreement upon desirable goals as measured by targets, which could be fixed, dynamic and non-binding, as well as monitored, enforced and adjusted throughout their implementation life cycles (OECD, 2003a). Instituting specific policy requirements, entering into technology agreements, introducing carbon taxes, and targeting specific economic sectors rather than the economy as a whole are additional strategies for reducing greenhouse gas emissions (OECD, 2003a).

Local governments can utilize the market system more efficiently to encourage development of cleaner technologies and assist in technology transfer, through reducing barriers that delay employment of newer technologies (such as revoking outdated subsidies and misplaced incentives) and investing in niche markets. Other tactics include subsidizing research and development, implementing technology and performance standards to reduce unintended environmental externalities, implementing taxes and cap-and-trade systems, and promoting voluntary agreements. These instruments should be used in conjunction with one another, rather than in isolation.

3.3 The costs of inaction

Cities will face many economic costs related to climate change…

There are many significant direct and indirect economic costs related to the impacts of global climate change. Damages to market-priced sectors such as agriculture, forestry and energy are expected to be considerable. But the total cost also includes non-market impacts, because the effects on human health and ecosystems are predicted to be devastating. Additionally, the added uncertainty associated with more frequent extreme weather events and the possibility of a catastrophic event could entail colossal costs of infrastructure rebuilding. Aggregate damages are considered to be underestimated and increasing with time (OECD, 2007e). Costs likely to be incurred if climate change continues unabated include direct financial costs to valuable economic sectors, such as decreased yields for commercial fisheries or disrupted water, energy and transportation infrastructure systems and indirect costs manifested in lost economic activity and productivity (OECD, 2007e).

For example, a recent report from the University of Maryland evaluated the economic impact of climate change on major regions in the United States. It found that as climate change progresses, most economic sectors will be affected – from insurance and infrastructure to manufacturing and agriculture. Billions of dollars in damages are predicted from the increased risk of fires, droughts, agricultural production losses, infrastructure damages and evacuations, and water shortages. Other studies that attempt to quantify the cost of failing to combat climate change project numbers in the trillions. The results of the prominent studies on the subject by Nordhaus and Stern disagree on the figures because of differences in methodology. However, they both conclude that the cost of inaction by far outstrips the losses incurred from policy responses aimed to mitigate and adapt to the event (OECD, 2007e).

…hidden costs…

Most economic loss will come in the form of "hidden" costs. Real costs of rerouting traffic, lost productivity, provision of emergency and continued aid, relocation and retraining costs will be felt throughout a country. In addition, higher risk and uncertainty stemming from global climate change imposes additional costs on the insurance, banking, financing and investment industries (CIER, 2007). In general, these costs will hit cities and their competitiveness.

…costs of lost ecosystems and cultural heritage

Ecosystem damages can be staggering. Over three-quarters of the world's fish stocks are exploited beyond sustainable levels, causing not only irreversible damage to the integrity of the ocean ecosystem, but inflicting economic costs on coastal and ocean economies. Global climate change is expected to bring additional stress to all ecosystems, and minimizing future costs depends on immediate aggressive policy actions (OECD, 2007e). Unrecoverable loss of environmental resources can seriously undermine important economic sectors in cities and degrade their overall competitiveness in the global economy.

Because of the difficulty of estimating the value of non-market entities and services, costs of lost ecosystems and cultural heritage as well as health-related matters are often ignored in economic studies. However, they may constitute a significant portion of the total damages associated with climate change impacts. Attempts to incorporate some of the relevant costs concentrate on analyzing the market-based constituent elements associated with each system. For example, estimating the costs of water pollution to health involves studying the disruptive economic effects of water-borne illnesses, such as additional health care costs, lost productivity, and the costs of policy control mechanisms employed to tackle the issue. Such intangible factors as discomfort, suffering and loss of life are either crudely measured or ignored. Despite the incomplete availability of costs, studies suggest that inaction on climate change will result in major health costs, by affecting levels of water and air pollution, as well as temperature increases. For instance, total damages from air pollution emitted by the 10 000 largest sources in the United States amount to 0.7 to 2.8% of the country's GDP. In China, damages from air pollution represent 3.8% of the GDP, and water pollution can cost nearly 2% of GDP (OECD, 2007e).

There are costs of non-implementation

Since emissions and pollution today will have an enduring effect far into the future, the temporal difference in value of money should be considered. It is generally agreed that costs and benefits incurred today have a greater value than those incurred in the future because of the opportunity cost of capital. The difference in the value is measured by the discount rate. Its precise size, however, is

uncertain, and researchers may attribute different rates to it depending on their purpose or preference (OECD, 2007e).

Secondly, since distributional impacts will be uneven within and between countries, certain analyses incorporate equity weighting into their estimates. The presence or absence of the equity weighting element can significantly influence the final results (Pittini, 2004). Thirdly, since the exact shape of adaptation policies is not known, estimates rely on one or two scenarios to predict the outcome. An inherent variability exists in the actual implementation, which make the results less predictable (OECD, 2007e).

Complicating the picture further, environmental impacts are dynamic. Not only do they often exhibit non-linear and cumulative effects, but they have sustainability thresholds and involve irreversiblities. Finally, the exact nature of these dynamic interactions is unknown, as is the likelihood of certain catastrophic events (OECD, 2007e). While it is obviously difficult to project the aggregate costs of inaction on climate change, the final message is clear. The cost of inaction is likely to be monumental and will only increase as global climate change continues.

3.4 Implementation of action plans

Making policies

The implementation of particular climate mitigation and adaptation plans in cities will require agreement on the broad parameters for policy laid out above – the role of public, private and nonprofit sectors in setting a policy course of action, the relative roles of local, national and international communities in identifying and supporting concrete solutions, the relative weight given to technological, social, economic and environmental change in promoting mitigation, adaptation and competitiveness, and the minimisation of negative externalities and inequitable impacts.

The need for pro-active measures…

Anticipatory and pro-active adaptation policies (*i.e.*, those policies that are site-specific, consider local threat extremes, and prescribe strategic investments in preventive mechanisms) minimize maladaptation costs and other inefficiencies compared to passive, reactive policy actions (Schneider, 2004). For example, a study on climate change in Asia, Latin America and Africa found economic benefits of adaptation policies over recovery after the fact (OECD, 2003b).

…and partnerships.

Managing the complexities of the real world necessitates a policy that is designed to work on multiple fronts – involving partnerships with private and non-governmental organisations to work from the bottom up at the local level, as well as incorporating top-down policies and collaborating with regional, national and international players (OECD, 2003a). Technology transfer to developing countries should be encouraged on the international level through grants or preferential or concessional loans. Establishing an international emission-trading framework and assisting developing countries in their participation – potentially through non-binding or dynamic targets – would promote technology transfer (OECD, 2003a). Expansion of public sector capacity through productive and mutually beneficial partnerships within the public sector, as well as with the business community and non-profit organisations, is integral to addressing the complex and expansive impacts of climate change.

One of the persistent barriers to the implementation of environmental policy is the concern that the costs will be too high, reducing economic competitiveness. While there will be losers as well as winners, inaction will entail high costs. OECD analyses show that well-constructed environmental policies have an overall net benefit, and that most disproportionate costs and unequal distributional impacts can be corrected through the use of proper allocation mechanisms (OECD, 2007f). Some strategies to maximize net benefits include gradual policy phase-ins, supplemented by stakeholder involvement and pre-announced schedules; integration of environmental issues into sectoral policy making, allowing each sector to adjust appropriately; support of economic and scientific modeling to better understand the underlying complexities and develop more effective solutions; and enhancement of enforcement systems to ensure compliance (OECD, 2007f). An example of London's plan to respond to climate change is summarized in Box 5.

Box 5. The case of London

The Mayor of London, Ken Livingstone, recently developed an action plan for the city to respond to climate change. In the Mayor's words, "The plan sets out a series of measures…to use energy more efficiently, to change fundamentally the way London is supplied with energy; to maintain London as a world leader in sustainable transport; and to ensure that new development…is of the highest environmental standards." The success of the plan hinges on three factors – a firm commitment from the city to the project; employment of carbon trading and latest investment technologies; and development of new sustainable technologies.

London's plan affects the largest culprits of CO_2 emissions, including energy supply and demand as a primary target. The plan calls for aggressive local decentralisation of wasteful centralized power stations. It encourages the use of combined cooling heat and power (CHP); combining carbon-producing and -consuming sectors to create closed-loop energy systems (*i.e.*, using waste from one to generate energy); production of energy from waste byproducts without incineration; investment, development, and employment of renewable energy sources; and supporting carbon sequestration. Lastly, programmes have been developed to curb private and public citizens' energy consumption (Mayor of London, 2007).

Policy instruments

A full arsenal of policy instruments will need to be employed to mitigate climate change, adapt to the irreversible impacts, and minimize inequitable distribution of benefits and costs, while maintaining city competitiveness and economic security. Mitigation policies will need to address greenhouse gas emissions from existing domestic, commercial, municipal, and industrial activities; new buildings and developments; current energy supply; and ground and air transport. Adaptation policies will need to focus on existing and future infrastructure – including transportation, water and energy networks, and emergency preparedness.

Market-based instruments are promising…

Market-based policy instruments can be valuable tools for implementing abatement of greenhouse gas emissions, but a full understanding of their reach and limitations is required to administer them properly. Generally, the success of market-based instruments depends on three broad parameters – the surrounding policy environment, existing institutional framework and the socio-cultural setting (OECD, 2003a).

Specific policy instruments include carbon/energy taxes, taxes on other gases, voluntary approaches involving government and industry, voluntary approaches through other types of

partnerships (although their effectiveness is in question and should be included as part of a policy package, not as the only response), greenhouse gas emissions trading, energy-efficiency trading, and renewable energy certificate trading. Depending on the specific policy goals, policy instruments should be chosen and evaluated based on their complementarity as well as their individual impacts (see Box 6).

Box 6. Applying policy instruments: The case of India

India's strong economic performance in recent decades has increased its demand for energy, resulting in more greenhouse gas emissions. Two policy instruments designed to abate greenhouse gases are being considered – a price-based approach of introducing emission taxes, and the quantity-based method of launching tradable emission permits. Economically, an emission tax is the more efficient technique in a global abatement system, but because its implementation will entail a large transfer of capital from private firms to governments, such a tax is politically unpalatable. Starting a tradable emission permits system requires a step-by-step approach in India, where command-and-control policies dominate the regulatory spectrum. Instituting carbon taxes should not be entirely avoided. In fact, even marginal taxes can raise significant amounts of revenue. Current subsidies on fossil fuels need to be discontinued, and market-based instruments encouraged (OECD, 2003a).

…and have been implemented in several cities

Another prominent example where a variety of policy instruments has been put in place is London. For example, the city's recently released action plan on global warming tackles private energy consumption through the creation of the Green Homes Programme. The programme provides subsidies and other types of incentives for loft and cavity wall insulation; a "one-stop-shop advice and referral service" for citizens who have questions on implementing energy savings measures; energy-efficiency changes for the city's social housing stock; as well as a public outreach programme to educate and train interested parties on the issue. The business and public sectors will be reached through the Green Organisations Programme. This aims to encourage better buildings partnerships, upgrading and refurbishing buildings to minimize their ecological footprint. An education component of the programme focuses on instituting changes in the operational styles of the buildings, as well as lobbying efforts to support and broaden participation in the programme. Since transportation activities account for a large proportion of greenhouse gas emissions, the London plan considers this as well. The aspects addressed include encouragement of better maintenance and driving practices for private vehicles; promotion of low-emitting vehicles and fuels; employment of carbon pricing for transport; and improvement and support of public transit options.

Tokyo's climate change strategy implements an aggressive CO_2 emissions-cutting approach. It intends to incorporate every economic stratum in the effort – from employing the latest environmental technology to outlining specific involvement from large, medium and small companies and households and designing a private fund to finance the scheme if necessary. The specific instruments Tokyo is implementing are: introduction of a cap-and-trade scheme for the largest CO_2 emitters; promotion of energy conservation measures; work with financial institutions to expand environmental investments and loans; elimination of the use of incandescent light bulbs in households; revitalisation of the solar thermal market; spread of energy-efficient appliances, equipments, and buildings; expansion of the use of hybrid cars; encouragement of private conservation efforts; and the introduction of an "Energy-Efficiency-Promotion Tax System" (Tokyo's climate change strategy).

3.5 Governance challenges

Local governments set and implement a wide range of policy decisions. Traditional wisdom holds that they are better equipped to deliver public goods and services by making use of economies of scale and providing a crucial co-ordinating function to reduce excessive fragmentation and inefficiencies. Additionally, metropolitan institutions can promote redistribution of services between rich and poor areas. Conversely, as municipal governments are often confined by physical boundaries that may not best reflect the needs of the metropolitan region, multi-agency and other co-operative governance frameworks become necessary. Public-private partnerships could also take advantage of economies of scale through contracting and central co-ordination (OECD, 2006).

Vertical co-ordination is essential…

Because different economic sectors, demographic and social patterns, and government structures make up the larger aggregate economy, a co-ordinated response from all levels of government is needed to successfully prevent the most costly scenario. The probable costs of unabated climate change include direct financial costs to valuable economic sectors (such as decreased yields for commercial fisheries and disrupted water, energy and transportation infrastructure) and indirect costs from lost economic and labour productivity (OECD, 2007e). Mainstreaming, co-ordination, and co-operation across government agencies are vital. Moreover, partnerships with the business community, research institutions, non-profit organisations, and trade unions can aid in developing solutions to environmental challenges that benefit all parties (OECD, 2007f).

Regardless of the makeup of government, every element of policy – decision-making, implementation, enforcement, monitoring, review systems, and reporting – requires adequate institutional capacity (OECD, 2003a). Only those cities with such capacity will be able to successfully confront challenges of climate change. One function that will become crucial in addressing upcoming challenges is intersectoral, multilevel co-ordination within the public sector. Successful co-ordination can expand a city's institutional capacity, both through private and non-governmental partnerships working from the bottom up at the local level, as well as top-down policies and collaboration with regional, national and international players (OECD, 2003a).

As central governments spin off environmental governance to local authorities, local jurisdictions can acquire the flexibility and the enforcement mechanisms to create effective policy. The managing role of the central authorities should not be underestimated. Only through co-ordination will it be possible to respond successfully to the impact of global climate change (OECD, 2007f).

…as well as urban funding

Of particular importance is the capability of governments in urban regions to raise the necessary funds. Since local governments rarely have unfettered authority to levy taxes, effective co-ordination with central regional, state and national authorities is crucial. A lack of co-ordination can lead to a multitude of problems related to local fiscal competition, and efforts to avoid such occurrences usually fall within one of three categories. The first method involves tax-base sharing within a metropolitan area. In circumstances where the physical administrative borders traverse metropolitan boundaries, the municipalities within the urban centre agree to share tax proceeds. A more widespread approach is for a higher-level government to divide resources among the local authorities. Another approach involves the establishment of supra-municipal governments that pull in smaller municipal governments under the umbrella of a larger governmental entity. The purpose of these is usually related to providing services, such as water distribution, transportation or waste disposal (OECD, 2006).

One particular aspect with regard to mega-cities should be considered. Studies suggest that the existence of diseconomies of agglomeration – larger populations correlating with lower incomes – after a threshold of around 7 million people. Similar diseconomies may exist for institutions governing the cities (OECD, 2006).

3.6 Compensation for inequitable distribution of climate change impacts

Climate change impacts are predicted to be most costly to the poorest developing regions. For example, the costs of natural disasters – which are predicted to increase in frequency as climate change progresses – can be as high as 13% of GDP in poorest countries. Economic dependence on climatically sensitive sectors such as agriculture is one factor. Another is the inadequate institutional capacity to formulate and oversee policy response mechanisms (OECD, 2007e).

Moreover, as has been discussed, the costs and benefits of climate change policies will probably be disparate, both temporally and geographically. This holds for international policies as well as local and regional measures. These trends could exacerbate poverty in many areas, and to combat the resulting lack of social cohesion, which compromises cities' competitiveness, measures are needed to prevent it from worsening. Financial mechanisms to compensate those who are harmed should be built into climate change policy strategies. These include progressive tariffs, direct subsidies for basic service provisions, and policies restricting disconnection from basic services (OECD, 2007f).

4. Summary and conclusion

4.1 Summary and discussion

Cities play a special role both as drivers of global environmental change and as victims of it. The material and energy requirements of cities, the aggregation of people and the investment in infrastructure all exert influence on local, regional and global resources and waste assimilation capabilities to such an extent that their ecological footprint by far exceeds their spatial extent. As global environmental conditions change, the availability of those resources and waste assimilation capabilities that support urban life may be curtailed. Similarly, global environmental change may alter the location and size of the markets for goods and services generated in cities. At the same time, global environmental change – and particularly the changes in sea levels, water availability and temperature regimes concomitant with climate change – will directly affect cities. Many cities are located on coastlines or major bodies of water and rely heavily on transportation and other infrastructure that is sensitive to weather conditions. Their populations are typically heterogeneous, exhibiting great diversity in income, education, ethnicity, age and aspirations. The institutions that govern that diversity within the given infrastructural, environmental, social and economic constraints are equally diverse, including public, private and nonprofit organisations whose mandates range from local to global concerns. Even under stable conditions, management is a complex task, and it will become all the more difficult given the impact climate has on all aspects of urban activities.

How far cities' competitiveness will suffer depends in part on the rate at which they can adapt to the changes in their environment. As regards resource availability, waste absorption, input and output markets, cities attract the very technologies, institutions, individuals and knowledge that can help to identify solutions. In the long run, the extent to which they can reduce their ecological footprint, and especially their greenhouse gas footprint, will determine whether global climate change can be slowed, halted or even reversed. The longer cities wait to implement strategies to mitigate greenhouse gas emissions, the more they will have sunk into infrastructure, technologies and institutions that maintain or increase emissions of greenhouse gases, and the greater the climate change they will have to adapt to. Greenhouse gases have mean residence times in the atmosphere of more than a century, and every

false step today will make it harder to combat climate change in the future. The costs of undoing damage in the years to come has frequently been overlooked, although it may well be significantly more expensive than the costs associated with climate mitigation.

Even aggressive, immediate action to curb greenhouse gas emissions cannot reverse the climate change caused by emissions to date. Cities will also need to embrace adaptation strategies that reduce current and likely vulnerabilities. In many instances, though, mitigation and adaptation can go hand in hand, and can at the same time maintain or improve competitiveness. A more efficient and robust energy supply will benefit both business and the environment, while a reduction in poverty and social tension will reduce vulnerability to adverse climatic conditions and create an environment that encourages creativity, entrepreneurialism, and economic and social stability.

Many concrete steps towards the design, implementation and administration of mitigation and adaptation measures have already been identified in the literature, and many of them have been discussed in this report. Strategies for mitigating greenhouse gas emissions and for adapting to climate change are evolving through experience, and the policy mix used is changing as a result.

Commonly, voluntary agreements are used to negotiate both incentives for efficient policies (*i.e.*, subsidies for emission abatement), as well as penalties for inefficient polices (targets, timeframes, fines, emission trading, and taxes) (OECD, 2003a). Increasingly, market-based mechanisms are promoted to limit emissions while retaining the maximum freedom of choice among decision makers about the best way – given their individual characteristics – to achieve emissions reductions.

Historically, much of the responsibility for adaptation lay with government institutions. Increasingly, insurances and public/private partnership partake in the effort to reduce vulnerabilities, avoid losses, and undo damages done. Frequently, each level of investment decision-making can include a different partnership with a unique set of challenges and solutions. For example, the initial assessment phase, the planning procedure, the actual construction, the management and monitoring, as well as the decommissioning of the particular infrastructure, may each be done by separate partners. The synergies of the partners' goals and resources should be evaluated and maximized at each phase of the process.

As local, regional and global actors begin to shape strategies for cities in the light of climate change, a host of research questions and management challenges arise. Addressing them thoroughly and in a timely manner will be essential to maintaining and increasing the competitiveness of cities. Several of these challenges are discussed in the remainder of this section.

4.2 Agenda for further research

Several areas for research and management remain that need thorough attention as climate change unfolds around the globe. Among these are the following:

The need for adequate measures of urban economic performance: Currently, GDP per capita is used as a measure of competitiveness. Its neglect of non-marketed goods and services – especially social and environmental ones – skews decision-making towards actions that stimulate economic growth (and thus growth of material and energy use), but do not necessarily stimulate the qualitative improvements that promote sustainable social, economic and environmental conditions. Moreover, measures of economic activity do not take into account the essential social, distributional and environmental issues that may undermine urban resilience in the light of climate change. A lack of multidimensional measures that capture the interrelationship of social, economic and environmental

performance in urban areas tends to favour improved performance (reduced vulnerability and increased competitiveness) judged on the basis of narrowly defined economic criteria only.

The need for better understanding of the relationships among economic sectors of specialisation, city competitiveness, and climate change: As the spatial and temporal resolution of climate impacts increases, city-level investigations are possible that relate urban dynamics to regional and global economic, social and environmental change. Identifying the short and long-term consequences of alternative actions is a process so complex that it is beyond the ability of any individual decision maker. By the same token, the ramifications of any substantive mitigation or adaptation strategy may be so large, like the range of uncertainties in outcomes, that it is advisable to explore alternative scenarios with the help of advanced computer simulation. Simulators are already used to train pilots to fly airplanes, and, properly designed, may be used to hone the decision-making skills of those who "fly" cities. Given the complexity of the challenges at hand, the result of modelled outcomes of alternative actions will not be the "optimal investment" decisions identified by traditional economic modes, but "robust strategies", *i.e.*, strategies that fare equally well under a wide range of future conditions and evaluation criteria. Embedding the processes by which robust strategies are identified into the learning process of urban institutions will provide the basis for adaptive and anticipatory management of the urban complex.

The need to capture distributional effects of climate change within urban regions: To date, mitigation and adaptation research on climate impacts has barely focused on urban areas in general, or on individual social groups and economic sectors. Yet, the distributional impacts of climate change, as well as mitigation and adaptation measures, will influence current and future social and economic dynamics, and as a result, shape the competitiveness of cities in the region, nationally and internationally. Since it has typically been the distributional implications of policies that guided urban decision-making, it is high time that climate policies connect with real criteria for policy choice.

NOTES

1. Produced by the OECD Secretariat with a contribution from Matthias Ruth and Daria Karetnikov, Center for Integrative Environmental Research, University of Maryland, College Park, United States.

2. Ecological footprint is a uniform measure developed to assess human impact on ecological systems. It consists of six components: the area of cropland required to produce the crops consumed; the area of the grazing land used to produce the animal products; the area of forestland needed to produce wood and paper; the area of sea required to harvest the fish and seafood; the area of land needed for housing and infrastructure; and the area of forest required to sequester the carbon dioxide emitted from energy consumption (Jorgenson, 2003).

3. The temperature rise will not be even, with the largest changes in the middle of mid- and high-latitude land masses in winter (IPCC, 2001c).

4. This is the variation between emission scenarios; the range including variation between climate models is 9 to 88 centimetres (IPCC, 2001c).

5. For a rigorous discussion of coping ranges, see Jones (2004).

6. There may be a reduction of flood risk in some areas, depending on how precipitation patterns change, in which case flood control infrastructure based on historical data would represent an overinvestment.

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CHAPTER 2:

CITIES AND CLIMATE CHANGE: HARNESSING THE POTENTIAL FOR LOCAL ACTION

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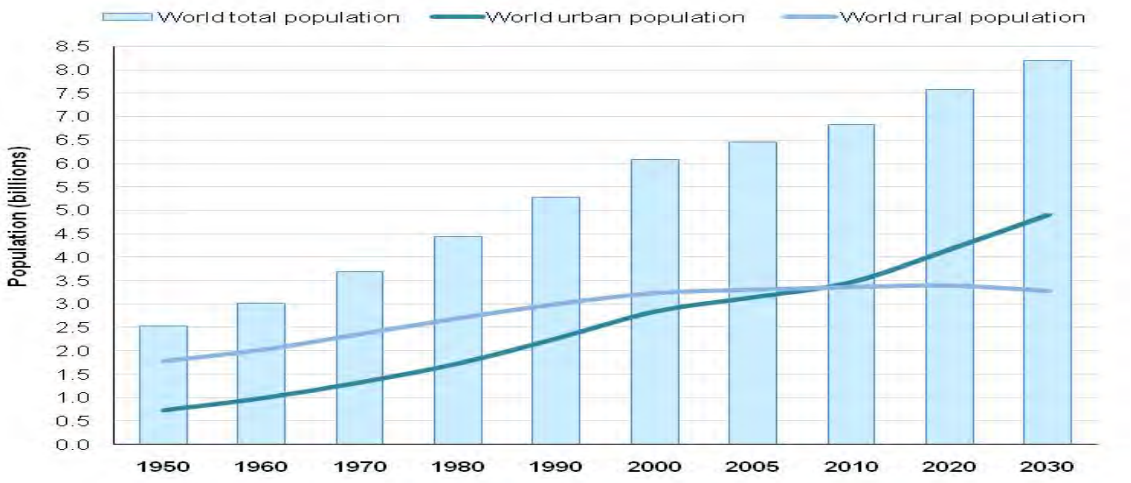
Despite a flurry of activity in cities on climate change and growing interest in the research community, climate policy at city-scale remains fragmented and basic tools to facilitate good decision-making are lacking. The paper highlights two different tools for further development that can be enhanced by strengthened multi-level governmental and public-private partnerships to support city-scale action to address climate change: harmonised inventory preparation and registries for monitoring GHG emissions at city-scale over time; and improved mechanisms for sub-national science-policy exchange to develop, assess and integrate knowledge about climate change impacts into urban policy and decision-making. While the agenda for multi-level governance of climate change is inevitably much broader than this, first steps by national governments to work with sub-national governments, cities and experts to advance capacity and tools in these two areas could be important first steps to move the policy agenda forward.

1. Introduction

The policy challenge for cities can be simply stated: *The fate of the Earth's climate and the vulnerability of human society to climate change are intrinsically linked to the way the cities develop over the coming decades and century.* [3] Roughly half of the world's population live in cities, and this share is increasing yearly and is projected to reach 60% by 2030 (OECD 2008; Figure 1). Most of the urban population growth will occur in developing countries which are projected to have urban growth rates roughly double those of OECD countries in the 2005-2030 timeframe.

Cities also contribute a large proportion of national GDP, both individually and in the aggregate, and can thus be expected to be the dominant hubs of economic activity for every nation. While this is especially true in the developed world, it is increasingly the case in the context of developing countries. For this reason, cities provide not only jobs but also a variety of social, environmental and cultural services to people around the world (OECD 2008). This concentration of population and economic activity, however, also makes cities particularly vulnerable to climate change as they are the home to valuable built infrastructure as well as to large numbers of the world's poor.

Figure 1. World population trends – urban – rural breakdown



Source: Based on data from the United Nations (2006) as cited in OECD 2008.

Due to their concentration of economic activity and people, cities can provide economies of scale and potential opportunities to provide innovative solutions to such complex environmental problems as climate change. A recent IEA analysis estimates that cities account for 60-80% of world energy use (IEA, 2008), which also suggests that the way cities develop and how they mitigate energy-related emissions will be key to successful climate policy. Looked at from another perspective, the mitigation of greenhouse gas emissions at city-scale will deliver not only global benefits in the form of avoided climate change but also local co-benefits, including cleaner air, quieter and greener outdoor spaces and, in some instances, more jobs in new "green" business areas such as clean energy or waste recycling and reuse (OECD, 2000; Bollen *et al*., 2009).

Table 1. Land, population and GDP of selected cities as a share of the country total

City	Brussels	Budapest	Lisbon	Mexico City	New York	Paris	Seoul	Sydney
Per cent of land	2.3	0.8	3.2	0.1	0.1	0.5	0.6	0.02
Per cent of population	10	25.3	26.3	23.9	7.8	21.2	25	24.4
Per cent of GDP	44.4	45.6	38	26.7	8.5	27.9	48.6	23.5

Note: These data should be interpreted carefully. Due to data availability, data sources for each factor are different. There could be a significant discrepancy between data sources regarding the boundaries of cities, except for Lisbon whose data was provided by the Portuguese National Institute of Statistics (population of 2005, GDP of 2003).

Sources: OECD Env Outlook 2030.

There is some evidence that cities can be effective agents of change and centres of innovation to address climate change. A growing number of cities have initiated bottom-up initiatives to add greenhouse gas reduction to city policy objectives (Bintliff *et al.*, 2007; Bulkeley and Betsil, 2005; Betsill and Bulkeley, 2007). Indeed, cities have begun to work together in transnational networks to strengthen greenhouse gas reduction efforts and learning, including through combining their purchasing power to achieve common goals such as improved energy performance of public buildings (*e.g*., C-40 2008; Betsill and Bulkeley, 2007).

Impacts, vulnerability and adaptation to climate change have received significantly less attention than mitigation opportunities at city-scale, despite some evidence that cities could be hard hit by

shifting climate patterns and extremes (Baettig *et al*., 2007). The European heat wave in 2003 for example in Paris (Beniston, 2004; Schaer *et al.*, 2004) and the landfall of Hurricane Katrina in the city of New Orleans in 2005 (Hallegatte, 2006) are two prime examples of the types of extremes that could become more common with a changing climate. As such, there is a small, but, growing academic literature on city-scale vulnerability and adaptation (see Hallegatte *et al.*, 2008 for a review). Furthermore, a few cities appear to be at the forefront of adaptation planning and implementation (*e.g*., Chicago, London, Miami, Paris, Toronto) [4] and a number of umbrella groups have grown up to assist cities to learn from each other as they develop capacity and experience in this area.[5]

Despite increasing levels of attention and action at the city scales, much of this activity is largely decoupled from national policy frameworks. Moreover little policy analysis or research has considered the issue of the multilevel governance of climate change and the unique role of cities is within such a framework.[6] A key issue for national policymakers is what they can do to empower cities to become effective in the design and implementation of policies for mitigation and adaptation to climate change and to take advantage of the opportunities to learn from city-scale experimentation with a range of different climate response policies.

This paper highlights the nature of the policy challenge to address climate change at urban scale within the broader domestic policy context. After briefly reviewing the nature of the policy challenge, it outlines two areas for priority attention for "linked up" action across scales of governance on climate change.

2. The policy challenge

Climate change poses a difficult, intergenerational challenge, since the decisions being made today will shape the climate for future generations. Choices about the way we produce and use energy, about transportation modes, about what and how much we consume, and also about land use will influence GHG emissions in the coming decades. Inaction will commit us to a rapidly changing climate and a range of possible climate surprises. These could include the melting of the Greenland ice sheet and possibly the West Antarctic, an extreme but not altogether unlikely scenario that could raise sea levels by as much as 7 meters over centuries to come and effectively flood many of the world's existing coastal cities (Hansen, 2007; Rahmstorf, 2007). Equally, ocean acidification resulting from increasing CO_2 concentration could have wide-ranging effects on marine systems and the food chain more broadly (Caldeira and Wickett, 2003). Potential impacts – some already being observed today – include increased intensity of heat waves, with direct effects on human health particularly in cities, where there is an urban heat island effect; increases in intense rainfall events, which increase the risk of inland flooding; retreat of mountain glaciers, with impacts on water availability and quality in urban regions; and an increased risk of drought and water shortage in already dry regions (IPCC, 2007b). Furthermore, changes in temperature and the hydrological cycle will most likely shorten the maintenance and replacement cycle for key infrastructure (*e.g.*, energy production, transport, etc.) as well as influence their operational capacity (brownout and blackouts; service interruptions) if not addressed (Mansanet-Bataller *et al*, 2008; Cochran *et al*., 2009). Action must be two-pronged: the earlier and more cost-effective our action to mitigate GHG, the more we can do to protect the climate and limit the risk of dangerous climate change. Equally, the earlier we adapt, the more we can cost-effectively protect people and infrastructure from dangerous impacts of inevitable climate change (IPCC, 2007a; Stern, 2007; OECD 2008).

With respect to vulnerability, it is important to recall that physical exposure to climate change will not discriminate between the rich and the poor. However, the poor are expected to be more vulnerable due in part to the lack of resources and capacity to respond in a timely manner. As Hurricane Katrina reminded us, climate extremes are likely to fall the hardest on the poor (Mathew,

2007), who lack the resources to respond quickly and effectively to protect themselves from extreme weather patterns. The urban poor are also more exposed to climate change, since they are likely to occupy on the cheapest land, sometimes illegally, or un-developed floodplain areas such as the Dharavi slums in Mumbai and the New Orleans' 9th Ward. The high vulnerability of the urban poor to climate change makes cities a key centre for design and implementation of anticipatory adaptation action.

In this light, a first priority for cities is to better understand the risks of climate change, in particular from the probable increase in the intensity and possibly the frequency of extreme events in the century to come. Vulnerability to climate change depends upon cities' physical, social and institutional characteristics, for example, on the vintage and location of building stock and other infrastructure, as well as on the types of businesses operating in a city and how public services are provided. City structure and density are defined over time; reducing vulnerability may also take concerted effort over a relatively long period. Since today's decisions whether to invest in new or refurbished infrastructure will have a critical influence on the future vulnerability of cities to climatic changes, it is necessary for decision-makers to anticipate these changes. Understanding the risks of climate change at city-scale can help cities to better work in tandem with the national government to manage national risks more efficiently.

One critical issue is to understand the urban development interface with climate change. A large proportion of the world's population resides in coastal zones, which are likely to be hard hit from rising sea levels and intensifying storm surges.[7] Recent OECD work shows how a 50-cm sea level rise due to climate change combined with socio-economic development patterns could lead to a tripling of the population exposed to coastal flooding by 2070 and a tenfold increase in asset exposure, increasing the value of exposed assets from about USD 3 trillion to USD 35 trillion, *i.e.*, from 5% of today GDP to 9% of 2070's GDP (Nicholls *et al.*, 2008). We estimate that about two-thirds of this increase in exposure is driven by socio-economic development whereas climate change amplifies the exposure by one-third. The most affected port cities are found not only in rapidly growing developing countries (*e.g.*, Kolkata, Shanghai, Guangzhou) but also in some of the most wealthy of countries worldwide, including the United States (*e.g.*, Miami, New York City), the Netherlands (*e.g.*, Rotterdam, Amsterdam) and Japan (*e.g.*, Tokyo, Osaka).

To some extent, citizens, cities and nations have development choices that will exacerbate or limit the damage that climate change brings. These include decisions concerning the carbon intensity of growth as well as investment in adaptive measures to limit vulnerability and exposure to extreme events today and in the future. Any political decision to deal with climate change inevitably involves balance and the tension amongst a range of choices: the balance of effort to adapt "now versus later" to a range of uncertain climate changes and tension between different types of effort, such as to "mitigate and/or adapt" in any particular regional setting (Corfee-Morlot, 2009). Climate changes are increasingly observed in real time, and projections on a regional scale have become increasingly reliable and robust. Both developments have increased the importance of making decisions about adaptation and mitigation today, particularly on the sub-national or local scales (Cash and Moser, 2000).

Just as cities are part of the climate problem, they are also part of the solution (Hallegatte *et al*., 2008; OECD, 2009, forthcoming). The right choice of urban policies is particularly important to ensure that long-lived infrastructure – commercial and residential buildings, roads and ports, water and transport networks – is designed to withstand the expected increase in climate hazards while simultaneously improving the energy and emission performance of the built environment. Integrated urban planning is central to land use decisions and zoning that may exacerbate or limit the exposure and vulnerability of urban dwellers and infrastructure to the growing threat of climate

change. Similar issues pertain to mitigation, for example, in transportation and land-use planning which is key both to improving accessibility while at the same time to reducing the demand for mobility and emissions.

3. Developing the toolbox to harness city-scale decision making

Cities and other sub-national governments hold the unique potential to work closely with local constituencies to develop visions of the future that match the needs of these constituents (Moser and Dilling 2006; Brunner, 1996). At smaller geographic scales, experimentation and learning can be expected to be more rapid and lessons learnt can disseminate more quickly than otherwise and lessons from such experience may filter up or over to influence action elsewhere (Corfee-Morlot, 2009). However, cities cannot operate effectively in isolation from other parts of government.

Not surprisingly, recent trends in national policy making reflect the emergence of multi-level governance on climate change, operating vertically across multiples levels of government (*e.g.*, local to national) and horizontally across governmental departments as well as non-governmental actors (UNFCCC, 2006; Bulkeley and Betsill, 2005). Although political interest in climate change may initially have emerged through international or national policy processes, regional and local decisions are critically important to the design and implementation of adaptation strategies to respond to climate change. While, regional and local policies may determine land use, human settlement patterns and transportation planning, the local governmental authority to act in these areas is almost always hierarchically "nested" in legal and institutional frameworks at national or sub-national level (Dietz *et al.* 2003; Hooghe and Marks, 2003).

How can cities best contribute to international efforts to address climate change and how can national governments help cities to do this? We outline two core activities that national governments could support to help cities become more effective in the design and delivery of locally-adapted policy solutions to climate change. First is the issue of developing city-scale GHG inventories such that mitigation performance can be monitored and compared across urban jurisdictions. Second is the need for regional science-policy capacity to support timely and cost-effective adaptation at local scale. Progress in both of these areas could build crucial capacity at local scale to address climate change and both require support from national governments. In the case of GHG inventories, international attention to the challenge is also required to advance the development of the necessary tools.

3.1 Monitoring progress: cities, mitigation and GHG inventories

Cities have been active in efforts to reduce greenhouse emissions for at least a decade and the level of ambition and scale of statements of intent to mitigate have grown with time. For example, following an initiative of city of Seattle's Mayor Greg Nickels, in 2005 more than 130 US cities announced plans to achieve Kyoto-like emission reductions (Brown, 2005). These ambitious goals imply bringing city emissions to below 1990 levels by 2012. Cities may or may not achieve these hortatory goals, but they will learn from their experience. And the next steps will be easier due to their leadership efforts.

However, there is a need for cities to bring rigour and structure into their efforts to measure progress in achieving their mitigation goals. Today we still lack harmonised, internationally agreed methods and inventory data to assess progress within and across cities.

Without better tools for comparable emission reporting and performance assessment, it will be difficult to share experience and lessons from city mitigation efforts. One prerequisite is to establish a common set of metrics for comparison of progress across cities. Agreement on metrics, methods and

common reporting frameworks for cities can establish a common language for cities to speak to each other, to measure progress and assess performance (both ex ante and ex post policy implementation), to identify and share understanding of best practices in urban-scale mitigation activities. Also, emerging carbon markets combined with harmonised inventory methods, reporting and data sets at local levels could provide cities a starting point to access to carbon-finance to leverage their otherwise limited resources.

This recommendation draws on past experience in the building of reliable and transparent international monitoring systems to support improved environmental decision making and performance. In the late 1980s, the OECD began working with governments to develop harmonised GHG accounting methods and reporting systems. At that time, a number of industrialised countries had pledged to reduce GHG emissions following the landmark Toronto Conference on the Global Atmosphere (World Meteorological Organisation, WMO/OMM, 1988). Yet there was no way to accurately assess and compare national efforts since at the time there was no standardised inventory system to account for national GHG emissions. The OECD was tasked to work with experts and governments to agree and to establish a system of harmonised methods and a reporting framework to enable governments to communicate with each other on the issue of GHG mitigation (Corfee-Morlot and Schwengels, 1994). It took several years to develop and pilot a system; as the effort became more firmly institutionalised, the work of the OECD in this area was handed off to the Intergovernmental Panel on Climate Change. The National Greenhouse Gas Inventories Programme (NGGIP) is now one of several technical support units of the IPCC and is operated out of Japan.[8]

Today parties under the UN Framework Convention on Climate Change (UNFCCC) have adopted the IPCC methods as a standard framework for preparation of national inventories. Furthermore, through the UNFCCC, a common national inventory reporting system is in place, as part of a broader set of national reporting requirements that is particularly structured and firmly established for industrialised countries (Yamin and Depledge, 2004). National GHG inventories, which are submitted annually by all industrialised (Annex I) Parties, provide solid, comparable and high-quality emissions data at the national level to support peer-review and transparent assessment of mitigation performance under the UN Framework Convention on Climate Change and the Kyoto Protocol.[9] These data are the backbone of the international climate regime, allowing countries to monitor their performance over time. And, importantly this system, when combined with other tools to ensure quality of information and the ability to accurately track compliance and transactions, has enabled the creation of an international carbon market. That market has grown significantly in recent years, with total value to equal about USD 64 billion by 2007, more than doubling in value from 2006 (Capoor and Ambrosi, 2008).

If cities are serious about their interest to contribute to the global effort to limit emissions and protect the climate then they will work together to establish and use common inventory methods and a standard reporting framework. A common framework will allow cities to assess progress over time as well as across locations. It will also allow them to compare results and cost-effectiveness of emissions reductions at the sector level – for example in the waste sector, in the transport sector or residential or office or commercial building energy end-use sector.[10] It will also allow them to consider how they stack up, for example in comparison to other cities of similar wealth, population, or geographic features, and to understand how and why major changes in emissions occur over time. In this way, it will open new possibilities for collaboration and learning. Standardised city inventories and datasets will also open opportunities for cities to become actors in the international carbon market, as providers or enablers of emission offsets.

Although some progress in making carbon finance available at urban scale is being made (Bodiguel *et al.*, 2008; Roberts 2008), much more could be done. With standardised measurement

approaches, city scale policies could lead to measurable emission reductions that are eligible for certification and sale through some existing mechanisms under the Kyoto Protocol (*e.g.*, joint implementation or the clean development mechanism) or similar mechanisms that are expected for a post-2012 agreement. This could open the way for new sources of funding to city-scale mitigation efforts, helping cities to exploit least cost options for reducing emissions in the coming decades. Beyond further opening opportunities for carbon finance, harmonised inventory methods and reporting is essential to enable performance assessment and comparison across urban locations, for example to assist national decision-makers to understand the comparative cost-effectiveness of urban scale action, as well as to aggregate performance across locations to better understand the overall contribution from urban scale action.

3.1.1. The inventory challenge

What is standing in the way of inventory harmonisation at city-scale? Cities require solid technical input and international support to connect their inventory approaches or protocols to existing IPCC guidance and FCCC national reporting systems. Without these critical links to the institutional framework that has emerged to support international monitoring, review and verification process under the Convention, it will be difficult, if not impossible to integrate city-level mitigation action into emerging regulatory frameworks and markets for emission reductions.

Currently, a number of competing inventory protocols have been developed that are in use in data collection and inventory preparation at city level. The ICLEI Cities for Climate Protection program[11] has been active worldwide over the last decade to support mitigation action at the local level. Each of its more than 800 member local governments has committed to produce an emissions inventory using its "Clean Air and Climate Protection" software. Embedded in this software are a number of inventory methods and a simple reporting structure. However cities have wide choice in how they use this tool and the ICLEI guidance points out that it is a tool explicitly developed to enable city management of emissions over time rather than to permit cross-city comparisons.[12]

Assuming that comparability across entities is desirable, the IPCC guidance for national inventory preparation is a necessary starting point (UNFCCC, 2002a). For example, in response to the need for harmonised approaches for "entity-level" reporting, the World Resources Institute and the World Business Council for Sustainable Development (WBCSD) collaborated to develop "The Greenhouse Gas Protocol", primarily for corporate use to track emissions (WRI/WBCSD). It builds on the IPCC guidance but develops it for use at a different level or scale of activity.[13]

Building on the WRI/WBCSD work, the California Climate Action Registry (CCAR), is the first state registry to have developed a standard inventory protocol and set of methods for inventory preparation by cities (CCAR, 2006). In describing that programme in 2006, Diane Wittenberg then president of CCAR said: *"The hardest part is boundaries, what's in and what's out… some of them are reporting [individual] buildings in the city, and others are skipping things like the airport. And you've got everything in between. …so we're looking forward to tightening up the way that cities are reporting."* Also commenting on how to advance uptake and use of the protocol, Diane Wittenberg said: *"ICLEI …would try and push this to other cities outside of California and let those states kind of take the ball with their own cities."* In 2006, San Francisco became the first city in the United States to submit an inventory validated with the CCAR protocol, which focuses on city operations.[14] More recently, a number of US states have formed "The Climate Registry" which is intended to establish a harmonised system for entity level reporting across participating states. This move could expand the influence of the CCAR city-scale protocol and see it extended more widely for use across the US. In addition, the US EPA is in the process of developing an official registry (Rich 2008),[15] however it is unclear whether that registry will include a protocol to cover cities. Furthermore, ICLEI and the

Climate Registry are now working together to develop a standard protocol for wider diffusion across ICLEI members (see below).

In France, the Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME) has created the Bilan Carbone (ADEME, 2008), an emissions accounting system developed for both corporate as well as municipal users. This looks at both city operations as well as emissions occurring within the geographic boundaries of cities, focusing on 10 primary emissions areas: energy generation, industrial processes, the service sector, residential, agriculture and fisheries, freight, passenger transport, construction, and waste disposal. The Bilan goes beyond direct and indirect emissions to include the emissions associated with products consumed (*e.g.*, emissions embedded in the production of cement used in city infrastructure) as well as the tourism-related air travel for destination cities. The ADEME has also established a structure both to train evaluators and to partially finance local-level inventories through grants. Many French cities have used the Bilan Carbon to evaluate their emission levels, however, as with the ICLEI inventory tool, cities have choices in what and how they choose to include in their inventory. As a result, application of Bilan Carbon leads to incommensurable results across cities.

To date no single protocol or set of process guidelines has been adopted to harmonise compilation of data, estimation of emissions or reporting of urban inventories. As a result, cities have taken different approaches in defining what sectors to include, in establishing the geographic boundaries of the area included, as well as in aggregating data in different ways. As such, any comparison across existing inventories is hampered.

3.1.2. A brief review of selected inventories: technical issues

A brief review of selected city inventories (Table 2) provides an overview of the range of technical issues embedded in the task of inventory preparation that influence comparability. Beyond differing reporting formats or inventory construction protocols (see above), these features include:

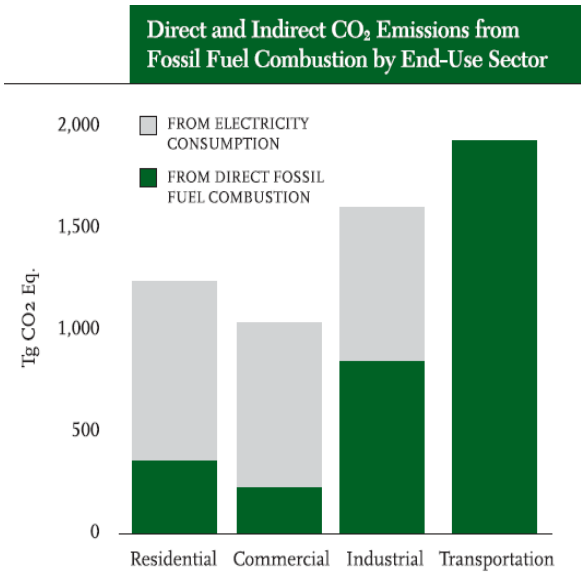
- Different definitions of the city (*i.e.*, is it defined by the larger metropolitan region or the city limits, or by something else);
- Choice of inventory years presented;
- Scope or boundaries of the inventory, *i.e.*, whether or not more than city-owned operations are reported, and whether indirect emissions are included or not: *e.g.*, treatment of electricity emissions;
- Methodological issues.

A look at each of these issues in turn provides insights to the complexity of developing comparable inventories. On definitions of the city boundary, city emission inventories tend to be divided into two categories: community-wide emissions, which correspond to all of the emissions related to the urban area's geographical boundaries, and city-operation emissions, which are those emissions produced by the municipal government itself. Table 2 considers a selected number of US and Canadian cities indicating the range of choices. Some urban areas limited their study to administrative boundaries (*e.g.*, Seattle, Toronto, New York City) while others chose to include the entire metropolitan zone and/or the surrounding region (*e.g.*, Vancouver, including the Lower Fraser Valley). The choice of inventory years also appears to vary widely across cities.

On the scope of GHG covered, the majority of the inventories outlined in Table 2 take both direct and indirect emissions into consideration. Direct emissions are those produced by operations occurring

in within local boundaries by local activities, such as transport, commercial and residential fuel combustion, industrial production or processes as well as the treatment of waste. Indirect emissions are those resulting from energy use or imports but where the emissions occur outside local boundaries (*e.g.*, electricity or steam production). Inventories of city operations also include direct and indirect emission sources related to functioning of the city and the actions of its staff. Direct emissions include those associated with public utilities or public entities, but again occurring within city boundaries (*e.g.*, electricity if it is publicly provided, water, etc.), buildings, vehicles and landfills. Indirect emissions primarily group energy imports, as above, but also include employee commuting, business-related air travel.

Figure 2. US National CO_2 Emissions, by End-Use Sector



Source: US EPA (2007) as cited by Rich 2008.

Central to the question of direct or indirect emissions accounting is how to deal with the electricity sector. Most often electricity is generated outside city boundaries but largely consumed within them, *e.g.*, by residential and commercial customers (see Figure 2). Cities differ in the way they account for these emissions. For example, while some choose to allocate emissions associated with power generation to the end user category, *i.e.*, in terms of residential or possibly even further to water heating, lighting, other cities report electricity and heat/steam generation emissions as a separate category, and others not at all.

Beyond the challenge of addressing electricity emissions for urban energy use is that of how to address emissions embedded in products purchased and used in cities. For example, in the Seattle city-operations inventory includes emissions associated with concrete and asphalt manufacture (*i.e.*, for road maintenance operations and other city infrastructure), even though these emissions may occur outside the city boundary. Furthermore, the French Bilan Carbone protocol, which is also designed to support city-scale inventory preparation, calls for including estimates of emissions for goods used within the urban area but produced elsewhere. In addition, a few cities attempt to factor the extra-urban travel behaviour of residents into totals. These more extended analyses represent the "carbon footprint" of urban consumption activities but go beyond the accounting of emissions within administrative geo-political boundaries, which has been adopted by the IPCC national GHG inventory guidelines (UNFCCC, 2002). However, accounting for city-scale carbon footprints could be an important tool and source of information to support policies that target consumer behavioural change to limit emissions. They can therefore usefully be added to inventories, but for consistency of reporting purposes must be separable.

Another important boundary question is how emissions from the transport sector are accounted for. Here the key issue is how to estimate and link emissions from this sector to the urban area. Typically this would be based on standard measures of activity, such as fuel consumed in the transport sector within the geographic area of concern. However at city scale, these data are often not available. Alternatively, proxies based on distance travelled or the indicator of vehicle miles travelled can be developed. But there is no harmonised approach or broad agreement on how best to allocate a share of national or regional transport activities to urban areas. A variety of different models and assumptions are possible, each with different outcomes.

Table 2. Selected city-scale GHG inventory reports: comparison of key features

Basic Information				*Inventory*				
City	Region	Population	Metro	ICLEI CCP	Data yr(s)	Indirect	City Operations Breakout	Protocol
Seattle	WA	573 911	City limits	Yes	1990, 2005	Yes	Yes	GHG Protocol; IPCC National Guidelines
Vancouver	B.C.	2 600 000	Lower Fraser Valley	Yes	2005	No	N/A	IPCC National Guidelines
New York City	NY	18 815 988	NYC Metropolitan Region	Yes	1995, 2000, 2005	Yes	Yes	CCAP ICLEI
San Diego	CA	1 291 700	City Limits	Yes	1990, 2004	Yes	Yes	n/a
Toronto	ON	2 503 281	City limits	Yes	2004	Yes	Yes	CCAP ICLEI
San Francisco	CA	7 264 667	County	Yes	2005	Yes	Only	CCAR
Columbia	MO	99 174	City limits	Yes	2000, 2005	N/A	No	CCAP ICLEI
Northampton	MA	28 978	City limits	Yes	2000	Yes	Yes	CCAP ICLEI
Palo Alto	CA	61 200	City limits	No	2005	Yes	Only	CCAR
Sacramento	CA	475 743	City limits	Yes	2004	Yes	Only	CCAR
Santa Barbara	CA	90 400	City limits	No	2005	Yes	Only	CCAR
Somerville	MA	77 478	City limits	Yes	1997, 1999	Yes	Yes	CCAR

Sources: 2005 Inventory of Seattle Greenhouse Gas Emissions: Community and Corporate; 2005 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast; Inventory of New York City Greenhouse Gas Emissions; City of San Diego Greenhouse Gas Emission Inventory; Greenhouse Gases and Air Pollutants in the City of Toronto : Toward a Harmonized Strategy for Reducing Emissions; Annual Emission Report: City of San Francisco; City of Columbia Emissions Inventory; Executive Summary Greenhouse Gas Emissions Inventory Summer Internship, 2001 Cities for Climate Protection Campaign City of Northampton; Annual Emissions Report: City of Palo Alto; Annual Emissions Report: City of Sacramento; Annual Emissions Report: City of Santa Barbara; Greenhouse Gas Emissions Inventory Report: Including Recommendations for the Emissions Reduction Plan.

Finally, there are other methodological differences associated with individual emission source categories. These include, for example, how to estimate the emission factor for electricity, when emissions will vary by type of primary energy used to generate electricity? Beyond limiting the ability to compare emissions between cities, the level of aggregation and choice of methods to estimate and report emissions may alter the usefulness of the inventory for policy development. These differences suggest the urgent need for a harmonised set of methods and reporting protocols.

3.1.3. Towards harmonised reporting, comparable data

While a number of different protocols exist, an increasing number of cities have undertaken urban emission inventories in recent years. Yet to date, only two programmes are attempting to consolidate these inventories using a formalised reporting process. First is the ICLEI CCP campaign noted above. However given the lack of standardisation in reporting or inventory construction, the city inventories prepared under the ICLEI effort are used to monitor performance across time within a single city rather than to compare performance or trends across cities. Second, the Climate Alliance's Local Governments Climate Partnership is also working to compile and compare emissions data from participating cities in Germany, the United States and Japan (Climate Alliance, 2008).[16] This program was launched in early 2008 and has not as of date reported its results.

Making city GHG inventories comparable will require agreement on a common format for reporting as well as key methodological issues. Consensus will be needed on how to treat key issues such as those outlined above in a consistent manner. Even if cities are given the flexibility to construct inventories with different boundaries (*e.g.*, in terms of reporting direct and indirect GHG emissions), at a minimum it will be necessary to report these in a modular manner such that comparable estimates could be constructed. Due to the high costs associated with producing the quality of data necessary to produce emission inventories, it will most likely be necessary to find a middle ground, with enough detail to remain useful, but not so onerous as to make its production burdensome or financially unfeasible for local budgets.

As with the challenge of developing firm-level reporting guidance – which was led by WRI/WBCSD – the tools that cities use to monitor progress will need to be linked up or nested in the IPCC GHG inventory guidance to avoid double-counting with other local authorities or even across sectors as national governments establish nationwide policy frameworks. It will require support and resources from both national governments and the international community, including from experts engaged in the review and monitoring taking place under the Convention. While it would take time and resources to get such a system up and running, it would be one step in the right direction to empower cities in their efforts to achieve cost-effective GHG emission reductions.

Regarding standard methods and reporting protocols, the ICLEI Cities for Climate Protection (CCP) network – one of the oldest of the city networks on this issue – is currently developing a city-level protocol and guidelines. This work was originally slated for delivery in 2008 (this may now have slipped to 2009); it features co-operation with the World Resources Institute and the California Climate Action Registry (CCAR). This appears to be an excellent start. However, to be fully operational and accepted, the product of its work will need to be vetted and eventually endorsed by institutions formally charged with establishing monitoring requirements at national and international scales (*i.e.*, the IPCC).

3.2 Assessing local impacts through sub-national science-policy exchange

The second priority for national-local collaboration is on science-policy capacity building and information. The aim of any such effort should be to establish a capacity to improve understanding

about how climate change will affect cities. More detailed regional impact assessments, in turn, could be expected to influence the politics of climate change from the global to the local scale (Harris, 2001; Shackley and Deanwood, 2002). Importantly, regional impact and vulnerability assessments facilitate reflection about both adaptation and mitigation. That is, it supports dialogue and discussion about what types of risks are of greatest concern to affected populations and what adaptations might limit climate change impacts, and it facilitates communication about what climate change is and why we need to do something about it to mitigate emissions (Corfee-Morlot, 2007).

Some amount of climate change is unavoidable no matter how much we mitigate. To understand and properly assess adaptation options, cities require information from scientific impact assessments to consider how climate change may play out in local contexts to impact people, urban settlements and infrastructure. What will the temperatures of the 2020s or 2030s be? How will flood risk change in the coming five years or more? And how will these climate changes interface with urban environments?

Climate science over the last decade or so has focused on large, global models that integrated different types of physical models to predict how the atmosphere will interact with oceans to change climate over time (IPCC, 2007). There is little regional information coming out of these science assessments so working at local or sub-national levels requires another layer of effort and a special set of tools to scale down or relate global change predictions to local or regional conditions (Hallegatte *et al.,* 2008). This can be done in a variety of different ways, but it takes time, expertise and money. It is research-oriented rather than policy-oriented work and organising funding and institutional capacity to make it happen in a timely manner can be difficult.

Establishing capacity to generate and use impact assessment information at local or sub-national scale is a science policy exercise that presents a range of technical and procedural or institutional challenges.

On the technical issues, a recent OECD working paper proposes a framework to guide local scale impact assessment, including how global modelling results can be translated to a city scale as well as various issues in assessing climate impacts through use of a range of metrics (physical and monetary) and costs of responses under different conditions. In particular, it lays a conceptual approach to assess the avoided-impact benefits and the co-benefits of local adaptation and global mitigation (under different adaptation scenarios) (Hallegatte *et al.,* 2008). Moreover, two city case studies – Copenhagen (Hallegatte *et al*., 2008) and Mumbai (OECD, 2009b forthcoming) are being conducted to test and refine this framework.[17] Beyond providing original and detailed assessments of climate change impacts in these locations in the 2070s/2080s timeframes, these studies are also proving to be vehicles for engagement across key stakeholders in these locations. In particular, they are serving to stimulate dialogue among affected stakeholders across difficult questions such as what priorities to establish for adaptation investments given the range of possible outcomes surrounding uncertain climate projections (Hallegatte *et al.,* 2008). This highlights that procedural issues are also important, *i.e.,* it is insufficient to have good scientific or technical analysis. To make good decisions requires active reflection and dialogue between expert and stakeholder communities.

On the procedural or institutional side, there is a need for active interaction between customers for information – policy makers and other decision makers and the information suppliers – scientists and other experts (Stern and Fineberg, 1996). There are a number of notable examples featuring state-of-the-art deliberative processes to engage stakeholders from the start to shape the framings and findings of assessments. In Canada, for example, there is now some experience with regional (sub-national) participatory integrated assessment to support watershed management and climate change adaptation decision-making (Cohen *et al.,* 2004b; Vescovi *et al.,* 2007; Yin and Cohen 1994). An example of multi-lateral collaboration using deliberative methods exists in the recent assessment of

the Arctic region. The Arctic Climate Impact Assessment was published in 2004 and, importantly, sponsored by the Arctic Council, which represents eight member-state governments (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) and six permanent participants including two indigenous peoples' non-governmental organisations (ACIA, 2004).[18] This study was unique as it was both deliberative, employing a number of different methods to engage affected stakeholders, as well as an international process to facilitate deliberation among state actors with an interest in the region.

Relatively recent policy-driven scientific efforts to predict regional climate changes are also found at local and regional scales, for example, in the United Kingdom (McKenzie Hedger *et al,*.2006; West and Gawith, 2005) and in the United States (Hayhoe *et al.,* 2004; Moser, 2005; Parson *et al.,* 2003). The UK programme is somewhat unique in that it is initiated, organised and to a great extent funded by local and regional stakeholders, although the institutional mechanism overseeing the co-ordination of such regional efforts is national (McKenzie Hedger *et al.,* 2006). Some of the results from the UKCIP suggest that cities provide a useful spatial scale for the stakeholder engagement in decision making. In the US, initial climate impact assessment was conducted through an extensive nationwide effort (NAST, 2000). This national process featured a broad-based consultative process to engage local stakeholders across different regions of the United States in the preparation and vetting of these reports (Moser, 2005; Parson *et al.,* 2003). Although the national process in the United States after 2000, with the change in administration under President George W. Bush, the regional networks of people who worked on these studies have continued to support regional impact assessments in state and/or non-governmental venues (*e.g.,* in the case of California, see Corfee-Morlot, 2009).

Funding for such work will inevitably need to come from national governments or relevant sub-national authorities as it can be useful to stimulate adaptation across urban regions in an entire nation or region. Often the work will be carried out in local research centres or universities and joined up through "boundary organisations" to policy or other decision-makers. Again the lead time is long, often requiring nearly a decade to build significant expertise and competence in this area, hence the need to start today.

Table 3 highlights a number of different institutional models that have grown up in different places around the world to provide science policy support for impact analysis and adaptation policy decision making. In looking across the organisations studied, there is broad variation in their geographic scope and proximity to "local" clients, levels and sources of funding and key roles or functions of the organisation (see also Annex). However, there are also a number of common features. All of them focus on the same audience: stakeholders, local decision makers and citizens. Further, the organisations have various ways of interacting with the scientific community, acting either as consumers or as suppliers of new scientific information. But they all target the same goal, which is to facilitate stakeholder and decision makers' access to scientific information. Finally, all the institutions also target use of the local scientific community to contribute relevant information, working through universities, local and national institutions and research centres.

Table 3. Institutional models for climate change information development and exchange

Organisation	Geographic Scope and Key Role	Clients/Audience	Interaction with Scientific Community	Source of Expertise	Lead Organisation	Core Funding
IRI - International Research Institute for Climate and Society	**Africa/Asia Pacific/Latin America** • Understanding local decision process; • Sharing climate information to meet the needs of the decision makers; • Linking institutions and build capacities to improve climate risks management; • Develop climate information generating tools that meet local decision makers' needs.	• Developing countries' decision makers • Developing countries' public/private sector • Developing countries' citizen	Suppliers	• Columbia University Depending on the region: • National/local Institutions • NGOs • Research centers	Host Institution: • University of Columbia Funders: Public and Private Sectors • NOAA Office of Global Problems • Several Organisations involved in project funding	Public/private $9M/Year
Ouranos	**North America/Canada/Québec** • Develop knowledge; • Co-ordinate multidisciplinary initiatives; • Help decision makers to integrated adaptation to climate change into their decision processes.	• Local decision makers • Local stakeholders • Researchers	Suppliers	• Federal agencies • Local and national universities • National research centers • Ouranos	Funders : Public and private sectors • Government of Quebec • Valorisation-Recherche Quebec • Hydro-Québec	Public/private $12M/Year
PIER-EA - Public Interest Energy Research, Environmental Area	**California/USA** • Conduct and fund research in the public interest; • Research the environmental effects of different energy technologies used in California; • Attract collaborators to share data and work conjointly to develop mitigation strategies; • Develop California's capability to make informed decisions on climate change mitigation.	• Californian decision makers • Private sector • Researchers	Consumers	• Federal agencies • California State Agencies • Nonprofit groups and academic • Private laboratories	Host institution : • California Energy Commission Funders : Public • Charge on retail electricity sales	Public $6M/Year
UKCIP - United Kingdom Climate Impact Programme	**United Kingdom localities** • Communicate information on climate change impacts to stakeholders; • Provide policy-making tools to decision makers; • Establish relationships between researchers and decision makers.	• Local decision makers • Local stakeholders • Researchers	Consumers	• Oxford University Centre for the Environment • Tyndall Centre • Research groups within universities across the UK • Private laboratories	Host institution: • Oxford University Funders: Public & local resources • UK Department for Environment, Food and Rural Affairs • UK's Knowledge Transfer Partnership scheme	Public/private $1.25M/Year
Club ViTeCC, Villes, Territoires et Changement Climatique	**France** • Provide information to stakeholders, institutions and private sector on their roles in climate change adaptation; • Propose concrete recommendations for funding new infrastructures; • Make scientific and technical information understandable to local decision makers and developing the proper decision tools.	• Local authorities • Stakeholders • Private and public sectors	Consumers	• Private/public services • National meteorological center • National and international Universities • Known local and international experts	Host institution : • Caisse des Dépôts • Météo France • ONERC Funders : Private/public • Contributions from clients	Public/private N/A

Websites: http://portal.iri.columbia.edu/portal/server.pt; http://www.ouranos.ca/; http://www.climatechange.ca.gov/research/climate.html; http://www.ukcip.org.uk/; http://www.caissedesdepots.fr/spip.php?article647

Developing climate change information relevant to local decision makers is part of an iterative process engaging researchers and stakeholders in an ongoing exchange. Beyond engaging relevant participants, a first task is to establish a discursive process that allows ongoing exchange so that core research questions are framed with input from decision makers and decisions are made in local contexts based on the best available information from the scientific community. Up-to-date information on climate change impacts provides a basis for communication with stakeholders and a means to generate dialogue and understanding about the need for policy reform and behavioural change to respond to climate change. Information on climate change impacts provides a means for lay people to understand and care about the issue. It brings the abstract and distant problem of climate change into a local context and helps people – investors and consumers alike – to relate it to their daily lives and think about how to address it. It provides at once a motivation for mitigation and a powerful source of information for adaptation. Adaptation is necessarily local and will include disaster management to address nearer-term impacts such as floods, water shortage or heat waves. It will also include urban planning solutions to ensure that infrastructure and land use planning is resilient to climate change.

Furthermore, local stakeholders can provide essential input to impact researchers to yield results that are most relevant to their concerns. Growing experience with regional science policy processes demonstrates the value and ability to frame regional impact and vulnerability assessments around themes that are identified by affected stakeholders, to deepen knowledge and promote strategies for adaptation that resonate from the bottom up.

4. Conclusions

Despite a flurry of recent activity in cities on climate change and growing interest in the research community, climate policy at city-scale remains fragmented and basic tools to facilitate good decision making are still lacking. Action on climate change at city-scale is necessarily nested in the authority of national governments to advance the policy agenda, yet national governments have only just begun to take notice of the importance of cities in their efforts to advance policy. Yet this review joins others to suggest that cities may have a number of unique advantages in the design and implementation of locally-adapted responses. These include: i) the ability of cities to work closely with local stakeholders and in context specific ways to make climate change more tractable for decision makers; ii) the possibility for cities to incorporate climate change into reform of pre-existing local policies and practices (*e.g.*, land use and urban planning); and iii) the ability of cities to experiment with and learn about a range of possible responses to both cost-effectively adapt to inevitable climate changes and to mitigate greenhouse gas emissions.

Cities are central to our efforts to understand, communicate and act to limit and adapt to climate change. Communication strategies will benefit from the use of image and metaphor to connect climate change to local geography and culture (Leiserowitz 2005; Corfee-Morlot 2009). Climate change cannot remain a specialist issue; it needs to become a community issue, along with safe streets, clean air and good schools. The key to good decision making is engagement and understanding about the issue. Understanding climate change in local contexts, in turn, will bring political support for action, local know-how and ideas about how to address it to the table.

National governments have the opportunity to help or to hinder city competence on climate change. We have argued for two priority types of action that will empower cities on this issue. Working with sub-national and national governments, as well as with the international community, cities could help to contribute to cost-effective solutions by the development of:

- Harmonised GHG emission inventory and reporting protocols for cities to allow them to monitor and compare progress in mitigating emissions and eventually to become active participants in international carbon markets; and

- Regional impact science programmes to support local communication efforts on climate change and adaptation decision-making.

While the agenda for multi level governance of climate change is inevitably much broader than this, first steps by national governments to work with sub-national governments, cities and experts to advance capacity and tools in these two areas could be important first steps to move such an agenda forward. National enabling frameworks will be essential to support cities to design and deliver cost-effective and locally adapted policies to address climate change in urban areas. In this context, they will need to resolve the inevitable jurisdictional overlaps and issues of mandate. National governments will need to work closely with the international community, *i.e.*, to ensure that there is legitimate policy space for cities to participate, for example in market mechanisms in a post-2012 agreement. These are enabling activities that if tackled today could carry cities forward to deliver on the promise of climate protection over the decades to come.

ANNEX: INFORMATION ON REGIONAL IMPACT SCIENCE-POLICY INSTITUTIONS

IRI

Created in 1996, the International Research Institute for Climate and Society (IRI) collaborates with local institutions and stakeholders that understand local needs in Africa, Asia and Latin America. After having studied the region's basic social structure, the IRI chooses the regions and partners it wants to be involved with (Agrawala *et al*., 2001). It focuses on its partners' climate risks management strategies and aims at strengthening them through the integration of climate risk management. "IRI participates in the transnational flow of technical knowledge and skills, usually along a gradient from North to South" (Agrawala *et al.*, 2001). Their research and tools help address development and adaptation issues in developing countries (IRI, 2007). IRI works collaboratively with the local and national partners to help them better plan and manage activities. Its climate change projects focus on actions needed to improve actual outcomes and the future interactions of environmental, economic and social systems with the climate (IRI, 2008). Their focus is on four major points (IRI, 2007): (1) understanding the local decision process; (2) sharing useful climate information to meet the needs of the decision makers, disentangling short-term from long-terms issues; (3) linking institutions and building capacities to improve climate risk management; (4) developing climate information and generating tools that meets the local decision makers needs.

Ouranos

Ouranos was created in 2001 in a joint initiative by the government of Quebec, Hydro-Québec and Environment Canada to provide them with an organisation capable of linking climate science with the needs of different sectors of society. Its mission is to acquire and develop knowledge on climate change in order to inform decision makers about probable climate trends and advise them on identifying, assessing, promoting and implementing local and regional adaptation strategies (Ouranos, 2008). This involves developing structures for analysis of multidisciplinary problems, promoting synergetic work, developing tools or climate scenarios required to support vulnerability and impact assessments, and develop adaptation strategies (Vescovi *et al.,* 2007). Among its partners, eight provincial departments and agencies are involved, along with three universities. Ouranos can also provide external clients and stakeholders with reliable regional climate projections. Ouranos meets the needs of its partners from various sectors and defines effective adaptation strategies according to the specific needs (Ouranos, 2008). The communication between climate specialists, impact researchers, and user groups is co-ordinated by Ouranos. Thus, evaluation of the potential impacts is ensured and the development of adaptation solutions is facilitated (Vescovi *et al* 2007). The organisation's budget amounts to about 5 million Canadian dollars (CAD) per year and is generating CAD 12 million of external resources (Ouranos, 2008b). Its source of funding mainly comes from Quebec's *Ministère du développement économique, de l'innovation et de l'exportation* (MDEIE). It also received, in 2008, CAD 10 million grant from the government of Quebec for its impact and adaptation work.

PIER programme

Over the last decade, the California Energy Commission (CEC) has developed the Public Interest Energy Research Programme (PIER), which includes an Environmental Area covering climate change

modelling and policy research (Franco, 2005). Part of the PIER mission is to conduct and fund research in the public interest that would otherwise not occur. The PIER programme, managed through the CEC, co-ordinates a broad-based research effort on climate change and solicits collaboration by partnering with research and development organisations, individuals, businesses, utilities, and public or private research institutions with experts throughout the state. The programme often leverages funding through this collaborative model, working with various institutions throughout the state. Ongoing national and international research efforts are the basis of its research program and funding of research projects to inform policy makers in the state (Franco *et al.*, 2008). In 2003, PIER programme created a five-year research plan on climate change in California. To implement it, the PIER programme created the (virtual) California Climate Change Center (CCCC), the first state sponsored climate research programme in the United States (Franco *et al.*, 2008). Although the Center is managed by the California Energy Commission, Scripps Institution of Oceanography at the University of California at San Diego and the University of California at Berkeley (CEC, 2008b), it draws on research partners across a broad network of universities and institutions across the state. A number of major outcomes include improved capability for California to make informed, economically grounded decisions on climate change mitigation and adaptation, including applications the management of water and agriculture, electricity and energy among other sectors (Franco *et al.*, 2008). PIER allocates roughly USD 4 million to USD 6 million per year to climate change research (CEC, 2008).

UKCIP

The United Kingdom Climate Impacts Programme (UKCIP) was founded in 1997 to help co-ordinate scientific climate change research, and to help organisations adapt to its impacts (UKCIP, 2008). To achieve its main objective, UKCIP works with scientists, policy makers and stakeholders to co-ordinate and influence climate research and to share the useful outputs with stakeholders. UKCIP supports the development of institutional capacity by raising stakeholders' awareness on the need to adapt and by providing tools allowing decision makers to make well-informed decisions when choosing adaptation strategies (McKenzie *et al.*, 2006). The Programme recognises that stakeholders can be experts in their domains and that the information provided by them allows researchers to use the best available regional information (McKenzie, 2006). It works on a contract basis with different sub-national regions or local communities to assess possible climate change impacts, vulnerability and adaptation options. While areas explored in the initial stages of a typical contract might include high impact-low probability events and to define the implications of climate impacts, the emphasis can rapidly shift to equipping stakeholders for adaptation (UKCIP, 2008), which in practice means combining the latest cutting-edge academic research with decision makers' knowledge of what works in practice (UKCIP, 2005). The majority of UKCIP's funding is from the Department for Environment, Food and Rural Affairs. Other contributors include the Environmental Change Institute (Oxford University) and the Government's Knowledge Transfer Partnership scheme (UKCIP, 2005).

Club ViTeCC – Villes, Territoires et Changement Climatique

The Club ViTeCC is a French research center focusing on the analysis of the carbon economy. It was created by a consortium of institutions in France including the *Mission Climat of Caisse des Dépôts*, *Météo-France* and the national observatory on climate change impacts (ONERC). In 2007 and in collaboration with these other institutions, the *Mission Climat* launched ViTeCC as part of its work in analysing the linkages between climate change mitigation, adaptation and urban infrastructures in France. Focused on cities, territories and climate change, Club ViTeCC's main objective is to provide local authorities, stakeholders, private and public sectors and citizens with information on their role in climate change mitigation and adaptation by bringing together economists, scientists and engineers for informal discussions (CDD, 2008). It aims to make scientific and technical information understandable to local decision makers and to develop the proper decision tools on emission reductions funding and

management of urban infrastructure adapted to future climate risks (*Association pour la Recherche en Economie du Carbon* or APREC, 2008). Equally, part of the Club ViTeCC's research program will focus on concrete recommendations for funding new infrastructures (APREC, 2008). The club brings together French local leaders (cities, towns, counties, regions, urban planning agencies etc.), management firms (energy, construction, transport, water, financial services) and recognized climate change and economic infrastructure experts. Its team is composed of members of the *Mission Climat, Météo France*, the National Observatory on the Effects of Climate Change (ONERC) and experts involved in a number of international research programmes. Participation in Club VITECC is subject to an annual fee (set for 2008 to EUR 4 000 for the public and EUR 16 000 for companies) dedicated to funding the operations and research conducted for the club. Club ViTeCC is a non-profit organisation, its funds are managed by the *Association pour la Recherche en Economie du Carbone* (APREC), founded by the *Mission Climat* of *Caisse des Depots* and the Université Paris Dauphine.

NOTES

1. Organisation for Economic Co-operation and Development, Environment Directorate; Jan Corfee-Morlot is leading a project at the OECD on cities and climate change (see *www.oecd.org/env/cc/cities*) and is the corresponding author for this paper: *jan.corfee-morlot@oecd.org*. The views contained in this article are solely those of the co-authors and do not represent the views of the OECD or of its member countries.

2. Mission Climat de la Caisse des Dépôts / CERNA - Mines ParisTech.

* The authors would like to thank Stephane Hallegatte (CIRED), Peggy Foran (California Climate Action Registry), and ICLEI staff (comment as co-ordinated by Konrad Otto-Zimmerman, ICLEI Secretary General) for commenting on an earlier version of this article.

3. Opening statistics from: Tyndall Centre. 2004. A briefing on climate change and cities: Briefing Sheet 30, British Council. This statement is reworked from the Tyndall Centre report which argued"...the fate of the Earth's climate is intrinsically linked to how our cities develop over the coming decades" and thus focused uniquely on one dimension of this relationship.

4. See Chicago Climate Action Plan (2008) and Parzen (2008); Greater London Authority (2008); Miami-Dade County Climate Change Advisory Task Force (2008); Mairie de Paris (2007); Toronto Environment Office (2008).

5. See: Urban Leaders Adaptation Initiative *www.ccap.org/index.php?component=programs&id=6*; Alliance for Resilient Cities (ARC) *www.cleanairpartnership.org/arc.php*; and ICLEI's Climate Resilient Communities in the US and adaptation work in Europe: *www.iclei.org/*.

6. For example, the IPCC Fourth Assessment Report acknowledges the role of cities in design and delivery of climate responses is acknowledged and relevant academic literature reviewed, however it remains marginal to the full volume which is largely focused on the global dimensions of the problem and its possible solutions. For chapters that address local dimensions of climate change and policy responses see: Wilbanks and Romero *et al.*, 2007; Gupta and Tirpak *et al.*, 2007; Sathaye and Adjam *et al.*, 2007. Bulkeley and Betsill (2005) and Betsill and Bulkeley (2007) are notable exceptions in bringing attention to multi-level governance. The UNFCCC (2006) in their review of progress in national policy under the Kyoto Protocol also highlight some trends for national governments to work more closely with local governments.

7. NOAA estimates that 53% of United States' population live in coastal regions (Crosset *et al*., 2004).

8. For more information see: *www.ipcc-nggip.iges.or.j* (last accessed 12 December 2008).

9. For access to latest inventory reports and data see: *www.unfccc.int* (last accessed 8 December 2008).

10. Industry emissions may vary widely from location to location or even over time within a single location; *e.g.*, as industries increasingly move outside of city boundaries this may dramatically change urban emission levels. Decisions of city governments may also have little influence over industry emissions relative to large influence of local policy over residential and transport emissions. Thus special attention to this source of emissions may be warranted in the assessment and comparison of urban emission performance across cities.

11. ICLEI is the International Council for Local Environmental Initiatives, which now also operates a Cities for Climate Protection Campaign. See *www.iclei.org/index.php?id=800* (accessed 12 November 2007).

12. *www.icleiusa.org/cacp* (last accessed 12 December 2008).

13. It is important to note that a number of different registries and protocols exist in the United States to serve different purposes, some of which are mentioned here. Because there is no single top-down mandatory federal system requiring entity or state-level reporting, a patchwork of state systems, some of which are mandatory, combine with voluntary reporting. For a review see Rich, 2008.

14. CCAR, 2006. San Francisco first city in U.S. to certify greenhouse gas emissions. Los Angeles: California Climate Action Registry.

15. This was originally slated for delivery in the fall of 2008, however at the end of the year it had not yet been unveiled.

16. This work is co-funded by the European Commission – see *www.climate-compass.net/_project.html* (last accessed 9 March 2009).

17. For more information on OECD work on cities and climate change, including links to this initiative from the Governance Directorate, please visit the website: *www.oecd.org/env/cc/cities*.

18. See also *www.amap.no/acia*. It is interesting to note that the report stopped short of having powerful policy recommendations in part because of reluctant state actors.

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CHAPTER 3:

CLIMATE CHANGE, URBAN INFRASTRUCTURE AND ECONOMIC DEVELOPMENT[1]

by Gianmarco I.P. Ottaviano

University of Bologna and FEEM

Madam Mayor, Mr. President, Mr. Ambassador; OECD Delegates, Ladies and Gentleman,

I am very honoured to open this conference, which addresses one of the biggest challenges at the global scale.

As you may know, Fondazione Eni Enrico Mattei, the institution which I am proud to direct, is one of leaders in research on sustainable development. 2007 Nobel Prize winner IPCC has officially acknowledged the contribution of FEEM to climate change research and to such accomplishment.

Fondazione Mattei provided scientific support to the organization of this Conference, which us the great opportunity to interact with our fellows at the OECD on climate change, and with our local governments. I hope that Comune and Provincia di Milano are now better acquainted with a reality of the scientific landscape of the city of Milan and that there will be scope for co-operation in the future. Obviously, the same expectation is maintained for the OECD.

But…why climate change is becoming so crucial to the world economy and society? And which role will our cities play in this context?

Today, more than 50% of the world population lives in cities.

While the current figure for Europe reaches an impressive 80%, such a threshold will be soon achieved by Asia, the most populated continent.

Due to their large diffusion, urban settlements have a great impact on their environment, being simultaneously:

- The place of highest consumption of energy and of transformation of material resources;
- The most relevant source of contamination/pollution and waste, that makes it the most relevant contributor to regional and global environmental threats.

Moreover, cities are characterized by a high degree of complexity, for the broad interaction of actors, processes and dynamics that take place mainly within the urban settlement but also between the city and its surroundings.

This complexity is reflected on the main challenges that the city has to deal with to continue its development without compromising local and global environment. This complexity needs to be properly handled to achieve local and global sustainability.

Cities have a great power to lead the reduction of their carbon footprint, having a critical mass of population and activities, hosting leaders of political and economic power, being centres of technological innovation.

The key to the success of any sustainable energy policy builds upon on approach where each urban stakeholder plays its role in an holistic game. Institutional, financial, entrepreneurial, research and community actors need to come together and operate with co-ordinated, integrated and co-operative attitude.

With the involvement of the broadest set of urban stakeholders, all in all, it will be possible to make a step further from a voluntary responsible approach to a, shared, strong and binding commitment of the entire urban society. I hope that this conference will allow to advance in this direction.

NOTES

1. Expert presentation prepared for the *2nd Annual Meeting of the OECD Roundtable Strategy for Urban Development "Competitive Cities and Climate Change"*, 9-10 October 2008, Milan, Italy. Sections 2 and 3 are based on Ottaviano (2008). Email: *gianmarco.ottaviano@unibo.it.*

CHAPTER 4:

WATER IN THE URBAN ENVIRONMENT: MEETING THE CHALLENGES OF A CHANGING CLIMATE

By Matthias Ruth and Rebecca Gasper

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Warming trends in atmospheric and oceanic temperatures have caused, and will continue to cause, real changes in the Earth's hydrological cycles. Impacts of these changes vary locally, and include rising sea levels, greater incidence of extreme precipitation events, more severe droughts and increased frequency of flooding. These trends present a unique challenge to urban areas, whose growing populations and industrial activities put increasing pressure on water resources and are particularly vulnerable to changes in water quality, availability and flood management and to negative impacts such as infectious disease and natural disasters. This paper synthesises research on the current and potential demands that changing hydrological activities will impose on the urban environment, and provides a basis for discussion about how to address these impacts through integrated policy, urban planning, innovations in infrastructure and changes in behaviour.

Current and anticipated impacts of climate change on hydrological cycles

Evidence of climatic changes is now well documented, and the implications are becoming increasingly clear as data accumulates and data and climate models become increasingly sophisticated. Mean annual global surface temperature has risen significantly from 1906-2005 by 0.74^{o}C, with the rise in the past 50 years occurring at an accelerating rate. Sea surface temperature has also risen, as oceans absorb 80% of atmospheric heat energy (Figure 1), causing sub-surface warming to at least 3 000 meters (IPCC, 2007).

Warming oceans and atmosphere have affected the hydrological cycle. Since 1978, sea ice extent has declined by an average 2.7% per decade, contributing to an estimated 10 to 25 centimetre increase in global sea level, a rise that is expected to continue over the next several decades (McCarthy *et al*., 2001; Arendt *et al*., 2002; Williams *et al*., 2007). Cumulative impacts of the rise in sea level and increased climatic variability have caused greater annual extreme high water levels around the world (Woodworth and Blackman, 2004).

Deviations from average weather patterns have been observed globally, most often involving hotter high and low temperature extremes and more frequent droughts. Mean precipitation increases are variable, with general summer and winter increases in the tropics, eastern North America, northern Europe, and northern and central Asia, while summer decreases have been documented in mid-latitude regions. Precipitation has generally occurred, and is predicted to continually occur, in bouts of more intense, sudden events punctuated by seasonal droughts (IPCC, 2007). Likewise, severe weather events and natural disasters are occurring more frequently and intensely than expected, compared to historical records (Sumi *et al*., 2004). As global temperatures continue to increase, these extreme events are predicted to occur more often and with greater severity (Figure 2; Klein Tank 2005).

Evolution of the urban environment

Urbanisation, though characterised by significant regional differences, is following an overwhelming upward trend. The world has seen a fifteen-fold increase in urban populations since the beginning of the twentieth century. Both total population and urban population at all levels of development are increasing, though at a decreasing rate. Consistently, wealthier and more developed nations are characterised by greater levels of urbanisation, though the majority of urban *growth* is occurring in lesser developed countries (UNDP, 2003; UNDP, 2006; World Bank, 2005). Indeed, the rate of urbanisation in the least developed places is as much as seven times that in the most developed nations (UNDP, 2003).

Approximately half of the world's population now lives in urban areas, with more than 50% of those in cities of less than 500 000 people (McGranahan and Marcotullio, 2006). Though some of the world's largest cities have experienced slowed growth rates in recent decades, the average size of the world's 100 largest cities has increased from 200 000 in 1800 to 5 million in 1990 (Cohen, 2004). This trend in urban expansion is anticipated to continue, as transportation and communication networks, two of a city's most extensive infrastructure systems, expand outside traditional inner-city boundaries. Figure 3 shows estimated population changes for some major cities, as well as trends for urban/rural population ratios.

Purely demographic changes are exacerbated by a suite of environmental conditions that are influencing and being affected by urbanisation. Most cities are located in and are growing primarily in coastal zones, in part because of the importance of access to natural resources and transportation networks in an increasingly globalised world. Population densities in coastal areas are approximately 45% greater than global average densities (McGranahan and Marcotullio, 2006). As the size and make-up of cities changes, new urban economic and social inequalities come to the fore, and new pressures on the local environment are created. For example, increased demand for land often leads to settlement in ecologically vulnerable areas or an increase of imperviousness (*i.e.*, paved and built-up surfaces), in the urban landscape. As a result, the ability of wetlands and forested areas to protect coastal zones, flood plains and rivers is reduced and the likelihood of flooding is increased, with all its associated impacts on housing structures, transportation networks, water supply and water quality. These characteristics of cities and their associated demographics make the impact of climate change especially challenging.

Environmental impacts on cities

Sea-level rise

Sea level is an obvious concern for cities that are situated on coasts, where rising water levels and storm surges can cause property damage, displacement of residents, disruption of transportation and wetland loss. Already a nuisance for coastal communities globally, sea level rises and associated impacts are estimated to impact five times as many residents as they did in 1990 by the 2080s (Nicholis *et al.*, 1999). Projected sea level rise is associated with significant loss of land in coastal regions. For example, a 0.3 meter sea level rise in the United States, which is on the low end of IPCC projections (0.2 to 0.6 meters), would erode approximately 15 to 30 meters of shoreline in New Jersey and Maryland, 30 to 60 meters in South Carolina and 60 to 120 meters in California (Ruth and Rong, 2006). Adaptation measures to combat sea level rise will be necessary because of the lag time of warming and its effects on glaciers. Even under scenarios where emissions are eliminated, sea level rise continues well after temperature has stabilised (Figure 4).

Salinisation of groundwater and surface water is a critical problem that reduces the availability of potable water and can spread harmful pollutants through urban water systems. Cases of saltwater intrusion are nearly ubiquitous among coastal cities, documented in diverse environments including the eastern United States, the coast of Thailand, as well as both Chinese and Vietnamese deltas (IPCC, 2001). Costs of desalination are high, at approximately USD 1.00 per square meter to generate potable water from seawater, USD 0.60 per square meter to convert brackish water and 0.02 per square meter for freshwater chlorination (Zhou and Tol, 2005).

Storm water drainage and sewage systems

Hydrological changes can stress the capacity of drainage infrastructures, sewage systems and water treatment facilities in cities. Heavy precipitation events wash urban pollutants into rivers and lakes, and can reduce water quality in reservoirs by increasing turbidity (Frederick and Glick, 2000; Miller and Yates, 2006). Low river flow during times of drought amplifies the concentration of chemical and heavy metals, with potential implications on ecosystem health and recreational opportunities (IPCC, 2001). As intense precipitation occurs more often, urban planners will have to confront multi-faceted problems of controlling and managing precipitation inflows and protecting existing water supplies.

Urban runoff and failures of combined sewer overflows and municipal sewer plants can all introduce pathogens into water systems that pose a variety of health risks; documented cases globally range from wound infection to kidney failure (Nuzzi and Waters, 1993; Rose *et al*., 2001). Sea-level rise combined with increasing frequency of severe weather events can cause sanitation problems when urban infrastructures are not prepared to accommodate sudden influxes of water, leading to contamination of drinking or recreational water from sewage backup and introduction of microbial/chemical agents and biotoxins (Rose *et al*., 2001).

Severe weather events and flooding

The frequency and severity of flooding has generally increased in the last decade compared to 1950-1980 flood data, along with the frequency of floods with discharges exceeding 100-year levels (Kron and Berz, 2007). Although there is variation in regional predictions among different forecasting models, it is generally accepted that both trends will continue, especially in Asia, Africa and Latin America (Milly *et al*., 2002; Fox, 2003). More frequent severe precipitation events are predicted to cause a greater incidence of flash flooding and urban flooding.

Floods are one of the most costly and damaging disasters, and will pose a critical problem to city planners as they increase in frequency and severity. In addition to the obvious structural damages and loss of life that they can cause, floods can short-circuit transformers and disrupt energy transmission and distribution, paralyze transportation, compromise clean water supplies and treatment facilities and accelerate spread of water-borne pathogens (IPCC, 2001; Ruth and Rong, 2006). Socio-economic models of flood damage in cities in the future (*e.g.*, Boston, Massachusetts; London), independently predict vast increases in spending on damages due to climate change in the absence of adaptive infrastructure changes (Kirshen *et al*., 2005; Hall *et al*., 2005; Choi and Fisher, 2003).

Combating these problems requires consideration of structural flood defences (*e.g.*, river diversion, reservoirs and embankments), and the readiness of emergency alert systems and response services. Given the extent to which virtually all aspects of urban life depend on water, floods will moreover challenge the ability of planners and managers charged with providing reliable service in the face of a highly variable climate.

Increasing water demand

Higher air temperatures and more frequent droughts can cause increasing demand for household and industrial use of water in urban areas (IPCC, 2007). Although modelling evidence has not shown these increases to be dramatic (Protopapas *et al.*, 2000), effects may be exacerbated as population growth occurs in cities. This phenomenon has significant regional variation, making it difficult to predict impacts on a given area based on global or broad regional estimates of temperature change, for example. Modelling estimates for the United States have suggested large costs to meet increasing demand as temperature rises through 2060, while studies on Greece have predicted decreasing costs under certain climate change scenarios (Morrison and Mendelsohn, 1998; Cartalis *et al.*, 2001). Regional variation has proven significant at the state level of resolution in the United States, emphasising the need for understanding not only the anticipated regional effects of climate change, but also the differences in manifestation of these impacts for various urban sectors (*e.g.*, waste management, manufacturing and services) (Sailor, 2001).

Equally important is the analysis of demand relative to supply in a given environment. Estimates for gross demand increases that can be met by current levels of supply may not necessarily be met by supply in the future, if it is restricted by severe weather, pollution or other climate change impacts. In fact, when relative demand is considered in concert with additional stresses from the agricultural sector, it becomes clear that many parts of the world will be forced to confront infrastructure changes over the next several decades. For example, model results including population and climate change projections estimate large increases in relative demand in the northeastern United States, the majority of Latin America, sub-Saharan Africa, Eastern Europe and the Middle East (Vorosmarty *et al*., 2000).

Heat-related mortality and disease

Aside from deaths due to natural disasters, increasing temperatures can affect mortality in a number of ways, including heat-induced mortality, famine, exacerbation of non-infectious health problems and spread of infectious disease. Heat waves are likely to increase in severity and duration in the future, contributing to heat mortality in both developed and developing countries. Drought associated with long bouts of heat and reduced precipitation may contribute to regional loss of crops, contributing to malnourishment, especially in the developing world (Patz *et al*., 2005).

Spread of infectious disease stands as one of the most profound and universal problems associated with increasing air and water temperatures. The World Health Organisation attributes at least 150 000 annual deaths to disease issues associated with climate change that have occurred since the 1970s, and extends its analysis to estimate that death rates from climate-induced disease risk may double by 2030 (Patz *et al*., 2005). Warming climates favour many pathogenic agents and their vectors, often extending life cycles, increasing reproductive rates or allowing for range expansion. Diseases of particular concern include malaria, dengue fever, plague and West Nile virus. There is evidence that warming temperatures are also increasing the incidence of food poisoning, with reports from the United Kingdom and across Europe revealing correlations between temperature rise and food poisoning and salmonellosis, respectively (Bentham and Langford, 2001; Kovats *et al.*, 2004).

Economic impacts on cities

Most of the discussion of climate change impacts in the urban environment has focused on flood-related damages, human health, domestic use of water and industrial use in general. It is important also to explicitly consider how current and potential changes directly and indirectly impact local economies, and the subsequent consequences on the capacity to adapt and cope with the aforementioned issues associated with change.

Costs of climate change impacts

Direct costs from climate change impacts can be staggeringly high, especially when related to natural disasters and sea level rise. Shoreline retreat in the United States costs between USD 270 billion to 475 billion per meter climb in sea level; analogous costs in developing nations can amount to one-third of annual GDP (IPCC, 2001). Flooding is one of the most expensive disasters, with a single flood causing England, for example, to spend GBP 1 billion to repair damages in 2000 (Zoleta-Nantes, 2000).

Indirect impacts can cripple local economic activity as well, when transportation, commercial and industrial activities are interrupted due to severe weather events. Economic impacts can have rebound effects in the job market and reduce tax revenue. These stresses on the local economy may limit investment opportunities and deplete funds for infrastructure innovations, leaving cities more vulnerable to future change.

Costs of adaptation to climate change

Adaptation mechanisms have become an integral part of the climate change debate. Although it is clear that adaptive measures will be necessary to confront the problems associated with water in cities as the climate continues to change, there are sometimes very steep associated costs. The OECD (2008), reported a wide range of estimates for the costs of adapting urban water infrastructures from a variety of empirical studies, on the order of hundreds of millions to billions of dollars per year. In sub-Saharan Africa, adaptations in urban wastewater treatment systems (new and existing facilities), could cost USD 2 billion to 5 billion per year, while in Toronto, Canada, similar improvements were valued at around USD 9 billion annually. Given costs associated both with action and inaction in the urban water debate, the economics of climate change will be a critical component of the decision-making process.

Impacts of cities on the environment

As the changing environment brings with it demands and challenges to cities, the physical and social structure of cities also generates unique local environmental conditions. In particular, the urban heat island (UHI), effect and urban nitrogen pollution are common characteristics of cities that further stress hydrological cycles and the clean water available.

Urban heat island effect

Cities tend to have higher air and surface temperatures compared to rural areas, due to combined effects of structural interference with thermal radiation, low albedo of impervious surfaces and reduced evapotranspiration (Oke, 1982). This phenomenon, the urban heat island (UHI), effect, aggravates heat-related negative implications of climate change and imposes costly energetic demands on urban systems (McPherson, 1994). In the United States, for example, an estimated 3% to 8% of annual electricity use is required to offset UHI effects (Grimm *et al*., 2008).

Beyond increasing temperatures, UHI effects can generate changes in local atmospheric and hydrological cycles. Changes in solar influx and chemical composition of near-ground air masses can cause formation of photochemical smog and reduce air circulation, which would otherwise diffuse the concentration of air pollutants. There is also recent evidence that local precipitation rates may be impacted by urbanisation. For example, Shepard's (2006), analysis of arid regions revealed a statistically significant increase in precipitation in Phoenix, Arizona, and suburbs during its urbanisation period, compared to its pre-urbanisation period. This study also noted increased variability in precipitation for this region and for Riyadh, Saudi Arabia.

Strategies to combat UHI impacts include redesign of surface composition, construction of light-coloured buildings, installation of green roofs and curbside planning. However, the cost-effectiveness of these measures is debated. Vegetation options are often water-intensive, and it is unclear whether energy savings are outweighed by planting costs and water use over time (Oke, 1997). The relatively active current body of research into both the physical and economic aspects of UHI effects may facilitate the identification and development of robust and cost-effective solutions.

Nitrogen cycles

Materials and energy are inevitably highly concentrated in urban areas, as large numbers of people consume food and resources, generating heat and waste. As a consequence, cities play a significant role in nutrient cycling locally and potentially, globally. Waste nitrogen is a particularly harmful nutrient that can cause excessive plant growth and eutrophication in aquatic systems, and can support toxic algal blooms. In cities this can reduce surface water quality, taint potable supplies, limit recreational opportunities and reduce biodiversity. Although many developed cities have the technology to limit leachate of nitrogen from industrial runoff and waste disposal, continued population and industrial growth poses the question whether existing infrastructures can handle increasing volumes of waste in the future. Improved efficiency of waste management will be necessary to handle these increases, as well as to prepare for the effects of nitrogen leaching in the events of combined sewer overflows and flooding of storm water systems. In addition to technological advances, innovative approaches to capture, store and transport of waste will be necessary to prevent nitrogen pollution from posing a significant threat to human and ecosystem health in the future (Bernhardt *et al*., 2008).

Confronting the challenge: policy implications and tools

It is clear that the implications of climate change in the urban environment stretch far beyond the environmental arena. As the number of urban residents climbs to an estimated 5 billion people by 2030 (Ash *et al*., 2008), urban planners, government officials and water management experts face the challenge of meeting growing demand in cities with diminishing supply, and of mitigating potentially severe negative social and economic impacts on the population. Although there is regional variation in terms of climate change, most local governments will be charged to varying extents with choosing where new development occurs and regulating for new development; regulating design of new buildings; and making investment decisions regarding efficiency improvements in industry and technology to reduce impacts. We have chosen to highlight a few of the pressing policy challenges that have emerged in the literature, in the hope of stimulating further thought and analysis.

Evaluation of local impacts

The critical first step toward addressing specific policy challenges that will confront a given city is to assess local vulnerabilities to climate change. This should involve analysis of climate models that predict impacts on the urban landscape and evaluation of existing mechanisms to deal with all issues that affect water resources management in a changing climate. What are the risks? Which sectors are anticipated to be affected and how? What plans are already in place to address these risks, and how can they be modified to minimise costs and impacts? What additional information is required to facilitate planning? Who is accountable for which specific actions?

In many cases, it may be preferable to use a standardised evaluation system to categorise impacts, solutions and associated economic costs and feasibility of changes. The City of London Corporation’s climate change adaptation plan uses the same set of qualitative criteria across all vulnerable sectors to indicate the severity and certainties of impacts, as well as costs and benefits of solutions.

Emergency preparedness

Local governments will have to respond to a variety of emergency situations in the face of climate impacts, including heat-related mortality, hurricanes, tornadoes, flooding, severely reduced air and water quality, and outbreaks of water-borne infectious diseases. Close attention must be paid to emergency planning. Existing plans must be scrutinised and updated, if necessary, to account for worst-case scenarios. Specifications should be in place for evacuation routes and procedures, supply of medicine, food and shelter, and for delivering important information to residents.

Hurricane Katrina has become the archetypical example in the United States of the drastic impact on human life of a failure to prepare for emergencies. After the Category 5 storm decimated New Orleans, Louisiana, it became clear that local and national levels of government were vastly deficient, both in preparing for the storm and dealing with damages in the aftermath. Considerations for all potential disasters that may impact a given city should include: *i)*, analysis of the infrastructure in place to protect residents (*e.g.*, sea walls, levees, drainage systems), and plans to fix any deficiencies; *ii)*, consideration, at the very least, of expected impacts in a worst-case scenario where events are expected to increase in severity; *iii)*, detailed plans of evacuation and aid procedures, and in particular carefully defining who is responsible for what action from local to national government.

In addition to being prepared for environmental disasters, city planners may consider development that minimises risk as urban areas expand. This can mean identifying areas within or around cities that are particularly vulnerable and generating building and zoning ordinances accordingly. Plans to reduce risk inherent in city infrastructure can include retrofitting buildings and houses to withstand impacts of extreme weather events and improving utility systems. Development officials in Caracas, for example, plan residential and commercial expansion according to a zoning program that identifies areas at high risk of landslides. The program also seeks to identify, manage and reduce risks in existing communities (Satterthwaite *et al*., 2007). Using existing programs as models can help cities that have lagged in their planning for climate change disasters to reduce losses in the future.

Land-use planning

Cities will have to accommodate increasing populations, as well as growing businesses and institutions, in the face of physical stress from the environment (*e.g.*, increasing intensity of storms and precipitation, flooding and changes in imperviousness of surfaces). The challenge for city planners will be to mediate competing demands for space within guidelines that minimise the costs and risks of climate change. Developing zoning ordinances that anticipate future impacts can reduce the costs of damage and health impacts. Evaluation of current codes and guidelines may be necessary where conditions are changing. For example, changes in precipitation can increase imperviousness of surfaces and increase subsidence, which should be accounted for by retrofitting buildings or bolstering foundations.

Incorporation of multi-use spaces can help reduce energy costs and in turn save water where it is used as part of the cooling process. Institutionalising climate change in infrastructure design, through installation of green roofs, building for efficient use of solar energy (*e.g.*, to reduce the amount of water and energy needed for cooling), and water-harvesting, is one way of generating changes in infrastructure (IHDP, 2008). Careful planning for transportation routes vulnerable to storms and heavy precipitation can minimise or reduce loss of economic activity following emergencies.

Water supply and treatment systems

Water treatment and waste management experts must evaluate the existing infrastructure for treating and transporting water. An understanding of the capacity of existing systems that might be subjected to sudden influxes of precipitation or seawater can help guide decisions about investment options, including stabilisation measures near shorelines, levees, storm water retention facilities and redesign of sewage and drainage systems. The City of London Corporation, for example, identifies particularly vulnerable flooding "hot spots" and plans for installation of new, sustainable drainage systems in these areas. Its plan further requires investment in the management and maintenance of these utilities, to ensure that their capacity is compatible with projections for increasing precipitation.

Mitigating differential impacts of climate change

The fact that climate change falls differentially on different sectors of local and national communities presents myriad challenges to those working in water policy in cities. Poor communities tend to be hardest hit by the impacts of change (IHDP, 2008). They are less likely to have access to health care, air-conditioning and bottled water, and more likely to have difficulties evacuating without assistance in the event of an emergency. Their options for relocating, if they live in a community likely to experience increasingly severe hurricanes, for example, are limited.

The distributional impact of water problems will need to be addressed, since many cities can share a single water source and meteorological disasters may involve large numbers of municipalities. Briefly, methods of assessing resource use can be used as indices of sustainable scale to inform discussions of just distribution of resources. The Ecological Footprint, for example, is one resource accounting tool that may be helpful in providing at least qualitative or relative approximates of how specific cities rate in their water consumption practices. Dynamic modelling (Hannon and Ruth, 2001), can be used to capture the interplay among environmental and socio-economic changes, and yield indicators of time-varying behaviours relevant to decision making.

Expanding the toolkit

The effects of climate change in combination with the evolving urban environment present unique problems to city planners. The many interacting layers of these effects (social, environmental, economic), call for creative, forward-thinking and integrated approaches. In the final section of this paper, we propose several broad themes as platforms for discussion to expand and inform the decisions about the policy issues mentioned above and to stimulate further research.

The marketplace: using economics to aid adaptation

The market is a potential tool for policy makers to provide incentives to use water efficiently, and to encourage investment in adaptation efforts. By pricing and granting property rights to water, scarcity can be indicated in the marketplace just like any other commodity, encouraging individuals to use less than they would in the absence of an economic signal. A water market in Australia established in the 1980s has proven successful for management of water usage in times of drought (OECD, 2008). However, it is not clear whether this approach will continue to work given increasing climate variability and more drastic shortages. Where water markets are considered, regulatory and pricing mechanisms must be carefully weighed to avoid monopolies and to ensure equitable distribution.

Because of the high costs associated with adaptation to climate change, public and private sectors often work together to generate funding for projects, especially in terms of infrastructure improvements. Generating incentives for private investment on the part of government can help fund and implement initiatives.

Application of a systems perspective

Given uncertainty in the degree and distribution of climate change and associated impacts, adaptability will be a necessary aspect of both policy mechanisms and their manifestations. Often, local areas will have to rely upon broad modelling predictions when planning for climate change impacts. Even where estimates are precise, an element of increased variability in climate can leave the door open for unanticipated and irreversible changes. For example, scientists may have underestimated the degree of warming that will occur as a result of greenhouse gas emissions already in the atmosphere, or there may be a temperature "tipping point" beyond which hydrological cycles change more dramatically than expected. There is no way to plan for every scenario imaginable, but it would be prudent to consider ranges of potential impacts and leave room in policy mechanisms and implementation to redesign, re-evaluate and evolve. What will be needed are "robust strategies" that make good economic, social and environmental sense under a wide range of future scenarios, rather than the more narrowly defined, economic optima espoused in prior policy decision making.

To design any plan for an entity as complex as a city requires an integrated planning approach and implementation of a systems perspective. It is clear that, like the hydrological cycle itself, the urban environment consists of dynamic networks, for example the networks that connect waste management with industry and households at local and economy-wide scales. Perturbations in one sector can cause rebound effects in others. Each part must be considered in relation to the others and to the whole as problems are evaluated and solutions weighed. It is likewise necessary to involve experts from a wide range of disciplines, including engineers, physicists, ecologists, economists, waste management experts and health officials.

Thinking outside the box

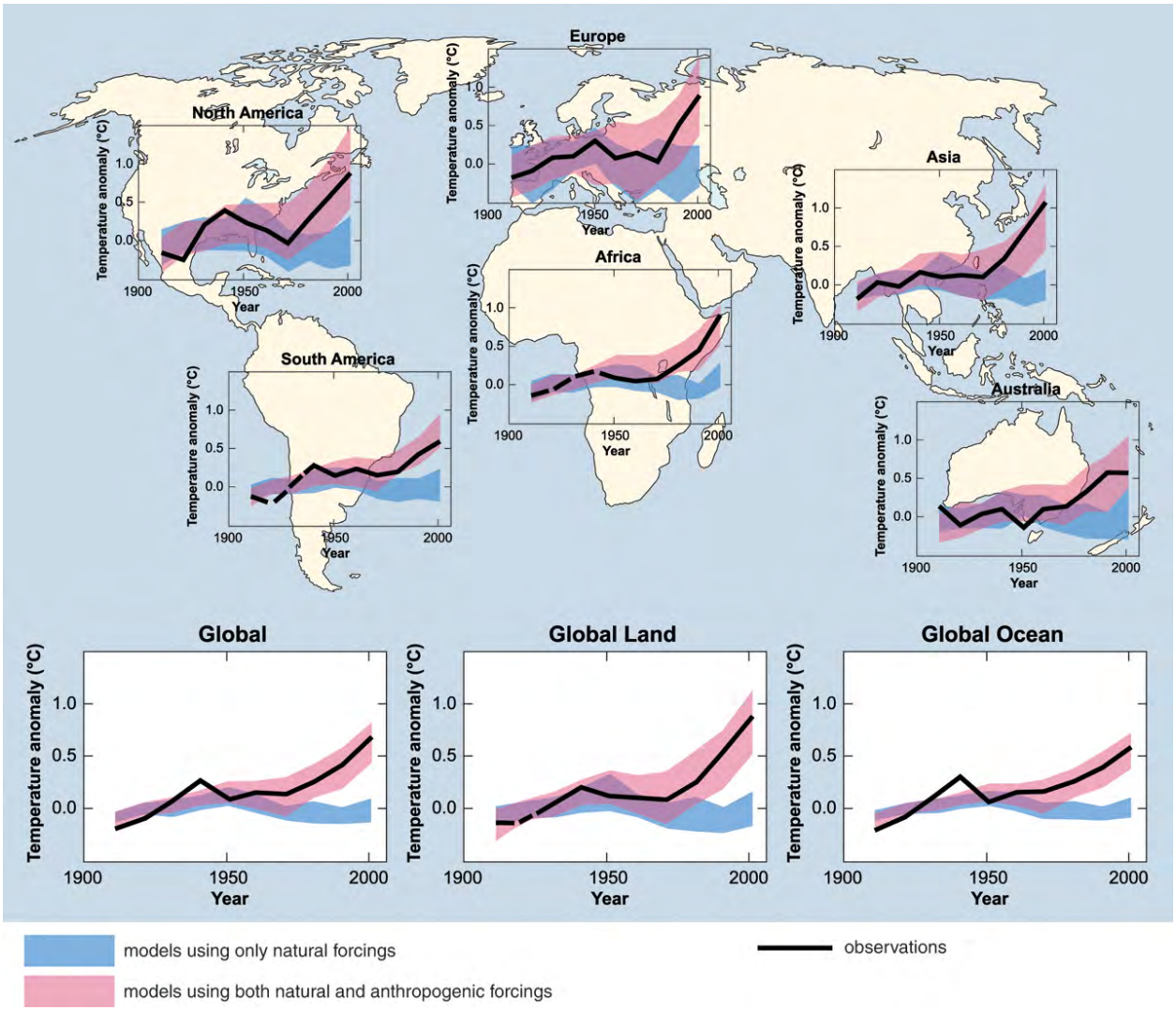
The dynamic nature of climate change makes it inherently difficult to identify solutions that work across sectors without negative effects. However, this also offers the freedom to think outside the bounds of a single, isolated system in the short or long term. For example, flooding and other extreme precipitation events can reduce the supply of potable drinking water because existing sewer systems cannot handle the influx of water. But mitigating effects can occur not only through costly redesign of sewage infrastructure, but also potentially through economic and social mechanisms that reduce demand for water or through the development and preservation of ecosystems that facilitate infiltration and cleansing. This can contribute ancillary benefits to society and the environment.

Recently, attention has focused on the possibility of using private insurance schemes to diffuse the costs of climate change impacts (Mechler *et al*., 2007). This option may be of particular interest to low- to middle-income countries where public insurance often falls far short of covering costs of climate-related disasters. In Venezuela, for instance, insurance covered less than 2% of the costs of floods in 1999 (Charvériat, 2000). Similarly, there have been efforts to form coalitions of high-risk individuals to reduce vulnerability by pooling resources for common goods, which may improve provisions for water sanitation services and sewer drainage (Satterthwaite *et al.*, 2007).

The necessary collaboration among disciplines and the systems approach to urban infrastructure offers a chance to tackle multiple problems at once (*e.g.*, development and adaptation to climate change). The challenges of water in the urban environment can afford an opportunity to combine programs and forge partnerships between public, private and nongovernmental sectors, paving the way for novel and creative ideas with the potential to address environmental, social and economic problems.

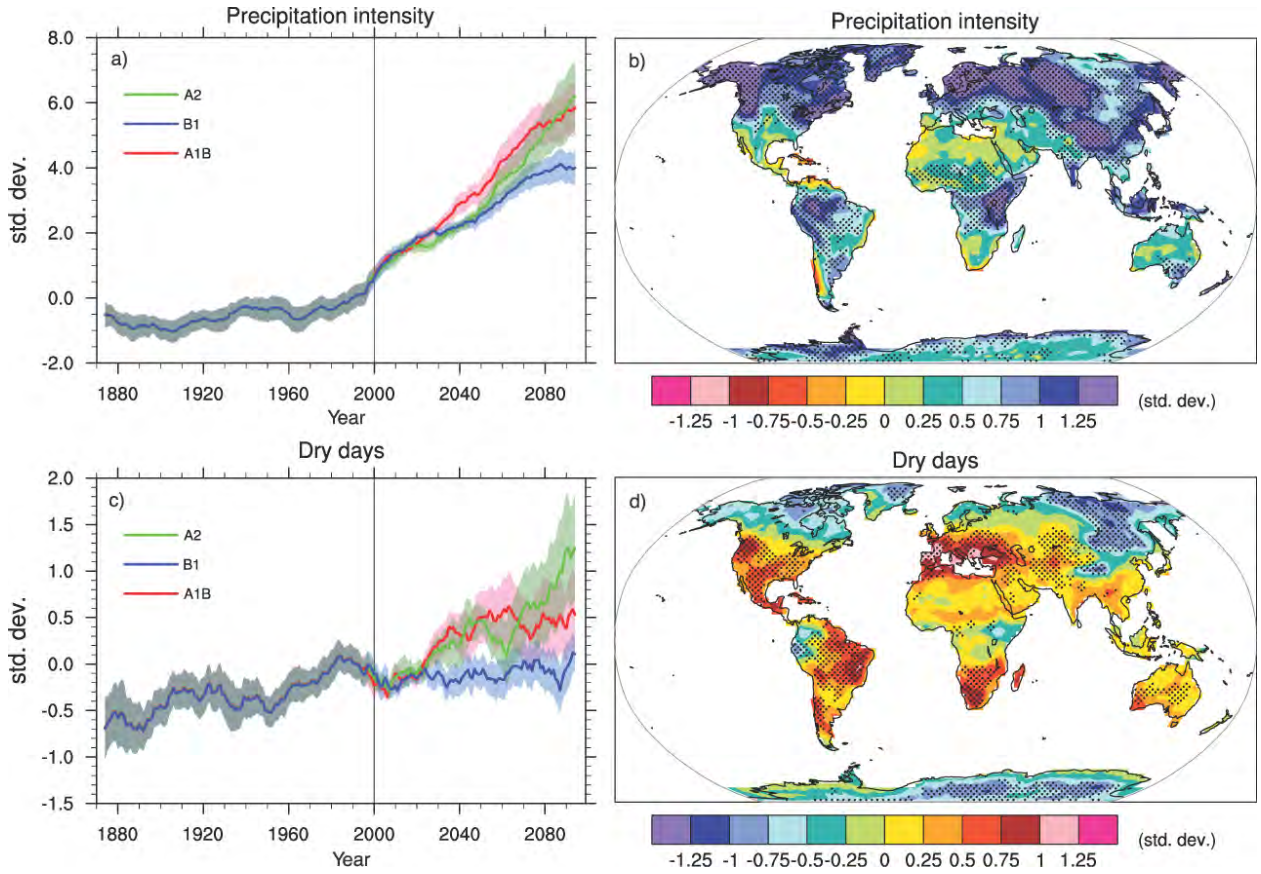
FIGURES

Figure 1. Global atmospheric, surface and oceanic temperatures have been rising from 1905-2000, with increases occurring at accelerating rates over the past 50 years



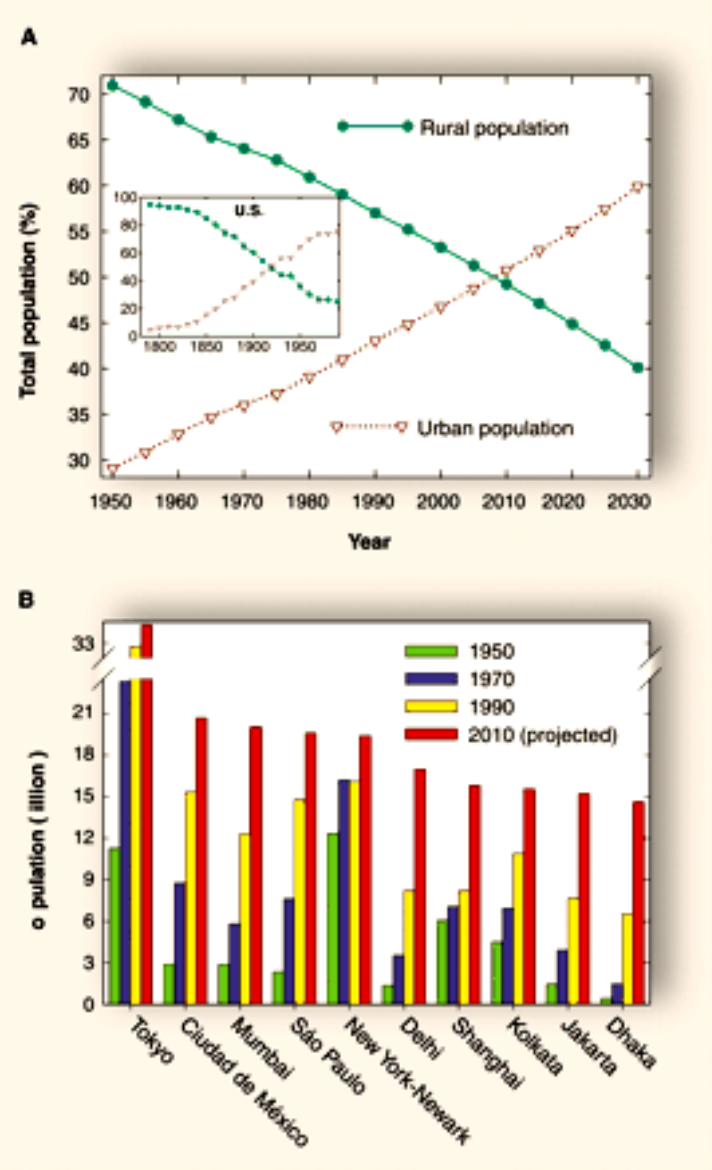
Source: IPCC (2007), *Climate Change 2007: The Physical Science Basis,* Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Figure 2. Multimodel precipitation projections through 2080 show regional variation, with a general trend of precipitation occurring in more intense bouts punctuated by more frequent dry spells, as compared with 2000 conditions



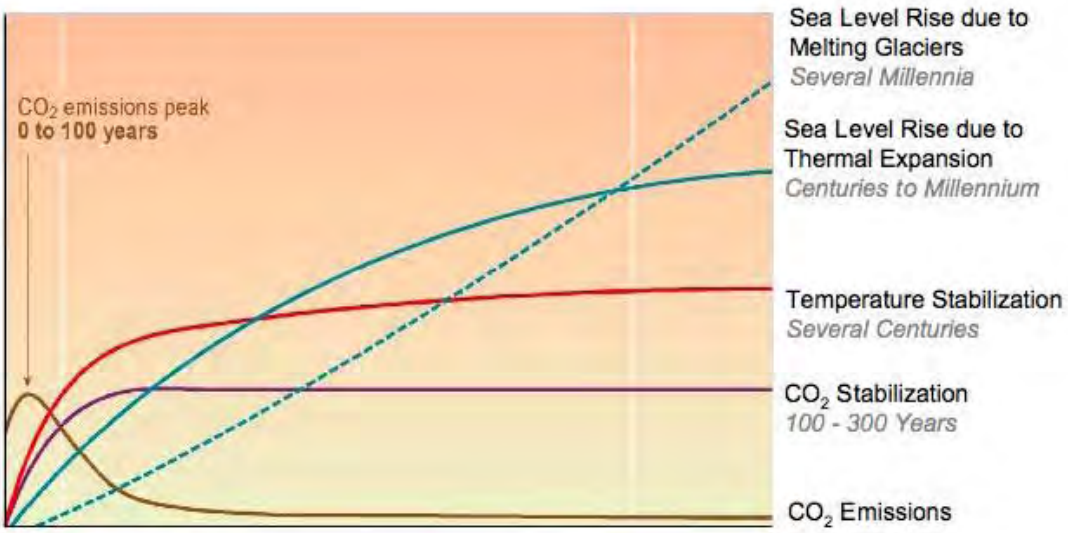
Source: IPCC (2007), *Climate Change 2007: The Physical Science Basis,* Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Figure 3. Population growth is expected to continue to occur in most major cities, with a continuing trend of rural to urban migration



Grimm, N. B. *et al* (2008), "Global Change and the Ecology of Cities", *Science,* No. 319, pp. 756-760.

Figure 4. As a result of lag effects, sea level rise is expected to continue well beyond temperature stabilization, even under a scenario of significantly reduced emissions



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CHAPTER 5:

REDUCING CO_2 EMISSIONS FROM URBAN TRAVEL: LOCAL POLICIES AND NATIONAL PLANS[1]

by Mary Crass

International Transport Forum

1. Introduction

Urban areas are vital to the economic, environmental and social future of our world. Cities in OECD and International Transport Forum countries account for approximately 80% of the population and around 90% of economic activity. But cities have also attracted a growing number of problems that can drain their economic and social vitality, many of them transport-related: congestion and gridlock on urban roads, road accidents, CO_2 emissions, poor air quality and sprawl, to name but the major ones, as well as social fractioning due to poor access to economic and social activity.

Clearly, urban travel problems are not just a concern for local government.

Making travel in cities function better so that economic and social activity can flourish without the negative side effects of travel – making travel more sustainable – has grown as a national and local priority over the last few decades.

All of these urban travel problems constitute a varied set of challenges for decision makers in urban areas. Decision-making for sustainable urban travel is an increasingly complex exercise – with no one level of government solely responsible for all aspects of urban travel policy development and implementation. Indeed, government now takes fewer and fewer policy decisions on its own: private sector companies and agencies are increasingly responsible for many aspects of public transport, road construction and management and land-use planning and development.

Climate change and transport: A national and local priority

With climate change at or near the top of most national policy agendas, increasing pressure is on cities to come up with solutions to contribute to overall climate change mitigation initiatives at a local level. A growing number of cities are making climate change a focus of policy initiatives, vying with transport issues as an area for attention. In other cities, reducing CO_2 emissions from transport is one of a wide range of objectives to improve the sustainability of urban travel, in addition to the environmental, land-use, safety and accessibility objectives listed above.

This discussion paper attempts to situate the problem of CO_2 emissions mitigation from urban travel in the context of a wider set of policy goals intended to improve the sustainability of travel in cities. It begins by briefly describing the problem of transport-CO_2 emissions, as well as policies to reduce CO_2 within the transport sector as a whole. The paper goes on in Section 4 to explore in general terms how sustainable urban travel policies can play a role in reducing CO_2 emissions. Section 5 points to a range of policy and institutional barriers that have made implementation of sustainable

urban travel policies particularly difficult, contributing to persistently high CO_2 emissions from travel in cities. The paper closes in Section 6 by proposing a certain number of good governance initiatives – agreed upon by ministers of International Transport Forum countries in 2006 – that national and local governments can take together to improve the implementation of these policies and pave a path to better, more economically, environmentally and socially sound travel in cities.

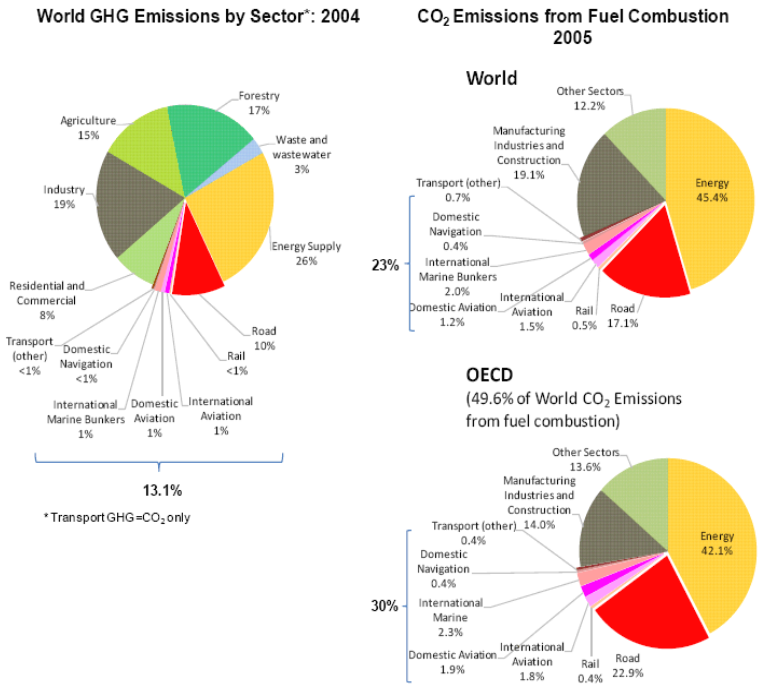
2. CO_2 emissions from transport: setting the scene[2]

Transport is a key driver of the economy: it supports economic development and growth, and facilitates exchange among countries. The transport sector is also, however, a significant and growing contributor to greenhouse gas emissions. Transport activity is responsible for 13% of all anthropogenic emissions of greenhouse gases and 23% of world CO_2 emissions from fossil fuel combustion – 30% in OECD countries. The sector is 95% dependent on oil, accounts for 60% of all oil consumption, and is therefore increasingly exposed to oil price instability and supply shocks.

In most countries, transport CO_2 emissions are growing faster than total CO_2 emissions: CO_2 emissions from fuel combustion in International Transport Forum countries grew 18% from 1990 to 2005, while transport CO_2 emissions grew by 23% over the same period. For OECD countries, these figures are 17% and 30%, respectively.

Transport activity varies greatly between countries and is growing at different rates. Car ownership, for example, varies from over 800 cars per thousand in the United States to less than 10 in India. Worldwide, car ownership is expected to triple between 2000 and 2050 (World Business Council for Sustainable Development, 2004). Projections for the future suggest continued strong growth in transport volumes in all modes, especially in non-OECD countries. Air passenger traffic is expected to be 2.5 times higher in 2025 than in 2005 (Boeing, 2007), and air cargo is expected to be three times higher in 2025 compared to 2005 (Airbus, 2007). Similarly, shipping volumes doubled from 1985 to 2007 and the fast-growing container sector is expected to triple from 2000 to 2020. Road transport accounts for by far the largest part of CO_2 emissions from the sector, and this will remain the case in the coming decades, despite more rapid growth in shipping and aviation (International Transport Forum, 2008b).

Figure 1. Transport accounts for a significant share of CO_2 emissions



Sources: CO_2 from Fuel Emissions, IEA, 2007; and National reports to the UNFCCC.

Finding the right balance between supporting the economic drivers of trade and mobility and reducing transport's energy intensity and emissions are among the top priorities on the policy agendas of most transport ministers today.

3. Policies and measures to reduce CO_2 emissions from transport

A diverse range of policy measures and instruments show potential for improving efficiency in and reducing emissions from the transport sector. These policy choices necessarily reflect the specificities of individual countries, which are approaching these problems from different starting points and under different economic, institutional, social and political circumstances.

If all measures currently proposed by countries are fully implemented, the projected growth in emissions can be reduced by over a third. Despite this, most indications are that transport emissions will increase by two-thirds over the next 30 years unless transforming technologies are developed. This presents an enormous challenge for the transport sector and calls for an urgent need for action. Studies and expert discussions show, however, that it is achievable in the long run. Meeting this challenge, moreover, will also provide promising new opportunities for business and industry (International Transport Forum, 2008a).

Focus on cost-effectiveness and energy efficiency

Research conducted in the International Transport Forum (ECMT, 2007) has affirmed that cost-effectiveness (cost per tonne of CO_2 abated) should be the fundamental factor in determining which

policies to adopt and, for example, how much the transport sector should contribute towards economy-wide abatement goals. Some of the potential measures for the transport sector have relatively low costs; others higher costs at the margin.

Whilst carbon and fuel taxes are the ideal measures for reducing CO_2 emissions because they send clear economic signals and distort the economy less than any other approach, the largest transport sector abatement opportunities emerge from measures to improve energy efficiency; these include: improving vehicle fuel efficiency and efficiency of components and accessories (tyres, lubricants and electrical components) through regulation and labelling; promotion of fuel-efficient driving (eco-driving) via driver training and feedback instrumentation; support for improved freight logistics; better use of differentiated vehicle taxes, and fuel taxes.

Key Messages of the 2008 International Transport Forum

At the 2008 International Transport Forum, Transport Ministers agreed that countries should aim to develop a broad strategic policy approach – both within and across modes and at all appropriate levels of government – to improve energy efficiency in and reduce CO_2 emissions from transport. This approach should be consistent with and contribute to economy-wide climate change mitigation plans.

The Forum's *Key Messages* call for a package of policy measures to reduce transport-related CO_2 that includes: strengthened research into new technology and fuels, increased use of information technology and integrated mobility management, as well as a wide variety of non-technology policy tools with potential to improve economic efficiency and reduce emissions.

A major component of this policy package includes measures that encourage the travel behaviour changes needed to combat climate change and simultaneously meet other objectives of transport policy. These measures include: improved organisation and telematics to optimize transport modes and their inter-linkages; and more effective use of rail, inland waterway and short sea shipping for freight transport.

They also include a number of policy initiatives that specifically address travel in urban areas:

- Enhanced public transport and rail services;
- Support for non-motorised means of travel: walking and cycling;
- Measures to manage traffic demand;
- More efficient logistics concepts;
- Continued efforts to better integrate land use and transport planning;
- Pricing mechanisms to encourage behavioural change and ensure that externalities are taken into account (International Transport Forum, 2008a).

These measures all have potential to reduce CO_2 emissions from travel activity while simultaneously serving a wider set of objectives to improve the sustainability of urban travel (*e.g.*, congestion mitigation, improved air quality, better accessibility). In this respect, they offer *co-benefits*, which while clearly essential to a robust CO_2 mitigation policy for transport, have proved to be fairly difficult to quantify in terms of their exact contributions to CO_2 abatement.

They do nevertheless constitute the core set of tools at the disposal of local decision-makers to improve urban travel sustainability and reduce CO_2 from transport. Given that the vast majority of the population in OECD and Forum countries either already lives or is moving to urban areas, an increasing proportion of transport CO_2 emissions is generated in and around cities; therefore, as stated earlier, mounting pressure is on local authorities to draw on these policy tools to mitigate the impacts of urban travel activity on climate change.

Interestingly, there remains in many countries something of a disconnect between local policy initiatives to improve the sustainability of urban travel and reduce CO_2 emissions, and national climate change mitigation strategies, which in a number of cases either overstate the role of urban travel policies in meeting national objectives (often without quantifying the actual abatement potential of these measures) or assign little importance to the CO_2 mitigation potential of local policies. This may be attributed to specific local and national division of transport policy responsibilities – addressed in Sections 5 and 6 below. In any case, some degree of better co-ordination between transport policies set at different levels of authority would appear to be beneficial.

4. Tackling CO_2 in the evolving policy package for sustainable urban travel[3]

In 1995, the OECD and the European Conference of Ministers of Transport (ECMT), which became the International Transport Forum in 2007, together developed an integrated strategy for tackling a wide range of urban travel problems, including CO_2 emissions from transport (ECMT, 1995). In their report, the ECMT and OECD identified a wide range of possible policy solutions to urban transport problems, and stressed that a combined package of regulatory, pricing and technology measures, co-ordinated across modes, is needed to send the right signals to urban land use and transport markets.

Over the decade-plus since the 1995 report, a number of new policy instruments have emerged as important in the urban travel policy package, while others have met with less interest. Technological improvements to vehicles and fuels have helped reduce air quality problems and increase energy efficiency, and are seen as a key contributor to the reduction of greenhouse gases. However, it is clear that they will not, on their own, solve the environmental problems of urban transport. Total travel is still growing, and while cars have become more fuel-efficient, there is also a persistent trend towards larger and more powerful vehicles. Recent high energy prices have for the first time reversed this trend in some countries – notably the United States; however, this change may only be temporary.

While new transport infrastructure continues to have a place in overall policy, more emphasis has been placed on the need for cost-effective design and consistency with wider policy objectives. There has been a growing focus on better management of existing road and public transport networks in order to improve their quality and reliability. An increasing role for the private sector is likely as financing opportunities have tightened. to improve efficiency and encourage innovation.

Information provision is being used to greater effect. Information technology is now used more widely to support the needs of users, operators and network managers, while education, awareness and better co-operation have emerged as particularly promising means of encouraging individuals and firms to better manage or reduce their demands on the transport system.

Finally, the application of pricing schemes has received a substantial boost with the successful introduction of congestion charging in London and Stockholm, but how to transfer this experience to other urban areas – a question long asked about the much observed and prolifically documented road pricing scheme in Singapore – is not obvious.

Despite the growing number of policy instruments at their disposal, governments still place too much reliance on the supply-side measures of infrastructure and technology and too little on management, regulation, information and pricing. In cities that are at an earlier stage of motorisation, more emphasis on cost-effective transport demand management measures seems important. However, information on the performance of many of these demand-side measures remains limited.

Above all, further work within the Forum has re-emphasised the need for an integrated package of mutually reinforcing policies and measures that will help cities move toward sustainability. Effective urban public transport operations require an appropriate combination of service improvements, better management of the road network, improved information for users, appropriate fare structures and stronger price signals to car users. Benefits from promotion of non-motorised means of travel (cycling and walking) can only be realised when they are considered to be integral parts of the policy package – linked, for example, with improvements to public transport and the road network – rather than being relegated to the margins of urban travel policy as policy afterthoughts. Congestion charging in London has worked well precisely because it was combined with improvements in management of the road network and substantial enhancements in bus service.

5. Implementing urban travel policies: the bumpy road to sustainability

It is clear from the evidence outlined above that progress has been made in improving the sustainability of urban travel. Transport authorities, service and infrastructure providers throughout OECD and Forum countries have recognised that their problems are no longer just transport-related – that environment, spatial development and road safety impacts, for example, must be taken on board in policy-making. This has meant that the processes for decision-making have become more multi-sectoral, and that the analytical and methodological tools have been adapted to meet the needs of this increasingly complex decision-making environment.

But ensuring that integrated decision-making is a practice that works is a persistent challenge in most countries. Integration of spatial and transport planning, for example, widely acknowledged as essential to ensure sustainable development of urban areas, remains a remote objective for many cities. Urban transport planners and spatial planners still largely have difficulty finding a common language. even when policy and institutional structures are designed to promote and accommodate this interaction.

In its work on implementing sustainable urban travel policies, the Forum has identified a number institutional and policy barriers.

First, institutional weaknesses include lack of a national policy framework for improving urban travel; excessive or incomplete decentralisation; poor policy integration and co-ordination, and counterproductive allocation of responsibilities. Legal and regulatory barriers include a lack of enabling legislation for new policy instruments such as pricing, inconsistent fiscal frameworks and ineffective controls on the performance of private sector transport service providers. Financial barriers include limited budgets and inappropriate restrictions on the ways in which these limited funds can be used. Finally, many policy instruments have yet to be accepted whole-heartedly by the public and the media, leading all too often to insufficient political commitment.

Other barriers relate to the *process* by which sustainable urban transport strategies are developed and implemented, including: a lack of clear policy objectives; incomplete or inconsistent ex-ante policy appraisal, often concentrating exclusively on economic rather than on environmental and social impacts, and with different appraisal methods for different types of solution; likewise, incomplete or

inconsistent monitoring and ex-post evaluation of the impact of policies. Key to the whole process of strategy development is the persistent lack of consistent, coherent urban travel data.

Many of these barriers persist in many countries and must be overcome if effective sustainable urban travel policies are to be implemented.

Decentralising urban travel policy

There has been a clear trend towards greater decentralisation of responsibilities for urban transport, with, for example, the Netherlands gradually transferring more responsibility and financial control from national government to cities since the late 1990s, and more recently, France devolving responsibility for urban public transport to its regional and local authorities.

Clearly, decentralisation plans such as these make sense in that they are designed to situate decision-making for managing car travel and public transport provision at the local level, where its impact is best understood. Problems can arise, however, when decentralisation is excessive or incomplete. This has been the case in a number of countries, notably (if not exclusively) several of those that underwent economic transition in the early 1990s, such as Hungary and Poland. Hungary, for example, found that too rapid a devolution of power left the central government unable to define a co-ordinated framework for urban transport, and local areas without commensurate resources to assume their new responsibilities (ECMT, 2004).

6. Making the national-local link for CO_2 abatement from urban travel

So in light of these policy and institutional barriers to implementing sustainable urban travel policies and measures, what specifically can national governments do to facilitate coherent, efficient implementation?

Following are some of the key findings of the work on implementation of sustainable urban travel policies undertaken to answer that question in the Forum and its predecessor, ECMT, over the last decade (ECMT, 2006).

A supportive national policy framework

This remains an essential requirement if cities are to be able to introduce sustainable urban transport policies – particularly if these policies are to serve as important elements of a national CO_2 abatement strategy. National governments need to establish a high-level vision and goals for urban transport. This will provide a context for local government, which must be enabled to use the full range of policy instruments identified earlier in this paper. It will also help to ensure coherence among approaches taken by individual cities. National government also needs to employ policy levers such as taxation in ways that are consistent with its vision for urban travel. Finally, local governments need guidance on good practice and encouragement to enhance their performance.

Improved institutional co-ordination and co-operation

Horizontal co-ordination

There is a pressing need at the national level for greater collaboration between the transport ministry and others (such as finance, planning, environment and industry ministries) that influence transport. The implementation barriers arising from inconsistent CO_2 abatement policies at a national

level are numerous, and ideally all ministries need to adopt a common policy approach to transport, which should be articulated by the Transport Ministry.

At regional and local levels, similar horizontal co-ordination is needed. One authority should preferably have responsibility for the full set of policy instruments, which can help achieve sustainability so that integrated packages can be effectively implemented.

Despite widespread agreement that spatial and transport planning need to be co-ordinated to ensure sustainable development for urban areas, it remains a remote objective for many cities. Urban transport planners and spatial planners still largely have difficulty finding a "common language," even when policy and institutional structures are designed to promote and accommodate this interaction. And with the other sustainability imperatives cited above (health, education and social inclusion, etc.) the integration task has become more complex.

Again, ideally, transport policies in the larger cities should be planned by one body for the whole travel-to-work area. Where this is not feasible, spatial co-ordination between adjacent authorities must be facilitated. Many types of regional or agglomeration-level transport authorities exist (*e.g.*, the "*autorités organisatrices*" in France, and the Metropolitan Planning Authorities in the United States) but in most cases are given authority only over transport planning, not control over land use.

Vertical co-ordination

Effective vertical co-ordination among the tiers of government is also essential. National, regional and local government must have common goals and objectives, with each providing a context for the next. National governments can achieve more by decentralising responsibility to lower tiers, but need to provide the necessary financial and advisory support and encourage collaboration. The decentralisation process undertaken in the Netherlands in the late 1990s and clarified for the transport sector in the recently promulgated National Mobility Policy Document is an example of how this can be done (ECMT, 2001). Research in the Forum has shown that organising and financing urban public transport is more efficient when the main responsibility for any one policy instrument is allocated to one tier of government.

Public/private sector co-ordination

Finally, clear co-ordination between the public and private sectors is needed, both in terms of investment in new transport facilities and in the provision of services. And single agencies responsible for the strategic planning and tactical development of all aspects of public transport can help, even if operations are split between several public or private entities.

Effective public participation, partnerships and communication

Public involvement must be encouraged throughout the policy process: from the identification of problems, through articulation of possible solutions, to acceptance of preferred strategies and support for their implementation.

Public consultation is not, however, always an easy undertaking. The London congestion charging experience demonstrates the value of preparing users for the introduction of new and controversial measures.

The media play an increasingly important role in influencing public acceptance, and public authorities need to fully engage with them to articulate a clear understanding of problems and the case for preferred solutions.

Another message emerging from the experience in London is that while public preparation was indispensable to the successful launch of the scheme, a clear political champion, embodied in the Mayor, was equally crucial to the scheme's early success. Political commitment at the mayoral level – observed perhaps most strikingly in the now-famous example from the 1970s of Curitiba, Brazil – has also been an important factor in the implementation of major changes to the public transport network in Paris – particularly the construction of exclusive bus lanes, as well as the extension of the tramway system.

These examples illustrate that strong political commitment is often a deciding factor in the success of policies designed to significantly change urban travel patterns.

A supportive legal and regulatory framework

Many countries have enacted strong legislation and regulation to support local implementation of urban travel policies and measures – particularly as concerns the organisation and financing of urban public transport.

In some cases, however, legislation is still needed to enable local government to apply certain types of policy instrument, particularly certain demand-management measures. In the United States, recent changes to transport legislation have made certain types of road pricing more feasible. Moscow has been challenged with difficulties in formulating strategies to manage demand where legislation is limited. The Japanese experience demonstrates how a highly de-regulated environment for public transport can function quite well under certain circumstances, though effecting improvements to the system may be more difficult, as policy levers are largely out of public hands.

Regulation needs to be consistent across transport modes and tiers of government. In particular, as mentioned earlier, there seems to be a clear case for some degree of competition in public transport – defined in a regulatory framework – whereby public agencies determine strategy and tactical planning of services, fares and information, and provide the context within which the private sector competes for the provision of efficient, high-quality services. One continuing challenge is the need to encourage and support innovation where services are procured through contracts with private operators.

A message emerging from the Forum's work on this topic is the importance not just of effective regulations but of effective enforcement of those regulations. All too often, controls on operators and users are made less effective by failure to devote resources to enforcement. This is particularly true, for example, with restrictive parking, speed limit and traffic calming schemes, which have limited effect if they are not backed up by robust enforcement measures. There is a strong case for involving interior ministries directly in this aspect of transport policy.

A comprehensive pricing and fiscal structure

A comprehensive pricing policy should include measures addressing public transport fares, parking charges and possibly charges for road use. The valuable role that direct pricing of road use can play for managing traffic congestion and raising revenues for public transport has been shown in London's charging scheme. This then set a challenge for governments to decide how widely such measures can be applied. At the same time, there is a need for greater clarity in the setting of fares,

with subsidies focused on those people in particular need, and more flexible pricing approaches, in order to encourage public transport use. Overall, pricing needs to be consistent across transport modes, with charges approaching the marginal costs of travel.

Rationalised financing and investment streams

Devolved financing needs to accompany devolved responsibilities, with governments providing finance that is secure in the longer term and providing flexibility in the use of those finances. Finance, and the appraisal processes that support it, needs to be carried out in a consistent way across all modes and types of policy instrument. Since budgets will continue to be constrained, greater emphasis needs to be placed on the most cost-effective solutions; the U.S. planning framework stresses the importance of financial realism in strategy development. There remains a case for identifying new sources of financial support, whether from hypothecation of charges for road use or from value capture from those whose property values rise as a result of transport investment.

Improved data collection, monitoring and research

Better urban transport data collection and monitoring involves identifying the types of data that are needed at each of the stages of the policy definition and implementation process; improving standards of collection; providing the finance to support data collection, and ensuring that the data collected, particularly by the private sector, is readily available for public use. Regular monitoring to understand trends and identify emerging problems is essential, as is benchmarking to help cities learn from one another and enhance their own performance. Finally, more consistent evaluation of new or innovative policy instruments is needed so that cities are able to learn from specific successes and failures. In particular, national governments can help to promote development of competence and skills among agencies responsible for regular data collection and monitoring.

Support for appraisal, monitoring and evaluation processes

Governments have a role to play – whether through technical, budgetary, or other means of support – in facilitating the development, appraisal, monitoring and evaluation process of integrated urban travel strategies at local or regional levels. Improvements to urban travel strategy development should then be monitored and evaluated to ensure the impact of this support.

Conclusion

The above recommendations have shown themselves through Forum research to be essential factors in the pursuit of transport sustainability in urban areas. With different starting points in countries shaped by a variety of factors – notably, decision-making structure, level of economic development, and size and density of urban areas relative to the country as a whole – there will clearly be no one approach to improving urban travel among OECD and Forum countries. The messages carried forward to governments in these recommendations, however, may provide insights into ways local and national authorities can identify and implement policies to reduce the impact of urban travel on climate change, and more generally, pursue together efficient, realistic, manageable strategies to improve the sustainability of travel in cities.

ENDNOTES

1. Disclaimer: The views expressed in this paper are those of the author and do not necessarily represent the views or policy of the International Transport Forum or of its individual member countries.

2. The theme of the recently held 2008 International Transport Forum's was Transport for Energy: The Challenge of Climate Change. At the Forum, Ministers of Transport agreed to a broad set of key messages based on a set of research findings from which this section is drawn. Both the Key Messages and the Research Findings can be found at *www.internationaltransportforum.org/Topics/forum2008.html*.

3. Information in Sections 4, 5 and 6 is drawn from ECMT (2006).

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CHAPTER 6:

CITIES AND ENERGY[1]

by Nigel Jollands

International Energy Agency

Washing lines are causing a stir in North America. Rather than use their clothes dryers, some residents have taken to trying to save energy and reduce CO_2 emissions by hanging their laundry to dry in the backyard. Unfortunately, often local ordinances prohibit outdoor clothes lines as eyesores. The washing line ban is just a small example of how local planning rules and city governments can and do influence their city's energy use. From washing lines to the way that city energy and transport infrastructure is laid out, city governments can play a significant role in influencing the energy use of city residents. This paper explores the rationale for why cities, their governments and their energy use patterns should be the focus of considerable attention. In doing so, the paper addresses three critical questions:

What is the potential for cities to mitigate energy-related CO_2 emissions?

What are the obstacles to greater action by city governments?

What action is needed, by whom?

Introduction

Washing lines have been causing a stir in North America (Carpenter, 2007; Lofholm, 2007; Rosenthal 2008). Rather than use their clothes dryers, some residents have taken to trying to save energy and reduce CO_2 emissions by hanging their laundry to dry in the backyard. Unfortunately, often the local ordinances prohibit outdoor clothes lines as eyesores. As a result, some people are trying to get these clothes-line bans declared an illegal barrier to conservation under provincial law (Rosenthal, 2008).

The washing line ban is just a small example of how local planning rules and city governments can influence their city's energy use. From washing lines to the way that city energy and transport infrastructure is laid out, city governments can play a significant role in influencing the energy use of city residents. The purpose of this paper is to:

- Outline the rationale for focusing on city energy use;
- Outline the potential for cities to mitigate energy-related CO_2 emissions;
- Investigate the obstacles to greater action by city governments in energy management;
- Identify actions that cities and other actors can take to address climate change.

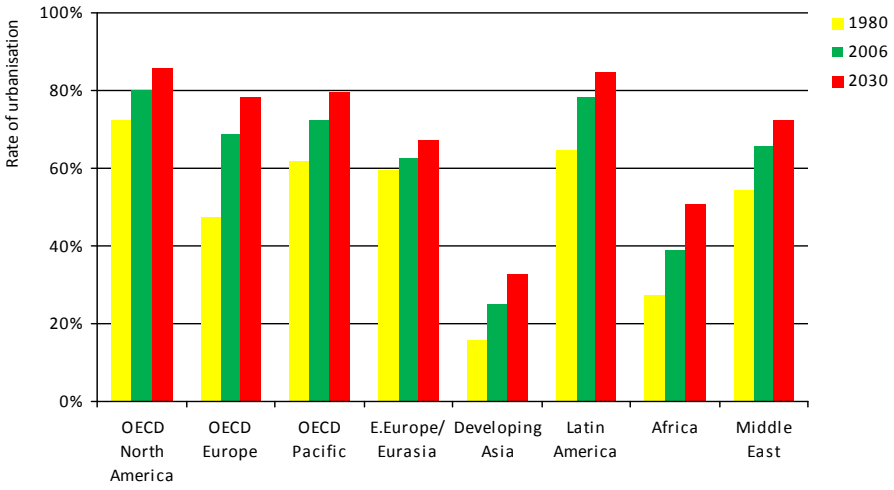
Why focus on cities and energy?

There are several compelling reasons why cities and their energy-use patterns should be the focus of considerable attention.

First, cities use a significant proportion of the world's energy. In today's world, cities are a dynamic and vital part of global culture and are the main engines of social, economic and technological development. But to provide their populations with services, cities need energy – lots of it – and much of it is fossil-fuel based. The Tokyo metropolitan area, for example, with a population exceeding 12 million people, consumed approximately 20 Mtoe – equivalent to the total annual energy supply of Bulgaria (International Energy Agency, 2007). Globally, cities today are estimated to consume between 60% to 80% commercial energy.

As urban population, economic activity and wealth increase, urban energy use is projected to grow rapidly. In 2008, half of the world's population lives in cities (see Figure 1). By 2030, cities will house 60% of the world's population – equivalent to the total global population in 1987. At the same time, the geographic distribution of urban population is changing: while global urbanisation in the first half of the 20th century was dominated by European cities, currently most urban population resides in the Asian continent, and some of the fastest-growing cities are found in the African continent. As cities grow, so too does city energy use.

Figure 1. Trends in global urbanisation



Source: United Nations Population Division (2007), *World Population Prospects: The 2006 Revision*, United Nations, New York and United Nations Population Division (2007), *World Urbanization Prospects: The 2007 Revision*, United Nations, New York.

Cities are likely to account for an increasingly large proportion of global energy use and CO_2 emissions. This is mainly driven by the rapid changes in cities in emerging and developing countries – both because of their urban population growth (the bulk of the world's population growth by 2030 is forecast to be in cities of developing and emerging countries) and because cities in these countries are a source of increasing economic activity. This increased economic activity requires growing energy use. In addition, as developing countries urbanise, they tend to shift from CO_2-neutral energy sources

(biomass and waste) to CO_2-intensive energy sources. As a result, there is potential for a trend towards an increasing global proportion of CO_2 emissions from cities.

Characteristics of city authorities (CAs) themselves provide a second rationale for engaging cities in energy management and climate change mitigation. Through their direct energy use, regulatory powers, capital works programmes and property management, community services and experience with translating national and international policy into action, CAs are actively involved directly and indirectly in energy management and climate change mitigation. CAs are significant energy users in their own right. For example, Sydney's local government spent around AUD 53 million on energy in 2006 to provide urban services for its population of 4.3 million people (ICLEI, 2007). CAs are significant owners and managers of energy-related capital infrastructure, including buildings, recreation facilities, transport fleets and energy distribution networks.

Through their regulatory functions, CAs also have a profound indirect influence over a city's overall energy use. This influence is principally through urban planning functions and their consequent impact on urban form and transport infrastructure. Many city governments can also levy rates and charges and to some extent provide incentives and disincentives for energy use through pricing policies.

Finally, CAs have had considerable experience in engaging with issues of sustainable development and attempting to translate global and national targets into local practice. For example, CAs are generally responsible for implementing national energy efficiency requirements in building codes. This experience means that many CAs are well placed to assist with sustainable energy and climate change mitigation strategies.

What is the potential for cities to mitigate energy-related CO_2 emissions?

Cities have significant energy and CO_2 savings potential. If one considers the range of policies and measures available to a country to reduce emissions, around two-thirds of the total global energy savings could occur in cities. Moreover, cities could go further than these national savings because many policy options to reduce energy consumption and decrease CO_2 emissions are under the authority of local governments.

City governments can also influence city energy use, both directly and indirectly. Through its provision of services (sanitation, water provision, public transport, etc.), local government consumes energy directly. Estimates of the proportion of city energy consumed by local government range from between 1% to 5% (for example, in New Zealand and France) to 16% (in countries like Austria) of total city energy use (International Energy Agency, 2008). Local government also has a significant indirect impact on energy use in cities. For example, local governments are typically responsible for enforcing energy-efficiency requirements in building codes. They also set land use and planning rules that have a profound influence on city layout and, among other things, transport energy use. Little information is available on the actual scale of local governments' indirect influence on city energy use. However, Lumb (1994) suggests that local governments can influence up to a quarter of city energy use.

Energy-saving potential varies between cities, reflecting their particular geographic setting and biophysical resource and infrastructure endowment (including industrial structure) and their social environment in terms of policy and institutional framing conditions. Of equal importance is the availability of a skilled workforce, public/private partnerships and networks with other cities. Despite the different contexts, policy challenges and the many demands on local government resources, there

are numerous examples around the world of local governments using policies to save energy (see Table 1).

Table 1. City energy and CO_2 savings examples

City	Sector	Description of Programme	Savings
Jakarta, Indonesia, and Bogotá, Colombia	Transport	Introduction of bus rapid transport system	120 000 tonnes CO_2 (Jakarta) and 287 000 tonnes CO_2 (Bogotá) annually
Barcelona, Spain, and Paris, France	Transport	Bicycle hire scheme	960 tonnes CO_2 in the first six months in Barcelona
Seoul, Korea, and London, England	Transport	Congestion fees	Between 10%-20% CO_2 emissions
Oslo, Norway, and Vaxjö, Sweden	Transport	LEDs for traffic signals and public lighting	Between 50%-70% of street lighting CO_2 emissions
Mexico City, Mexico	Transport	Replacement of old taxis with more efficient ones	665 000 of CO_2 annually
Kotka, Finland	Buildings	Combined Heat and Power (CHP) plant for district heating	390 000 tonnes of CO_2, or 30% of total city emissions
The Hague, Netherlands	Buildings	Seawater central supply unit	4 000 tonnes CO_2 annually
Sao Paulo, Brazil	Buildings	Landfill methane gas thermal plant	730 000 tonnes of GHG annually
Tokyo, Japan	Buildings	Energy Conservation Specifications – more stringent building specifications	30% of building CO_2 emissions annually
Berkeley, US	Buildings	Buildings standards exceeding state level	13% energy consumption annually
Alameda, US	Transport/ renewables	Alternative-fuel public transport vehicles	5 654 tonnes CO_2 annually
Calgary, Canada	Transport/ renewables	Light rail public transport system powered by wind-generated electricity	26 000 tons of CO_2 emissions annually
Copenhagen, Denmark	District heating	Using waste heat from incineration plants and CHP plants	665 000 tonnes of CO_2 annually
Rizhao, China	Renewables	Solar water heaters for households, traffic and street lights powered by solar cells	18 000 tonnes of CO_2 annually

Source: C40 website (*www.c40cities.org*), and other sources.

What are the obstacles to greater action by city governments?

Despite the initiatives that many cities have undertaken, there are several critical observations that can be made. First, only a relatively small proportion of all cities are active in pursuing CO_2 mitigation policies. Second, it appears there is still scope to fully mainstream climate change into day-to-day action. A large number of single actions are taken without being fully embedded in broader government operations. Finally, several policy areas have not been fully exploited. The use of urban and land use planning to address climate change is one example where local governments could make further progress.

There appear to be a range of obstacles to more widespread city-based energy initiatives. These obstacles include those external to the local government, such as the lack of acknowledgement,

encouragement and clear national-level guidance on climate change for local governments, as well as the lack of energy and climate change policy competence delegated to local governments.

There are also significant internal obstacles, including the presence of many competing demands for the local government's limited resources (both financial and staffing); the tension between short re-election periods and long-term infrastructure challenges; institutional barriers such as inflexible budgetary structures and lack of cross–departmental collaboration; the lack of co-operation beyond city borders; and the difficulty in measuring achievements. The lack of resources is often regarded as one of the most critical internal obstacles. This problem is exacerbated when, in some situations, local governments are expected to contribute to achieving the national CO_2 abatement target without being provided the necessary additional resources.

These barriers are diverse and complex. The next section outlines a series of critical next steps for cities to capture the significant CO_2 mitigation potential.

What is needed?

General actions

In general, cities can do three things immediately to achieve CO_2 savings and to tap into the co-benefits of energy security and environmental policies. Cities and their governments can:

- Implement measures that are both local priorities and that mitigate CO_2 emissions without imposing additional costs (such as energy efficiency, district heating or cooling, etc).

- Enable the implementation of those CO_2-mitigating measures that are of lower priority due to resource constraints by making use of international financial mechanisms and, Kyoto mechanisms and international carbon markets.

- Discourage measures that are high local priorities but are detrimental to CO_2 emission levels, for example, the construction of expressways and highways without restraining cars or improving public mass transport systems.

A starting point for many local government climate change actions is optimising their own facilities through energy management and strategic investment, campaigns to raise awareness in the private sector and working with citizens and businesses. These are areas of work every local government can tackle, regardless of their specific legal and financial framework.

Actions in four specific areas

In addition, there are four key areas where local governments can have significant policy influence and achieve energy savings. Cities can encourage the use of integrated energy production technology, such as combined cooling, heat and power (CCHP). Energy demand for space and water heating and cooling often exceeds two-thirds of building energy demand and can be significantly reduced through CCHP technology. The density of demand for energy services in cities provides economies of scale (less infrastructure unit cost *per capita*) as well as additional energy savings due to minimised transmission and distribution losses.

Passenger transport is another sector in which local government can have some influence. In particular, local governments have some influence over transport modes used for short trips. The provision of safe pedestrian and bicycle routes can encourage residents to use these transport modes in

preference to passenger vehicles. Other steps local governments can take include the use of land use and planning, measures such as low-emission zones, congestion charges, and improvements to make public transport more attractive.

Local governments can also influence the efficiency of energy use in buildings. In particular, local governments are instrumental in enforcing the energy components of building codes. In established urban areas, a typical rate of housing stock turnover is 1% to 2%, so the benefit accrues very slowly but over a long period of time. A far greater benefit is available in newly developed urban areas, but the trend toward larger houses has prevented any reduction in total energy use so far.

In the United Kingdom, about 100 local authorities have either fully adopted or at least included in policy drafts the participating in the "Merton rule", which requires new buildings over a certain size and major refurbishments to achieve at least 10% greenhouse gas reductions through on-site generation of electricity from renewable sources. Electricity production and heat generation in buildings can also be regulated through planning laws: Barcelona is widely recognised for introducing a Solar Thermal Ordinance, a law requiring 60% of hot water supply to be met through solar thermal collectors. This approach was later adopted in a less stringent form in the national building codes of Spain.

Co-ordinated action

In addition to work on specific sectors, local governments can achieve significant savings through co-ordinated action. Cities can begin by pooling purchasing power. For example, the C40 energy-efficient buildings initiative has led to several agreements for the collective purchase of energy-efficient products. At the second Summit of the C40 cities in 2007, 16 cities signed a USD 5 billion programme to improve the energy efficiency of buildings, starting with public buildings.

Cities can also pool resources and know-how to reduce policy development costs. For example, several city associations have developed methodologies and tools that can assist local governments to develop greenhouse gas reduction strategies (*e.g.*, ICLEI's milestones approach, and Climate Alliance's climate compass).

Another realm of action is urban design and spatial planning for an energy-efficient city. Research suggests that changes in urban design can have a profound and long-term effect on energy consumption. Cities need to consider using tools such as mixed-use zoning, "permeable" street patterns, densification, etc., to address energy and climate change issues. In these areas, cities have unique responsibilities and opportunities to tap CO_2 reduction potentials.

At the national level

There is an urgent need for many national governments to provide guidance to local governments on how to address climate change and related energy issues. This guidance can range from providing clear legal requirements to relatively indirect approaches such as guidebooks, etc.

One option is for national governments to establish a legal framework requiring local governments to take climate change actions. Past experience with such requirements for local energy plans shows these requirements have mixed results, depending on whether local governments have the technical skills to plan for climate protection and the financial means to implement programmes that go beyond business as usual. This makes the need for guidance and technical assistance important.

Some national governments have already started to provide guidelines for local climate policy. Examples include Germany's guidebook on local climate protection (Kern *et al.*, 2005), and Austria's Klima:aktiv programme (Austrian Energy Agency, 2008). In the United Kingdom, urban planning guidelines have been published by the national government, recommending that local governments make provisions to address climate change.

City energy use data collection could also benefit from co-ordinated guidance. Identifying policy options and evaluating their potential impact requires much more comprehensive and systematic data collection on city energy use. Greenhouse gas emissions inventories for cities are a good first step, but they need to be standardised and complemented by protocols for monitoring emissions reductions and gains in energy efficiency.

Another approach to encouraging local initiative is to provide local governments with additional funding targeted directly at climate change mitigation. The most far-reaching funding framework exists in the Netherlands: The *Klimaatcovenant*, a multi-level arrangement involving local government, provinces and several ministries at the national level (Netherlands Ministry of Housing, 2006). Funds will include EUR 37 million of subsidies between 2008 and 2011. Important features require that a city that receives funding has to present a comprehensive action plan based on a common methodology (Climate Menu), and that the funding is not related to projects, but a specific amount per inhabitant or land area that can be used for any part of the costs related to implementing the plan. Other promising funding initiatives for local governments are in the United States (as part of the 2007 Energy Independence and Security Act, Congress established the Energy Efficiency and Conservation Block grant program, a USD 2 billion per year pool of funds for cities and counties) and the various voluntary carbon markets being established around the United States.

Local governments and the UN climate process

Another potential avenue for enhancing local government action in climate change mitigation is encouraging greater local government participation in international climate change policy processes (Climate Alliance and Energie-Cités, 2002). Such involvement can provide cities/local governments with recognition of the value of their on-the-ground policy experience. In addition, it is important to distinguish between actions relevant to cities in developed and developing countries, and action relevant to all cities. In the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol processes, local governments currently play a minor role, and the visibility of local-government actions is limited.

Except for some governments that invite selected cities in their delegations, the role of local and regional governments is restricted to observers. Within the large group of non-governmental organisations, local governments have their own constituency, Local Government and Municipal Authorities (LGMA), providing them with opportunities for certain interventions and consultations. There has been lobbying for a stronger role of local government in the UNFCCC process, arguing that city networks are not non-governmental, but rather local government organisations. As such, their members, as elected bodies, have strong legitimacy and the powers to provide substantial contributions to the objectives of the Convention and the Kyoto Protocol.]

Local governments and their activities could be given greater visibility and recognition in the UN process. This can be achieved in at least three ways. As a first step, national governments could invite local and regional representatives in their national delegations. This would provide delegations the opportunity to draw on the on-the-ground experience of local governments in climate change mitigation action. Second, a range of topics ranging from local climate policy, options for national governments to promote local action, and models of multi-level arrangements could be considered at

thematic workshops on mitigation and adaptation in the UN process. However, a word of caution is needed. If participation in the UN climate process is to be extended to local governments, it needs to be done in a way that does not hinder an already complex process involving 198 parties.

A third approach is to include local and regional activities in national communications. The Guidelines both for Annex I and Non-Annex I National Communications under the Convention allow for the reporting on subnational policies and measures. While some countries already do this, local actions are not presented in a structured way. Since it is not practical to mention every policy and measure undertaken by subnational governments, it would be helpful to define a standard format and agree on guidelines for reporting on subnational action, and for allocating funding for developing countries to report on regional and local action. Furthermore, the UNFCCC Secretariat could place more emphasis on this level of action in their assessments of national reports, *e.g.*, within their in-depth reviews of national communications of Annex I countries, and include a section on local and regional actions in their Compilation and Synthesis Reports. A reporting template could include the number and role of local and regional governments within the state, a survey and an assessment of local climate policy (*e.g.*, main areas of work, percentage of active local governments in relation to defined activity levels, measurable results), national actions to promote, support and guide local climate change policies and programmes, and multi-level arrangements, if they are in place.

In some situations, local governments can participate in the Kyoto mechanisms, which have established a global carbon market, and related regional schemes such as the EU Emission Trading Scheme (ETS). For example, European local governments that directly or indirectly own power stations above the threshold level (through owning or holding shares of local utilities) can participate in the ETS.

Also, local governments can take part in other aspects of the carbon market. For the moment, they can invest in Joint Implementation and Clean Development Mechanism (CDM) or host JI projects (if they are in an Annex I country) or host CDM projects (if in a Non-Annex I country). For example, the ICLEI network is encouraging its members to participate, and is promoting some CDM projects (*e.g.*, in Indian cities). Furthermore, in some European countries, there are efforts to involve local governments in the carbon market (such as Italy and France) and to this end, allow for domestic projects. However, project-based mechanisms provide incentives only for individual projects, thereby failing to stimulate a process of mainstreaming of climate policy into the local policy (although programmatic CDM could, in the future, go some way to addressing this problem).

A crucial question is whether it is appropriate to allocate quantitative emission targets to local governments (the same issue concerns other sectors with devolved targets). This may not be effective or practical, since relatively small changes at the country level – like a plant's closure or opening – can have disproportionate impacts on a local government's reported emissions. Such targets may also be too limiting for a city's development in terms of population and economy. Moreover, there is a problem of quantification, since for smaller geographical units, the effect of transborder activities (*e.g.*, traffic crossing the city borders and "imported" electricity) can be substantial. One way around these problems could be to only allocate local government emission targets for infrastructure under their control – for example, targets for local-government-owned electricity generation.

There is a similarity between cities as part of the national system and developing countries as part of the global system. Thus, it might be possible to learn from, adapt, or even in some cases, apply the schemes that have been proposed at the international level to involve developing countries to cities in these countries.

One option could be to directly involve large cities in developing countries into the sustainable development policies and measures (SD-PAMs) approach. As for cities in developing countries, there could be arrangements between national and local governments, possibly within an international framework. A local governments' SD-PAMs scheme would rely on a discrete list of policy measures that countries could commit to, some of which would be implemented at the local level. The discrete set of SD-PAMs would need to emphasise actions where local governments have a unique role (fields of action that can exclusively be covered by local governments), such as urban planning, local transport, district heating, sitting of renewable energy installations, etc., and actions which are complementary to national action, such as implementing standards and ensuring compliance. They could also include adaptation measures at the local level, in particular measures to improve resilience.

Based on such a set of actions, individual local governments could then put together their climate action programmes and pledge to implement the actions, with the possibility for cities in developing countries to seek international assistance and funding, as envisaged under Article 1.b.ii of the Bali Action Plan.

Conclusion

Cities and their governments can play a crucial role in helping to address the climate change challenge and achieve a sustainable energy future. Many cities have already risen to the challenge and have demonstrated that they can deliver impressive CO_2 reductions on the ground. However, internal and external barriers exist that prevent more widespread adoption of such actions. Despite these obstacles, there are some actions all cities can pursue, such as implementing fiscally neutral emission reduction projects. Cities can also focus on four priority areas: CCHP, public transport, energy efficiency in buildings and improved land use planning and urban design. Co-ordinated action between cities, as well as improved national guidance, can also play an important role.

Together, these sets of actions can assist cities in continuing to provide the high level of services to their growing populations, while contributing to much-needed climate change mitigation action.

Questions for discussion:

- How can city leaders encourage energy conservation efforts among local businesses, individual households and municipal institutions?

- What are the priority sectors that city governments should focus on to achieve cost-effective CO_2 mitigation?

- What policies are required to promote energy-efficient buildings in the commercial, residential and municipal building sectors?

- What other measures have proven to be effective for cities to promote energy conservation and efficiency (*e.g.*, in traffic and street lighting, less energy-intensive water supply and treatment systems, heat and energy co-generation systems, waste-to-energy systems)?

- How can city leaders promote broader use of renewable energy sources for meeting urban energy demand?

- What is the potential for improved urban design/land use planning to achieve CO_2 mitigation? What urban design/in land use planning tools should cities consider using?

NOTES

1. Acknowledgements: This paper draws on research conducted by the Cities Energy Modelling International Expert Group (CEMIEG) convened by the International Energy Agency for preparing material for the World Energy Outlook 2008. Members of CEMIEG include Nigel Jollands, Paul Dowling (IEA), Gotelind Alber (Sustainable Energy and Climate Policy), Claudio Baffioni (Comune di Roma), Shobhakar Dhakal (National Institute for Environmental Studies), Steve Hammer (Columbia University), Stephen Kenihan (ICLEI), Lilly Parshall (Columbia University), Matthias Ruth (University of Maryland), Niels Schulz (Imperial College, London and IIASA), Wayne Wescott (ICLEI), and Tom Kerr (IEA).

Disclaimer: The views expressed in this paper are those of the author and do not necessarily represent the views or policy of the International Energy Agency or of its individual member countries.

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CHAPTER 7:

CITIES, CLIMATE CHANGE AND URBAN ECONOMIC DEVELOPMENT

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Many European and US cities are in the policy vanguard in addressing the interrelated environmental problems of global warming, pollution and energy dependence. European cities, supported by layers of national and European Union policy, have undertaken multiple initiatives in energy, transportation, building and land use to reduce their carbon footprints. Absent a comprehensive national policy, US cities have begun to implement similar strategies on their own, or sometimes with assistance from state governments. One aspect of urban climate change action that has not received much attention is the connection to green economic development.

This paper explores this connection, focusing on renewable energy and energy efficiency, both of which have considerable economic development and job creation potential worldwide. One key area where cities can make this link is in their efforts to make existing and new buildings more energy efficient. Buildings consume 71% of electric power, 39% of all power and create 39% of CO_2 emissions in the United States, with similar percentages in Europe. To reduce their greenhouse gas emissions, cities are establishing more stringent efficiency standards for new buildings, undertaking initiatives to improve the efficiency of existing buildings and creating incentives for using renewable energy. Each has particular links to jobs and economic development. Employment opportunities start with the people doing the retrofitting and installing solar energy systems, and also include manufacturing jobs in renewable energy and green building products.

The transition to a low-carbon economy can be an engine of economic development, with jobs in many sectors. A recent United Nations Environment Programme report on green jobs estimates that 300 000 workers are employed in wind power, 170 000 in solar photovoltaic and 600 000 in solar thermal production worldwide, with a potential of increasing up to 2.1 million in wind and 6.3 million in solar photovoltaics (PV) by 2030. Comprehensive energy-efficiency measures in the building sector are projected to employ between 1 and 1.4 million people in Europe by 2030 and 827 000 in the United States by 2020 (Renner, Sweeney and Kubit, 2008). As the report suggests, these jobs will be attractive to countries, regions and cities that have lost manufacturing jobs or to underdeveloped regions and countries.

The opportunity is real. But there are also many challenges. Cities of course cannot solve the climate crisis without international treaties and national policies to support them. But national policy gets played out in particular places, and cities can employ economic development strategies to attract renewable energy and other carbon-reducing technologies. There are many outstanding questions about what cities can and should be doing to become players in what commentator Thomas Friedman calls the “energy-climate era.” (Friedman, 2008). Can cities create enough demand for renewable energy or green building products to stimulate new manufacturing jobs? Or is this the job of national policy, with little role for city or regional planning organisations? What can national governments

learn from city and regional policy? And what types of national policy are needed to stimulate economic development through climate change initiatives?

Drawing from examples in a forthcoming book, *Emerald Cities: Linking Climate Change and Economic Development* (Oxford University Press), this paper presents an analysis of national, regional and city-led initiatives to reveal the policy formation process, how linkages between climate change and economic development policy are being made, and how policy learning takes place among different levels of government. The cases were selected by a snowball sampling method based on interviews with experts in the field and the author's knowledge of city sustainability efforts.[1] This paper focuses on renewable energy and energy efficiency.

The policy framework

Cities can link their climate change initiatives to several sectors or clusters of economic activity, including renewable energy, green building products and technologies, construction and maintenance, waste-processing technologies and transportation. Sectoral economic development strategies are well established as a means for cities, states or regions to maintain existing, or to create new, regional specialisations or clusters. The terms sectoral or cluster strategies are often used interchangeably, although sectoral strategies typically focus more on job creation.[2] A sector is a group of firms that produce similar products, or have shared markets, technology and workforce needs. A cluster is a bit broader in scope, defined as geographic concentrations of companies that are interconnected by the markets they serve, the products they produce, their suppliers and workforce needs (Porter, 1997). These strategies can be implemented by states, regional economic development organisations, cities and communities (see Fitzgerald and Leigh, 2003).

The OECD has analyzed regional specialisation and cluster strategies as the intersection of three policy families: regional policy, science and technology or innovation policy, and industrial/enterprise policy. All three emphasise facilitating collaborative research between industry and research institutions geared toward commercialising new (often high-tech) products (OECD, 2007). These strategies are often closely linked to urban economic development strategies. Due to their proximity to universities and research and production facilities, cities are often where these partnerships are centered and thus where the new products are developed and commercialised (OECD, 2006).

The cases examine how sectoral/cluster strategies in renewable energy and energy efficiency are playing out in practice. The analysis focuses on the interactions among various levels of government and nongovernmental actors in attempting to create regional specialisations in climate change technologies. This is the link between climate change and economic development.

Renewable energy: solar cities

This section starts with Freiburg, which along with other German cities, employed a regulatory policy, the feed-in tariff, to promote solar energy. Based on the success of these cities, the German government enacted a federal feed-in tariff that is credited with Germany's status as a top exporter of solar and wind technology (see text box). The German government is now directing development of renewable energy production in eastern Germany to stimulate economies of lagging regions. Despite this targeting, Freiburg is still an innovator in solar technology and illustrates how cities can stimulate demand for products to create a regional specialisation. The Freiburg case also reveals that national policy can replicate city policy innovations. In contrast, the growing capacity in solar energy production of Philadelphia, Pennsylvania, is almost exclusively the result of state policy. In the same way that German renewable energy policy is directing the industry to lagging areas, Pennsylvania is

directing production in renewable energy to smaller, de-industrialised cities, while headquarters and other business functions are attracted to the state's premier city.

Freiburg

A university town of 216 000 in the Ruhr Valley of Southwest Germany, Freiburg calls itself "the solar city." Its green focus emerged in response to a proposed nuclear power plant in 1975. Citizen activists were successful in stopping the plant, and soon began a movement to promote solar and other renewable energy. It took until 1986 to develop a citywide strategy, when the city adopted guidelines for an energy and development policy, SolarRegion. At this point, several environmental organisations, businesses and research institutes were created to promote solar energy. Other measures are a Climate Protection Strategy passed in 1996 to reduce CO_2 emissions by 25% by 2010.

The three pillars of the SolarRegion strategy are energy conservation, use of new technologies and use of renewable energy. All have become economic development strategies. Freiburg is creating demand for solar technology through several policy measures, including building city-owned solar projects; a local ordinance requiring that 10% of electricity be from renewable sources by 2010; public subsidies, pilot and demonstration projects; renting roof surfaces to solar power plant operators; a feed-in tariff that allowed local residents and business to sell power back to the grid (see text box) and proactive research and economic development support. The Fraunhofer Institute for Solar Energy Systems, the largest solar research institute in Europe, employs 500 scientists, who conduct basic and applied research on solar cells, amd work on off-grid power supplies, hydrogen technology and related areas.[3] A solar incubator, the Solar Information Center (SIC), houses small firms in renewable energy and energy efficiency. City planners are involved too. To respond to a housing shortage and demonstrate that energy-efficient neighborhoods could be built on a large scale, the city developed Vauban as a solar eco-community. Another eco-community, Rieselfeld, will be completed in 2010.

These efforts have paid off. The city now boasts employment of 700 in solar technology and 10 000 in the environmental and solar sectors. Solar-Fabrik built a zero-emissions solar module production facility in Freiburg in 1997 that employs 130 people. The majority of the thousands of photovoltaic modules the city has mounted on buildings are made in Freiburg.

At the national level, the German government has seen the economic development potential of renewable energy as well. In the words of Sigmar Gabriel, German Minister for Environment, "The systemic expansion of renewable energy is not only good from the environmental and climate policy point of view but also for innovation, growth and employment in Germany."[4] In 1991, the German government implemented a national feed-in tariff and several other policies to catalyse growth in both wind and solar technologies (see text box). The feed-in tariff has resulted in Germany's becoming the world's largest producer of wind energy since 1997. Global wind capacity has increased, on average, more than 25% a year over the last decade, to a current level of 60 000 megawatts, 40 000 of which is in Europe.[5] Production totals in 2005 were 18 000 MW in Germany, 10 000 in Spain and 9 100 MW in the United States (Kammen, 2006, p. 86). About 20% of wind and 10% of German solar PV technology is exported (Runci, 2005). Germany is second only to Japan in solar PV production. The PV market increased more than ten times from 1999-2003, while the cost dropped 20% (Stryi-Hipp, 2004). Germany accounts for 55% of global solar electricity production, and combined with Japan has a 70% share of global production in solar electricity equipment. Of the 1 727 MW of solar cells manufactured worldwide in 2005, 833 MW were produced in Japan, 353 in Germany and 153 in the United States. In 2004, the German renewable energy industry employed approximately 157 000 (64 000 in wind, 57 000 in bio energy and the rest in solar and others). Additional net employment growth by 2020 will be between 73 000 and 117 000 (Dürrschmidt and van Mark, 2006).

Box 1. Germany's renewable energy policy

Germany, like several European and other countries, has used feed-in tariffs to stimulate demand for renewable energy, and to create jobs and an export industry in renewable technology. The feed-in tariff is the dominant policy tool for promoting renewables in Europe, with 18 EU countries employing them. Feed-in tariffs require grid operators to purchase all renewable power available to them from renewable energy generators at prices set by government. The prices are set for a specified time period (varying, but usually around 20 years), with the amount of subsidy usually dropping over time (although fixed tariffs exist, they do not have the benefit of lowering costs). The idea is to guarantee suppliers of renewable energy a price above production cost, so as to create a stable market that encourages investment in technologies and reduces the unit cost of production. For most, tariffs vary for different technologies. The costs of feed-in tariffs are paid by suppliers and passed on to consumers.[1]

Germany's 1991 electricity feed law (EFL) set the price for wind and solar at 90% of the retail electricity rate and hydropower, landfill gas, sewage gas and biomass at 80%.[2] A new law, the Renewable Energy Sources Act (EEG), was enacted in 2000 to make some policy corrections and strengthen the EFL.[3] Its goal is to double the amount of renewable power from 1997 levels by 2010 and obtain 20% of electricity from renewable sources by 2020.[4] The 2000 Renewable Energies Law continues the commitment to doubling the percentage of renewable energy by 2010. And German national banks offer loans at 1% to 2% below market for the first 75% of project costs for renewable production initiatives.[5]

Key to the success of Germany's feed-in tariff are long-term contracts, guaranteed purchasers and pricing that provides an adequate rate of return for renewable suppliers. Further, the feed-in tariff is integrated into other long-term efforts to promote the development of an appropriate mix of renewable energy sources (Klein *et al.*, 2007). The law promotes a diverse ownership structure for renewable energy that includes power companies, municipalities, farmers (particularly with wind) and residential solar PV producers.[6] While critics point out that Germany's relatively low solar resources means that it can take several years for a photovoltaic cell to generate as much power as it took to manufacture it,[7] German companies have built expertise in building a product with enormous export potential.

Notes:

1. Sawin (2004). For a more detailed explanation of how feed-in tariffs work in different counties, see Sijm (2002).

2. See *www.wind-works.org/FeedLaws/Germany/ARTsDE.html* (accessed 15 June 2007).

3. A key difference in the new law is that it differentiates among energy producers, with low-cost producers compensated at lower rates than higher-cost producers, to provide more incentive for developing installations on lower-quality sites. This change was needed because concentration of wind energy in the northern part of the country (with higher winds) overburdened utilities there. Another difference is that grid operators are required to purchase power from local producers (an equalization program was added to reduce the cost differentials paid by grid operators in different parts of the country for renewable power). Network utilities are also compensated for supplying the grid with electricity from renewable sources.

4. Renewable Energy Sources Act, *www.bmu.de/files/pdfs/allgemein/application/pdf/res-act.pdf* (accessed 15 June 2007).

5. Other policies include the Million Roofs Program, which subsidizes installation of new solar panels. This program has stimulated growth in installed PV capacity from 50 megawatts in 1998 to 350 megawatts. The Market Stimulation Program provides grants and loans to individuals, schools and businesses for installing renewable heating systems. Other grants totalling USD 270 million in 2003 were earmarked for commercialization of renewable energy systems and another USD 40 million for export promotion (Runci, 2005).

6. The tariff can be paid to commercial and residential providers. Residential users who purchase solar PV systems for their homes, for example, can feed in electricity they do not use to the grid at the subsidized rate, ensuring a payoff from their initial investment in the system.

7. Krupp and Horn (2008, p. 39). Germany's solar energy potential is approximately 1 million kilowatt hours per square metre.

The German government is directing many of the new production facilities to cities in the east, where significant infrastructure investments were made following unification. Unemployment in the east has been high, and companies are taking advantage of skilled workers at lower wages than in the

west. Despite this targeting by the national government, Freiburg still benefits from its early leader status and its strength in research.

Philadelphia

Philadelphia's pathway to becoming a solar city is almost the complete opposite of Freiburg's, in that it would not have happened without state policy. Although Philadelphia did join the Cities for Climate Protection Campaign of ICLEI-Local Governments for Sustainability in 1999, sign the US Mayors' Climate Protection Agreement in 2005, and release a climate change plan in mid-2007, the city is just becoming a leader among US cities on climate change action. The plan commits the city to reducing its greenhouse gas emissions by 10% by 2010 and to set the stage for future reductions beyond 2010. Mayor Michael Nutter has also consolidated city initiatives around climate and the environment by creating a cabinet-level director of sustainability position. Despite the lack of a climate policy and any economic development initiatives targeting renewable energy, in the past three years, Philadelphia has become the US headquarters to the Spanish wind giants Gamesa and Iberdrola, as well as German solar conglomerate Conergy and its subsidiaries SunTechnics and EPURON. All have been the result of the state's aggressive strategy to develop manufacturing capacity in renewable energy.

Box 2. Renewable portfolio standards

Renewable portfolio standards (RPS) require utilities or suppliers to provide a specified percentage of electricity from renewable sources by a given year. At least 43 countries, 26 US states and a few cities have enacted RPS laws. The goal of the RPS is to create a market for electricity by specifying amounts to be used, with generators of renewable energy competing to supply it. For example, California's RPS stipulates that utilities must purchase 20% of their electricity from renewable sources by 2010. The premise is that market competition will drive down costs. States vary in the extent to which they specify specific types of renewable energy to be included (see Rabe, 2006, 2003). Many portfolio standards use renewable energy credits or certificates (RECs) as proof that one KwH of electricity has been generated by a renewable source. In some states, such as Texas, suppliers that do not meet requirements to purchase renewable energy credits are penalised.

The United States does not have a national portfolio standard. Compare this to the European Union, which has a 12% renewable standard for electricity production by 2010 in addition to standards in place in 25 member countries. Even operating at the state level, the RPS is having an economic impact. The American Council on Renewable Energy estimates that a national portfolio standard could create USD 700 billion in economic activity and 5 million jobs by 2025 (American Council on Renewable Energy, 2007). The Union of Concerned Scientists (UCS) estimates that about 45 gigawatts of new renewable energy capacity will be needed by 2020 to fulfill current state RPS policies, while Global Energy Advisors estimates that more than 52 gigawatts would be required, amounting to approximately 3% of United States 2020 electric sales. While seemingly modest, reaching this goal would nearly double the percentage of non-hydro renewable energy generation currently in the United States (Wiser *et al.*, 2007, p. 10). The Lawrence Berkeley National Laboratory estimates that about half of the wind power capacity built in the United States between 2001 and 2006 was partly motivated by state renewables portfolio standards (RPS) and up to 60% for 2006 installations (Wiser and Bolinger, 2006).

The RPS is too new and varied a policy instrument for its impact to be definitively evaluated. Modelling of wind capacity growth in states with different types of policy against states with no policy suggests that having a RPS in place does stimulate the early development of wind production (Blair *et al.*, 2006; Menz and Vachon, 2006). Preliminary evaluations suggest that successful RPS laws include: clear targets for in-state production; political support and regulatory commitment; predictable long-term purchase obligations; automatic enforcement penalties;[1] flexibility mechanisms; certificate trading; and development of adequate transmission capacity (see Wiser, Porter and Grace, 2004; Wiser and Langliss, 2001).

Note: 1. Blair *et al* suggest penalties must be at the level of USD 20 per megawatts to be effective. One of the strictest of current penalties is Texas, at the lesser of 5 cents per missing kilowatt hours or 200% of the mean trade value of certificates in the current compliance period (Deyette and Clemmer, 2005, p. 8).

Pennsylvania's two-pronged strategy for building a renewable energy sector is to grow its own companies and to attract international companies to jump-start job creation and create the critical mass needed for agglomeration. Underpinning these strategies is a commitment to revitalising the state's diverse manufacturing sector and lagging cities and regions.[6] As defined by Kathleen McGinty, Secretary of the Pennsylvania Department of Environmental Protection (the state agency responsible for developing and deploying energy technologies), "What makes us different from other states promoting clean energy and efficiency is that for us, it is a means to revitalise manufacturing and be an engine of job creation, rather than being first and foremost an environmental strategy. We only put state dollars in energy investments that create jobs."[7]

Appointed by Governor Edward Rendell shortly after he took office in 2003, McGinty immediately began linking energy and economic development policy. Aware of the lack of national policy to drive the growth of renewable energy, McGinty began promoting the state policies that would be needed to drive industry growth. She and her team knew the state needed a renewable portfolio standard (see text box), but also knew that getting one passed could not lead the renewable economic development strategy because it did not have political support in the legislature. Although the RPS would be essential to the second prong of the strategy, attracting a big player in both wind and solar technology, the opening salvo had to be one that would build both industry and political support for renewable energy in a state dominated by coal.

One of the administration's first initiatives was to establish the Pennsylvania Energy Harvest grant program. In its first year, the program allocated almost USD 6 million in grants to companies to encourage investment in renewable energy, energy-saving production processes and alternative energy production. Most of the grants were to help businesses become more efficient, rather than investing in production of renewable energy. Since then, the program has invested USD 21 million leveraging USD 51.9 million in private investment in wind, solar, biomass, waste coal and recycled energy projects.

The success of this small program enabled the governor to persuade the legislature to do something bigger. At Rendell's request, the legislature reactivated a defunct state agency and energy program, the Pennsylvania Energy Development Authority (PEDA), to invest even more in the jobs-energy strategy. Approved in April, 2004, PEDA provides grants and loans to support projects across the clean energy spectrum. In its first two years, PEDA awarded USD 15 million in grants and loans for 41 clean energy projects expected to leverage USD 200 million in private investment and 1 558 permanent and construction jobs. In 2007, PEDA awarded USD 6.1 million to sixteen clean energy projects from its USD 4 025 954.95 in funds. To date, PEDA has awarded approximately USD 31 million in 80 projects.

All the while, an economic case was being made to pass a RPS. Both state houses were controlled by Republicans, so bipartisan support was essential. After two years of negotiations to bring on board reluctant elected officials, utilities and the coal industry, the RPS passed in November 2004.[8] It requires that 18% of all retail energy generated by 2021 come from clean and efficient sources, broadly defined. The standard calls for 8% of energy to come from Tier I sources, which include wind and solar and 10% from Tier II, which includes waste coal and other nonrenewable sources.[9] The portfolio standard requires utilities to purchase about 850 megawatts of solar capacity by 2021 – the fourth-largest requirement for solar energy among the 25 states that have portfolio standards. Industry experts project that the new standard will catalyze about 850 MW of solar generating capacity in Pennsylvania and support 14 000 jobs, one-third of which will be in the state (Rosey, 2006).

In early 2003, Gamesa, the world's second-largest wind energy company, began looking for a US site. McGinty approached the company to present Pennsylvania's assets, including wind capacity, a

well-trained labor force, proximity to major wind markets and a strong electrical grid. Gamesa officials were impressed, and in September 2004, they announced that the company would build a USD 40 million plant in Ebensburg, Pennsylvania, to produce blades and towers for commercial-scale wind turbine generators and assemble the nacelles that house the turbines. Within days, Gamesa also announced that the company would build additional manufacturing facilities in the state and locate its US headquarters, marketing office and a training facility in Philadelphia. To top off the investment, Gamesa also committed to building 18 wind farms.

These investments provided the jump-start Pennsylvania would need to be a leader in wind energy. When all of the facilities are up and running (excluding the wind farms, which operate under another division of the company), Gamesa will have invested USD 175 million and created more than 1 100 jobs in Pennsylvania, of which about 900 are in manufacturing.

The ambitious portfolio standard was key to the decision of Gamesa officials to locate in Pennsylvania. Needing a regional market for its turbines, company executives wanted the state to commit to being a major purchaser of alternative energy. Gamesa's wind power division will sell 400 megawatts of power to Pennsylvania utilities, enough to power about 135 000 homes. The state, together with the three utilities, agreed to purchase about 1 100 MW from two of the Gamesa facilities.

It did not take long for another wind giant to take advantage of Pennsylvania's policies. In 2006, the US division of Spanish-owned Iberdrola Renewable Energies USA acquired Community Energy and set up its US headquarters in Radnor, in suburban Philadelphia. Attracted by the RPS and related renewable energy policies, Iberdrola will be developing new wind projects in the state.

And in November, 2006, Pennsylvania landed German-based Conergy AG, the world's largest solar power integration company. The company committed to locating the North American headquarters of its financial subsidiary, Voltwerk (now Epuron), and the East Coast operations of its solar engineering and installation subsidiary, SunTechnics, in Pennsylvania. Conergy supplies solar water pumps and photovoltaic and solar thermal components to a world market, but wanted to have a presence near customers in the eastern United States.[10]

The inclusion of wind, solar and biodiesel in the RPS was attractive to Conergy because its subsidiaries distribute all three. Secretary McGinty explains that the ambitious solar provision in the state RPS was established specifically with the goal of attracting a big solar player. As with wind, the idea was that the first large company would create momentum and result in other investments following. McGinty examined the growth potential of several companies, identified Conergy as a strategic attraction option and invited Conergy officials to come to Pennsylvania. The company decided to locate in Pennsylvania, and in February 2007, SunTechnics Inc. announced that it had acquired Mesa Environmental Sciences Inc. The new company, SunTechnics, installs solar systems and will be the East Coast headquarters for the company (*Philadelphia Business Journal*, 2007).

Conergy's US financial headquarters subsidiary, Epuron, located in Philadelphia. With the acquisition of MESA Environmental, Conergy has renewable engineering company headquarters in Pennsylvania, with offices in Philadelphia and Malvern. In total, Conergy will create up to 50 engineering, financing and management jobs and up to USD 100 million in clean energy deals over the next three years.

In April 2007, another start-up solar company announced it would open a production facility and headquarters at a brownfield site in Bucks County, in the Philadelphia metropolitan area. AE Polysilicon Corporation manufactures the polysilicon used in solar cells and modules. Landing the

company was a coup for Pennsylvania, as it is one of only ten polysilicon manufacturers in the world. Like Gamesa, the company will receive tax benefits for locating in a Keystone Opportunity Improvement Zone, where special tax abatements and other incentives are available. The benefits are part of a USD 1.92 million financial package created by the Department of Community and Economic Development, which includes a USD 1 million loan from PEDA, and USD 65 000 for customised job training. The company has also applied for a USD 5.8 million low-interest loan from the Citizens Job Bank program (created for companies that create jobs or expand existing employment in the state). The company broke ground a year later and expects to create 145 permanent jobs.

The state's efforts have only yielded 3 000 renewable energy jobs so far, but the future economic development potential could be enormous, depending on whether supply chains can be developed to create true clusters in renewable energy. Part of the rationale for providing subsidies to jump-start particular industries is not just the direct employment, but employment in supplier firms to the industries. Many of the projections of millions of new jobs in renewable energy assume that the firms will use regional suppliers (see Sternzinger and Stevens, 2006); Sternzinger, Stevens and Svrcek, 2006) and Sternzinger and Svrcek, 2005). Unfortunately, that has not been the case in either the wind or solar industries, both of which are highly concentrated. The top five largest wind turbine manufacturers, for example, control 82.2% of the world market (and only one, G.E., is a US company). The top four solar companies control 50% of the market. And in both wind and solar, foreign companies are buying up US companies to control sources of component supply (Glasmeier, 2007). Most are not using US suppliers. A spokesman for Spanish-owned Gamesa, which has 28% of its turbine manufacturing capacity in the United States, notes that the company imports its major component parts from overseas because US capacity is lacking. Likewise, the new Vestas turbine plant in Colorado imports almost all its component parts because it has long-established relationships with its European suppliers.

Time will tell whether the decline in the value of the dollar against the euro will motivate more use of US suppliers. Higher oil costs have increased the cost of shipping goods enough to motivate some offshore manufacturing back to the United States.[11] Much manufacturing infrastructure in the United States has been decimated, so states like Pennsylvania that have attempted to keep manufacturing jobs may have an advantage. Pennsylvania's attraction strategy begs the question of whether renewable energy is on its way to stimulating a new round of smokestack-chasing among the states and on an international level. In any case, for different reasons, renewable energy will continue to be the economic underpinning of climate change strategies in Freiburg and Philadelphia.

Energy efficiency

A negawatt, a term coined by Amory Lovins, is a unit of conserved energy. It is the cheapest source of energy available – every dollar spent on using less electricity saves USD 2 in investment in increasing electric supply. McKinsey & Co. estimates that worldwide energy demand could be cut in half by increasing energy productivity. Investment in energy efficiency can stimulate employment in two ways – by creating jobs for those doing the retrofitting and by stimulating demand for new energy-saving and pollution-fighting products.

EU directives and the EU commitment under the Kyoto Protocol have stimulated energy efficiency efforts in member states. Germany's Alliance for Work and Environment is one response to its commitment under the Kyoto Protocol to reduce greenhouse gas reductions by 21% from 1990 levels by 2012 and to stimulate the lagging construction sector. In contrast, the United States has not undertaken a national effort to improve efficiency of this magnitude. But several cities and regions see potential for revitalising manufacturing by promoting energy efficiency. These regions see the demand for efficient building systems and other green building products increasing and are positioning

themselves to take advantage of expanding markets. Although these approaches are often mutually exclusive in practice, they need not be. In fact, connecting them is essential to creating economic opportunity out of climate change initiatives. The initiatives described in US rustbelt cities Syracuse and Pittsburgh would be helped considerably by a commitment from the US government to spend billions on efficiency as recommended by former Vice President Al Gore's WE initiative and the Apollo Alliance, a coalition of business, labor, environmental and community leaders seeking to catalyse a clean energy revolution in the United States.[12]

Germany and energy efficiency

The German Alliance for Work and the Environment was created in 2001, with the dual goal of increasing energy efficiency and stimulating employment in the lagging construction sector. This collaborative of government, unions, NGOs and employer federations has achieved impressive results. A public investment of EUR 1 billion stimulated EUR 5 billion in investment, retrofitted 200 000 apartments, created 25 000 full-time jobs and saved 116 000 jobs in the construction sector. The initiative has created EUR 4 billion in new tax revenues and savings in unemployment benefits and reduced annual building emissions by 2%. Further, the initiative has created a market for new technologies that are being produced in Germany, including: low-temperature heating boilers; fuel cells, photovoltaic and solar thermal systems, heat exchangers for ventilation systems and triple-glazed windows with inert gas and thermal insulation material. Building on this success, the German government increased funding to 1.5 billion euros in 2005 (Renner, Sweeney and Kubit, 2008, p. 70; Dupressoir *et al*, 2007).

An analysis of the program's impact in stimulating manufacturing jobs producing new efficiency-related products has not been undertaken. Unlike renewable energy policy, this program does not target specific cities or regions.[13] To the extent that it reduces utility payments, however, it clearly frees up money in city budgets to spend on other items.

U.S. cities and energy efficiency

With no major federal efficiency initiatives to tap into, a few US cities are experimenting with comprehensive energy efficiency initiatives that do not rely on government funding. The Cambridge (Massachusetts) Energy Alliance was created by the city to organise and implement the nation's first city-wide energy-efficiency initiative. The program is unprecedented in both its scale and its funding model – its costs will be derived from the energy savings it produces – no government subsidies are involved. Two private foundations, Kendall and Barr, offered USD 250 000 each, and other institutional investors have raised USD 100 million to create a revolving fund to finance energy-efficiency improvements in commercial, residential and municipal buildings. The fund will finance 80% of the initiative; the remaining 20% will be derived from conservation fees on utility bills and a statewide utility rate increase. As the program demonstrates success, additional funding will be sought from the state's public benefit fund (state programs created to support energy efficiency and renewable energy projects, funded by small surcharges on utility bills). The Phase 1 goal is to achieve 50% participation in each of the three sectors (that is 23 000 residential, commercial and institutional buildings), which will reduce the city's total greenhouse gas emissions by 10% by 2011, reduce its peak power load by 15% and reduce CO_2 emissions by 150 000 tons a year. The Alliance estimates consumers will realise USD 160 million in savings over 10 years.

The Cambridge Energy Alliance, a non-profit organisation, is designing, marketing, financing and managing the program. The Alliance has hired energy consultants to conduct efficiency audits and make recommendations for improvements and retrofits. An approved contractor will then do the installations. Rather than paying up front, property owners receive low or zero-interest loans that are

paid back through the savings on their utility bills. The Cambridge Energy Alliance will also monitor efficiency improvements.

The City of Milwaukee and the Center on Wisconsin Strategy (COWS) at the University of Wisconsin are organising a similar initiative, Milwaukee Energy Efficiency **(**Me^2), which is attempting to raise USD 500 million for a private capital fund to finance retrofits. The fund will be paid back over ten years from the energy savings realised also in instalments on utility bills. The pilot of the program, which will focus on residential retrofits, started in the fall of 2008. Consumers will repay the cost of the efficiency improvements through a tariff on their utility bills. A feature of the program is that the repayment obligation is attached to the property rather than the property owner, eliminating any disincentive owners might have if they are planning to relocate. Me^2 will verify all work and performance. Even with the repayment, consumers benefit from reduced energy consumption costs on their utility bills. A key difference in the programs is a focus on employment. COWS estimates that Me^2 will create 4 300 person-years of employment and save residents and commercial property owners about USD 120 million annually in utility costs.

A few other cities are attempting similar initiatives on a smaller scale. They illustrate the capacity for innovation among cities to achieve greenhouse gas reduction and energy-savings goals in the absence of national policy. In fact, the Cambridge Energy Alliance has spurred the state of Massachusetts to expand the program to five other cities and eventually take it statewide. Like Freiburg and other cities implementing incentives for renewable energy, it is cities that are leading the way in energy efficiency in the United States. But the real economic development opportunity in energy efficiency may be in manufacturing, as we see in initiatives in Syracuse, New York and Pittsburgh, Pennsylvania. Both are collaborative policy initiatives that emphasise connecting university research to new product development. A key difference is that the Pittsburgh initiative operates separately from the city government, while in the Syracuse region, several cities are involved.

Pittsburgh

Even though it does not produce much steel these days, steel is what most people think of when Pittsburgh, Pennsylvania is mentioned. Few would guess that Pittsburgh ranks fifth among US cities in the number of its green buildings. Nearly 100 green building projects are completed or under way in the area. And it is not just new buildings – Pittsburgh has renovated 155 historic buildings to make them more efficient, four of which are certified green buildings. But all this green building and retrofitting is not the result of city policies or the vision of a mayor – it was not until 2007 that Pittsburgh passed an ordinance to provide incentives for green building.[14] And to date, Pittsburgh has not passed an ordinance requiring green certification through Leadership in Energy and Environmental Design (LEED) or other rating system.[15] Nor has the city thought of connecting all this green building activity to an economic development strategy.

In a city leadership vacuum, the connection between green building and economic development is being made by a non-profit organisation, the Green Building Alliance (GBA), which began in 1993 as an informal coalition of professionals interesting in green building. In 1997, a new executive director, Rebecca Flora, focused the organisation on economic development. To examine the extent to which green building could be an economic driver, the GBA conducted a study to examine the possibilities. The 2006 report, *Green Building Products: Defining and Verifying the Opportunity for Western Pennsylvania,* identified 1 800 building supply manufacturers in the region, with total employment of more than 68 000 (Flora, 2006). Flora's concern was that most of the region's building supply companies were unaware of the transformation taking place in their industry.[16] If building products manufacturers are not retooling to make advanced products such as fiber-optic daylighting, pollution-removing systems and making products from recycled material, she feared, the United States could

actually lose jobs as contractors look to European and Asian suppliers, which are already making the transition.

So Flora launched the GBA's Green Building Product Initiative in November 2006 to make western Pennsylvania a regional center for manufacturing green building products. Aware of the economic development opportunity, the Heinz Endowments granted the initiative USD 250 000, and the Ben Franklin Technology Development Authority, Pennsylvania's technology-based economic development provided another USD 1 million.[17] One part of the initiative is the Pennsylvania Green Growth Partnership, formed by GBA and Philadelphia University to retain and create jobs by helping building products manufacturers transition into green products. A research network associated with the partnership includes Carnegie Mellon, Drexel, Pennsylvania State, Pittsburgh, Temple and Villanova universities, to conduct research to support technological innovation and commercialisation of new green products and production methods. The partnership hosts annual forums to connect university researchers to corporate sponsors to commercialise their products.[18]

Through the initiative, the GBA is offering grants to companies, university researchers and partnerships of both to develop new green building products. Two rounds of grants totaling USD 588 000 have been given out to 10 projects. The projects represent a wide array of green building products, including:

- Ductmate GreenSeam II to further develop a product to reduce duct leakage
- Tegrant Corporation and University of Pittsburgh to test the performance of and production methods for insulated concrete forms
- Villanova University for developing a superlattice solar cell prototype
- Geothermal Energy Systems and Carnegie Mellon University for testing heating and cooling systems for a neighborhood of buildings
- Temple University for ReD, a type of window for large-scale commercial buildings made of a material that shifts from transparent to translucent to maximise light while reducing heat loss and solar heat gains.

To the extent that these and other products prove marketable, the GBA will catalyze an expansion of the rapidly growing green building supply market in western Pennsylvania and throughout the state.

But Pittsburgh and even the state have to take action to stimulate demand for these green products if the GBA strategy is to work. The city is just beginning to take a few small steps, such as a 2007 ordinance that provides incentives for green building.[19] The Pittsburgh Urban Redevelopment Authority (URA) offers lower interest rates for projects that earn LEED certification on its urban development loan programs.[20] The higher the LEED rating, the bigger the interest rate reduction (up to 2.5%). The loan program is part of the URA's Sustainability and Green Design Policy, which applies to its own office operations and to the development of large-scale mixed-use developments. In November 2007, the city council approved changes in the city's building code that offers sustainable development density bonuses. Developers of nonresidential projects that earn basic LEED certification can add 20% more floor area and 20% more height to their projects.[21] To date, Pittsburgh has not passed an ordinance requiring LEED for new construction. And Flora notes that there are still code and cost barriers that hinder implementation of some green building technologies and strategies. Pittsburgh is the largest city in western Pennsylvania, and no other cities in the western half of the state are undertaking efficiency initiatives or investing in green building.

The lesson of the Pittsburgh story is that demand needs to catch up with supply. The city and local non-profit groups can catalyse invention of new, greener products and technologies, but they need a mass market that is not produced by private supply and demand, because of well-known market failures in the pricing of energy efficiency.

Syracuse

In contrast to Pittsburgh, elected officials and city and regional planners in the Syracuse area have focused on green manufacturing for some time as an area with growth potential. Yet city efforts to stimulate demand in green building have lagged behind the economic development strategy. Syracuse is pursuing a traditional sectoral strategy based on research partnerships aimed at new product development and attracting new companies. The city has begun to move on the green building front, but here too, it is not clear how much demand can be stimulated in a largely rural region. And the one development that could stimulate considerable demand for green products, the world's largest green shopping mall, is plagued with fiscal and political problems. But if successful, Syracuse could provide hope for many Rust Belt cities that manufacturing economies can be revitalised in the energy-climate era.

Mayor Matthew Driscoll wants Syracuse to be the "green capital of the world". Creating a green economy may be a way to help the city stem the loss of manufacturing jobs and reduce the metropolitan area's 16% poverty rate. To its advantage is a strong economic base in higher education and a base of companies that could be suppliers to green building and retrofitting industries. Old-line companies such as Carrier, best known as a maker of air conditioners, hope to transform themselves into a 21st century industry focused on "indoor environmental quality".

In 1996, the Metropolitan Development Association (MDA) of Syracuse and Central New York targeted identified indoor environmental quality as one of seven sectors on which to focus its efforts. While the area's largest employer in this area, Carrier, now produces its air-conditioning systems abroad, the region still has a strong base of firms and employees in this sector, with average annual earnings of about USD 54 000.

To get started, the MDA tapped into state government programs to stimulate growth in lagging upstate regions. The first was a USD 15.9 million grant from the state's Strategically Targeted Academic Research (STAR) Centers program, to create the STAR Center for Environmental Quality Systems in partnership with Syracuse University. In 2002, the MDA received funds from the Centers of Excellence, a statewide network of centers created to stimulate economic development in declining upstate regions by supporting research centers in emerging technologies.[22] The centers are charged with facilitating joint industry-university research, technology transfer and commercialisation of products in defined sectors.[23] With an additional USD 22 million from the federal Environmental Protection Agency, the STAR center became the Center of Excellence in Environmental Systems. And in 2004, the focus of the Center was expanded to include energy systems and became the Center of Excellence in Environmental and Energy Systems (Syracuse CoE).[24] MDA Director Rob Simpson notes that CoE is the top lab facility in the country for research on indoor environmental quality and on the international level, second only to one in Denmark.

The Syracuse CoE describes itself as a federation with more than 140 institutional and business members. Several large companies anchor the federation, such as Pall Corporation, an international leader in the air-filtration industry, and Carrier Corporation, a leader in heating, air conditioning and ventilation systems. Although Carrier moved its two Syracuse manufacturing facilities, employing 1 200 people, to Asia in 2003, it still employs 1 600 in research and development (Luo and Polgreen, 2003). In 2006, Carrier started a research center, the Indoor Air Quality Key Competency Group, in

Syracuse, and also contributed USD 1.5 million to the Syracuse CoE to build and operate a Total Indoor Environmental Quality Laboratory.

Even with high levels of state support and key businesses on board, the MDA is fighting an uphill battle. A 2007 study by the consulting firm Battelle revealed that the region is still losing jobs in the targeted sectors. Environmental services employed more than 10 000 people in central upstate New York in 2001, but declined by almost 28% by 2005, compared to only 5.6% nationally (this large loss is due to the Carrier plant closings in 2003). During the same period, employment in green building design declined 16%, to 2 500 workers. Indoor Environmental Quality declined by 43%, to 2 400 (Battelle, 2007). So, in addition to stemming employment loss, the CoE has to focus on catalyzing new start-up companies and attracting companies into the region.

CoE grants to several start-up companies for product research and development have paid off. Hapcontrol LLC (Syracuse) produces "bio-furniture" that does not release harmful gases. Phytofilter Technologies (Saratoga Springs) is testing a plant-based system for removing volatile organic compounds from indoor air, and Isolation Systems Inc. (Tonawanda) is developing air purification and room air management systems.

NuClimate Air Quality Systems in East Syracuse received a Syracuse CoE grant to test and build a prototype for its "Q" Air Terminal, a highly efficient heating, cooling and ventilation unit for large public buildings such as schools and hospitals.

Several of these and other businesses funded by the CoE are certified or are seeking certification as eligible products under the LEED rating system, which offers points for commercial interiors that use products and furniture that have no or low emission of volatile organic compounds (VOCs).

Other green product start-ups were developed through research at Cornell University, such as e2e Materials, which has an exclusive license to patent materials created with its natural fibre glue made with a soy resin.[25] The company just developed a particle board that has the same strength as the traditional product, but only one-third the weight. It is inherently flame retardant, meaning it does not require the addition of chemicals that release VOCs. Given that more states and cities will follow the lead of California and New York City in banning formaldehyde resin, the product should be in demand once it finds its way into more building materials. A second Cornell-initiated start-up, Novomer, received USD 6.6 million in venture-capital funding in 2007 for scaling up production of biodegradable plastic made with carbon dioxide that breaks down naturally in as little as six months. The product is price-competitive with traditional plastic.

While these start-ups offer encouragement that the strategy can work, it's a long-term process – it took Govang and a Cornell University professor 15 years to develop e2e's natural fibre glue. And there is stiff competition. Two other companies, Metabolix, in Cambridge, Massachusetts, and Minnesota-based NatureWorks, already produce biodegradable plastic, but Novomer hopes that its advantage is that its feedstock is cheaper than the corn-based feedstocks these companies use (Patel-Predd, 2007). Several other regions of the country are trying to build the same strengths, and a few are ahead of Syracuse.[26]

To build a cluster, Syracuse will have to attract a few big players, and to that end, the MDA identified 340 US and international companies with potential interest in locating in the area. The MDA and Syracuse CoE have assigned 90 partners (including every economic development agency in the county) to a "green team" that is contacting the companies on the prospect list. It is paying off already. In February, 2008, BITZER Scroll, a German manufacturer of energy-efficient air compressors for state-of-the-art air-conditioning systems located near Syracuse. Several state and local economic

development organisations worked together to attract the company, which was considering sites throughout the world.[27] A skilled workforce and the region's strength in indoor environmental quality research were key factors in the location decision, as were business incentives including USD 1.4 million from Empire State Development and a USD 100 000 grant from the Syracuse CoE for a research and development project that will be conducted by faculty and students at Syracuse University. For its part, the company pledged to invest USD 30 million in its operation and to create 289 jobs over five years at an average annual salary of USD 60 000.

But Syracuse is behind other cities in instituting climate change policies that could support the MDA's economic development efforts. The city didn't pass a green building ordinance until September, 2007. And it is weak in that it only requires LEED silver certification, and only for major renovations or new construction of public buildings. On the plus side, the ordinance does include public schools, and Syracuse is just starting on a USD 927 million, 10-year renovation plan for 35 of the 42 buildings in the Syracuse City School District, which will follow the requirements of LEED for schools.[28]

Syracuse looks to two other developments to stimulate green product demand, its Near West Side Initiative and a controversial green entertainment complex, Destiny USA. The Near West Side initiative is redeveloping three census tracts that are among the poorest in the country. The goal is to transform the area into a green arts and technology corridor.[29] Destiny is an expansion of the regional Carousel Mall, which would be the largest green building project in the nation if it is built.

The revitalisation of the Near West Side is well under way. It started with two newcomers moving in, King and King Architects, a 140-year-old local firm, and a public television station WCNY, which has broken ground on a USD 17.5 million building. The Syracuse CoE is building a new green headquarters on a brownfield site in the neighborhood. Syracuse University is also building in the area as part of a broader commitment to revitalising downtown Syracuse under Chancellor Nancy Cantor. The university relocated its School of Architecture and College of Visual and Performing Arts in an old furniture warehouse in Armory Square, the entrance to Near West Side.[30] Finally, Home Headquarters is using a USD 4.2 million grant from the Syracuse Neighborhood Initiative to retrofit and renovate an eight-block residential area in the Near West Side containing 147 properties.[31]

Although the city's green building ordinance does not stipulate it, the MDA is encouraging developers in the area to build to LEED gold standards and has provided some assistance in helping them comply. The Syracuse Office of Community Development offers technical assistance to contractors on building deconstruction (LEED points are awarded for deconstructing and recycling rather than demolishing buildings), but Syracuse has not gone as far as cities like New York, which require recycling of construction waste. The Near Westside Initiative is projected to create more than 800 construction jobs and an additional 300 jobs in five green technology companies that will locate in the district, according to Marilyn Higgins, who chairs the initiative.

Another potential driver of green development is Destiny, a proposed USD 20 billion green regional shopping and entertainment center that includes a USD 450 million, 1 342-room hotel and conference center, an aquarium, a golf course and other amenities. It is an expansion of the Carousel Center shopping mall, the top tourist attraction in Syracuse. Originally proposed in three phases, it has gone through numerous revisions, the most recent being a proposal for a 1.5-million square-foot complex that would meet LEED platinum standards and would be powered entirely by renewable energy. Project planners estimate it will create as many as 122 000 construction jobs at an average wage of USD 31 000 and 250 000 permanent jobs after construction.

But many question its green credentials and its employment projections. For starters, Destiny is only accessible by car.[32] For many green buildings, the additional energy used for cars to reach them exceeds the energy savings realised by about 30%.[33] If the project succeeds as a tourist destination, it will create a lot of traffic. The developer, Robert Congel, defends the project's "greenness" by pointing out that the Carousel Center sits on what was a highly polluted brownfield site. He points to support from Rick Fedrizzi, a Syracuse native and president of the US Green Building Council, to defend his position. And the United States Environmental Protection Agency describes Destiny as "the world's largest structure to be built from recycled industrial materials", referring to the more than 3 000 tons of coal ash that will be incorporated into sidewalks and other concrete elements. Congel says he plans to make Destiny a showcase for green products and to that end, will create a green research and development center that he lightheartedly refers to as the "Rehabilitation Center for Petroleum Addiction" (McKnight, 2007). Mayor Driscoll also defends the project, saying it "will be a trigger to development elsewhere in the city" and will help fight sprawl (quoted in Senville, 2007).

Even more controversial is the staggering amount of federal, state and local subsidies Destiny has received. In addition to a 30-year exemption from city and county property taxes, state tax credits under the state Empire Zone and Brownfield Cleanup programs and federal Empowerment Zone tax credits, Destiny is also receiving subsidy under a federal program created exclusively for its benefit. A corporate tax cut bill, the American Jobs Creation Act of 2004, authorised up to USD 2 billion of tax-exempt private "green bonds", a low-cost financing program that allows developers of brownfield sites to borrow billions of dollars at very low interest rates. Funding for the green bond program made its way into 2004 National Energy Bill as a result of heavy lobbying by Robert Congel, Senators Hillary Clinton and Charles Schumer, then-Governor George Pataki, and several Congressional representatives. Only Destiny and three other shopping mall developments in the country fit the green bonds eligibility requirements.[34] Destiny is eligible to borrow up to USD 1.04 billion through the program. Congel contributed heavily to lobby for the legislation.[35] The bill passed, and in January 2006, Destiny became eligible for more than USD 1 billion in federal "green bonds." A year later, the Syracuse Industrial Development Authority issued USD 323 million in bonds as part of a USD 540 million financing package for Destiny. Fedrizzi announced that the United States Green Building Council would purchase a USD 50 000 bond to demonstrate support for the project.[36]

Figure 1. Proposed Destiny entertainment complex

Source: Planning Commissioner's Journal, accessed 18 June 2008, *http://pcj.typepad.com/planning_commissioners_jo/2007/11/whats-syracuses.html*.

Controversy also emerged over the question of whether Destiny's green expansion qualified for tax abatements granted when the Carousel Mall was developed. If the abatements were granted, the city would lose up to USD 310 million in lost property-tax revenues. The state program provides state

tax credits of between 10% to 22% of cleanup costs and redevelopment of polluted brownfield sites, which would realise between USD 200 million and USD 720 million in state-subsidised tax credits for Destiny (Lassman, 2008). In both cases, the New York Supreme Court ruled that Destiny was entitled to the tax benefits.[37]

What would the region get for its investment? Congel claims that Destiny will attract millions of tourists and generate USD 65 billion in net taxes over 30 years, in addition to the jobs. And Destiny managers claim the huge demand for energy from solar, fuel cells, biodiesel and wind power created by the project would create economies of scale for renewable energy large enough to drive down prices. The 32 megawatts of solar electricity that Destiny would produce and consume, according to project managers, would make it the world's largest solar installation, accounting for one-third of the total solar capacity installed annually in the country.[38]

It is not clear that even a project as large as Destiny could influence demand for green products or power. Thomas Leyden**,** a vice president with the solar development firm PowerLight Corporation (which has since been purchased by SunPower), one of Destiny's potential energy partners, concluded, "It may be the biggest solar installation and renewables project in the world, but there's no way Destiny will move markets to that extent within a decade, or even move markets in any substantial way."[39] Another doubter is state senator John DeFrancisco, who points out that Congel is "legally bound to build only a fraction of the square footage of his plan," and notes that "Congel could reap extraordinary tax benefits without actually meeting his goals." (Little, 2005). He notes that Phase One was supposed to be completed six years ago and is still not enclosed. Further, he points out that the proposed mall addition has no tenants to date and concludes that Destiny will probably never be built.[40]

Conclusions

In these examples, we see a combination of partnerships seeking to create regional advantage in renewable energy or green building products production. In Pittsburgh, a non-profit organisation engaged the private sector and universities to pursue joint research using funds from a private foundation and a state economic development agency. In Syracuse, the university was the leader of a partnership created entirely with state funds. In Freiburg, city government created what is still a leading research institution on renewable energy in Germany. With the exception of Philadelphia, the common element in these cases is the facilitation of collaborative research between industry and research institutions to commercialise new products and technologies.

With the research element in place, what determines success in establishing regional specialisations is the extent to which local and national policy creates incentives to support the commercialisation of the new technologies. There are successes in supporting new start-up companies, but they do not employ many people. NuClimate Air Quality Systems employs only five people and is unlikely to expand as it subcontracts most of its work (Palmateer, 2007). The economic development opportunity is in the supply chains. For example, e2e only employs seven people, but Patrick Govang, the CEO, focuses less on the employment expansion possibilities of his company and more on its becoming part of a regional economic cluster that allows him to realise his triple bottom-line goals.[41] The key input to the glue is soy meal, and to obtain it locally, Govang located the company on the property of Empire AgriFuel, a planned soybean and canola crushing and biodiesel production facility in Cortlandville.[42] Soy meal is the byproduct of the extraction and crushing process to obtain soy oil. Govang notes that the byproduct of e2e's process could be used for animal feed. Govang is seeking assistance from the MDA, the regional economic development organisation, in finding a local market for his byproduct. His hope is that the MDA will facilitate a regional supply network among businesses in the cluster.[43]

Neither Syracuse nor Pittsburgh has policies in place to stimulate demand in green building products, but it is unlikely that they have large enough markets to influence the location of firms producing green products. What seems to have attracted the larger firms to Syracuse is the research network centered at CoE.

In addition to stimulating demand, government policy is attempting to create a stable investment environment to support continued innovation. In Germany, national government policies, starting with the feed-in tariff, are creating a stable investment environment. Pennsylvania's renewable portfolio standard was critical to attracting the wind and solar firms that headquartered in Philadelphia. The question for cities and regions that are creating regional specialisations in renewable energy production and technology is whether they can maintain it in these highly concentrated industries.[44] And it is not clear that supply chains will develop – which is where the majority of the jobs will be. To date, many of the foreign wind and solar companies that have located in the United States are not using many local suppliers for parts. Even in Germany, many producers are subcontracting many components for solar and wind systems to China. The industry is changing fast, and it is not clear who the winners and losers will be.

NOTES

1. This paper draws from a broader research project. The selection of United States cities was based on published rankings and studies of urban sustainability efforts and the researcher's judgment based on interviews with leading practitioners and elected officials. The first cut was made from the top 15 cities in overall sustainability ranking and also the top 15 on "green economy" as rated by SustainLane, an online media company that provides information on green products and a ranking by National Geographic. While the methodology of these rankings is flawed, it provided a good first-cut list of cities. Five of the cities are included in a more methodologically sophisticated analysis of city sustainability efforts conducted by Professor Ken Portney of Tufts University (see Portney, 2003). The European cities for the studies were selected after discussions with policy experts and heads of various international sustainable city organizations in the United States and the EU.

2. Conway *et al.* (2007, p. 13) note that a sector is an employment strategy that has economic development ramifications, while a cluster is an economic development concept that has employment ramifications.

3. It is one of 80 research centers in the Fraunhofer-Gesellschaft, Germany's primary applied research organization.

4. Cited in a press release from the German Federal Ministry for the Environment, *www.erneuerbare-energien.de/inhalt/39983/4592/*.

5. Other European countries have realized the same results with feed-in tariffs. Europe now produces 40 gigawatts of wind power – about 75% of world capacity (see Pernick and Wilder, 2007).

6. The Steel Valley Authority's Strategic Early Warning Network (SEWN) was highlighted at the Summit for retaining 482 jobs in the last year. SEWN, primarily sponsored by the Pennsylvania Department of Labor and Industry, assists at-risk enterprises by introducing professional turnaround and buyout efforts. Already, the SVA has intervened in over 300 factories from Pittsburgh to Erie to Johnstown. The SVA has expanded to help other regions in the state in build retention networks to avert layoffs. To date, SEWN has helped more than 12 million workers in western Pennsylvania. The SVA has become a nationwide model for community response to economic dislocation and has provided technical assistance to cities and states across the United States. As the author of the federal government's first "Layoff Aversion Guidebook", the SVA has also helped shape national policy. The Guidebook, released by the United States Department of Labor, has influenced several states to strengthen their job-retention efforts (available in summary form at *www.steelvalley.org/guidebook.asp*).

7. Personal interviews with Katherine McGinty, September, 2006.

8. As a result of compromises with the Pennsylvania Coal Association, Pennsylvania has the only RPS in the country that includes fossil fuels in the form of generation fired with waste coal.

9. The state's utilities must purchase 8% of electric power from Tier I sources by 2020. These include low-impact hydropower, burning toxic landfill gas, wind, coal-mine methane, animal waste digesters, burning trees and crops, poultry waste incineration and solar energy (0.5%). Ten per cent must be obtained from Tier II sources, which include waste-coal burning, new coal plants (with gasification

technology), trash and industrial waste incineration, wood and paper mill waste, large-scale hydropower, energy efficiency and distributed generation.

10. According to the company's web site: "The Conergy Group is number one in sales among European solar power firms, with a global presence in 22 countries. With a vertical integration strategy that positions the company strongly in each component of the renewable energy value chain and local-market offices in California, New Mexico and Colorado, the company expects global revenues to continue to rise in 2007 and 2008 by at least another 50%". See *www.conergy.de/en/DesktopDefault.aspx/tabid-181/316_read-5561*.

11. Aeppel (2008). Aeppel cites economist Jeff Rubin, who estimates that every 10% increase in distance adds 4.5% in energy costs for shipping.

12. See *http://apolloalliance.org/about.php*.

13. These data are being collected for the Emerald Cities research project.

14. The Pittsburgh Urban Redevelopment Authority (URA) just began offering lower interest rates for green building projects on its urban development loan programs. These include the Urban Development Fund, Technology Zone/Enterprise Zone and the Pittsburgh Business Growth Fund. For more details on the programs go to *www.ura.org/bdcFinancingPrograms.html* and *www.ura.org/technology ZoneBackground.html*. In November 2007, the city council approved changes in the city's building code that offer sustainable development density bonuses. Developers of non-residential projects that are green-certified can add 20% more floor area and 20% more height to their projects.

15. The LEED green building rating system is a nationally accepted benchmark for the design, construction and operation of high-performance green buildings. LEED's whole-building approach to sustainability recognizes performance in five key areas: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. See *www.usgbc.org/DisplayPage.aspx? CategoryID=19* (accessed 3/20/07).

16. Personal interview, 18 December 2006.

17. The Ben Franklin gave another USD 1 million to Philadelphia University to lead the same activities in the eastern part of the state.

18. *www.paggp.org*.

19. Due to the death of Pittsburgh's Mayor Bob O'Connor seven months into his term, there had not been a permanent mayor in office for over a year, a partial explanation for the leadership vacuum on climate change generally and green building specifically.

20. These include the Urban Development Fund, Technology Zone/Enterprise Zone and the Pittsburgh Business Growth Fund. For more details on the programs go to *www.ura.org/bdcFinancingPrograms.html* and *www.ura.org/technologyZoneBackground.html*.

21. LEED for New Construction or LEED for Core and Shell certification.

22. The New York legislature has funded eight Strategically Targeted Academic Research (STAR) Centers. The Centers of Excellence were created by then-Governor George Pataki to revitalize the Rust Belt cities of upstate New York. The other centers focus on bioinformatics and life sciences, nanoelectronics, photonics and microsystems, small-scale systems integration and packaging

(microelectronics), and wireless and information technology (see New York State Foundation for Science, Technology and Innovation, *www.nystar.state.ny.us/coes.htm* (accessed 19 August 2008).

23. The other centers are: Buffalo, Center of Excellence in Bioinformatics and Life Sciences; Albany, Center of Excellence in Nanoelectronics; Rochester, Center of Excellence in Photonics and Microsystems; Binghamton, Center of Excellence in Small-Scale Systems Integration and Packaging; and Stony Brook, Center of Excellence in Wireless and Information Technology. Computing and data mining critical to genomics and other data-intensive areas, Internet applications, wireless telecommunications, health care applications and workforce development programs.

24. In addition to indoor environmental quality, the CoE focuses on clean and renewable energy and water resources.

25. The company's first commercial product is not a green one, its skateboards. When a California skateboard company, Comet, discovered the material, company officials tried to lure e2e Materials to relocate. When company president Pat Govang turned him down, the company moved to New York and is now the first subsidiary of e2e Materials.

26. This conclusion is based on the location quotient, a measure of economic advantage in a given industry or sector. A score of less than one means that the region does not produce enough of a service or product and has to import it. A score above 1 means the region exports the service or product. The Central Upstate New York region's location quotient of 0.97 indicates the area is not a net exporter, while the Eugene, Oregon region's is 1.67 (Battelle Memorial Institute, 2007).

27. The attraction effort was led by the Central New York office of Empire State Development in partnership with Syracuse CoE, CoE partner National Grid and Syracuse University. Other partners of the recruitment team included the New York State Energy Research and Development Authority (NYSERDA), New York State Foundation for Science, Technology and Innovation (NYSTAR), Onondaga County Industrial Development Agency and the Central New York Technology Development Organization.

28. Syracuse received USD 135 million from state and federal sources for this project.

29. The West Street Initiative is a part of a larger Syracuse Arts Initiative project, sponsored by Syracuse University, the City of Syracuse and Onondaga County.

30. The university plans to invest an additional USD 13.8 million in the area as a result of a debt-restructuring agreement with the state. The debt restructuring requires the university to invest money owed on a state loan in an operating fund for the redevelopment. The university will be repaying approximately USD 8 million of the USD 13.8 million debt by creating the Syracuse Arts, Technology and Design Quarter. The university will purchase and renovate warehouses in a three-block area into artist live-and-work space.

31. In addition to private development, the city received a USD 10 million state economic development grant for the USD 56 million revitalization.

32. A proposal that has not yet been added to the project is a USD 750 million monorail that would link Destiny to the airport and downtown.

33. The study, conducted by *Environmental Building News*, estimates that commuting by office workers accounts for 30% more energy than the building itself uses (Wilson, 2007).

34. The other projects are in Georgia, Louisiana and Colorado (Milligan, 2004). Eligible projects must be at least 1 million square feet or on 20 acres of brownfield land. Projects must create at least 1 million

construction jobs in most states and at least 1 500 full-time permanent jobs. At least 75% of the square footage of commercial buildings in the project must be registered for the LEED green building rating system. State and local governments must contribute at least USD 5 million to a project, which can include tax abatements and in-kind contributions (see *www.cdfa.net/cdfa/cdfaweb.nsf/pages/greenbuildingfactsheet.html).*

35. In addition to his own USD 69 084 in contributions to the 2004 Bush campaign and to congressmen promoting the energy bill, Congel's political action committee, the Green Worlds Coalition Fund, raised USD 82 897, which mostly went to the same campaigns. Other project advocates spent USD 200 million over two years lobbying Congress to approve the green bonds proposal (Milligan, 2004).

36. United States Green Building Council. See *www.usgbc.org/News/USGBCInTheNewsDetails.aspx?id=2971* (accessed 18 June 2008).

37. In March 2006, the New York Supreme Court ordered the city to maintain the tax abatement. In June 2008, the same court ruled that the state (New York Department of Environmental Conservation) could not deny Destiny the brownfield tax credits.

38. Company official cited in Miller (2005).

39. *www.grist.org/news/muck/2005/05/20/little-destiny/index.html.*

40. Personal interview 25 July 2008. Indeed, Destiny's construction has gone through a number of starts and stops. First proposed in 1997, construction for Phase I did not start until March 2007. Hotel construction started in October, 2002, but stopped a few months later. In January, 2006 Destiny laid off 190 out of 210 workers due to uncertainties in the retail sector and disputes with the city and state on tax abatements. In February 2007, the Syracuse Industrial Development Agency sold USD 322.59 million in industrial bonds to complete the financing of the project. In March, 2008, 45 workers were laid off, again, due to financing delays *http://blog.syracuse.com/news/2006/01/destiny_usa_lays_off_190.html* (accessed 20 August 2008).

41. Triple bottom line refers to cost accounting that incorporates economic, environmental and social goals.

42. The plant will begin at a capacity of about 200 tons of soy or canola per day and produce up to 5 million gallons of biodiesel.

43. Personal interview, 20 April 2008.

44. For example, the top five largest wind turbine manufacturers control 82.2% of the world market. As in solar energy, foreign companies are buying up US solar and wind companies at a record pace to control sources of component supply. And many are not using US suppliers. A spokesman for Gamesa, a Spanish-owned company that has 28% of its turbine manufacturing capacity in the United States, notes that the company imports its major component parts from overseas because US capacity is lacking. Likewise, a new wind turbine plant in Colorado built by a Danish firm, Vestas, imports almost all its component parts.

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CHAPTER 8:

GOVERNING CLIMATE CHANGE IN CITIES: MODES OF URBAN CLIMATE GOVERNANCE IN MULTI-LEVEL SYSTEMS

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Based on the results of both existing research and recent developments in OECD countries, this study focuses on two issues: the local and the multi-level dimensions of urban climate governance. Starting from the distinction between different modes of climate governance (self-governing, governing through enabling, governing by provision and governing by regulation), we discuss the relevance of these modes for both mitigation and adaptation policies. These modes are distinct in terms of their governing capacities, which range from soft forms of governing to traditional forms of state intervention. The development in many countries suggests that municipalities do not fully exploit their authoritative powers and are reluctant to apply authoritative modes of governing through regulatory measures and strategic planning.

Various forms of horizontal and vertical collaboration are relevant to the success of urban climate governance beyond the local level. Horizontal collaboration includes climate governance within metro regions and city networking. Due to a lack of horizontal collaboration within such regions, many metro regions are characterised by a spatial mismatch. A second form of horizontal self-governing, city networking at the national and transnational level, has become prevalent among pioneering cities in recent years. Such networks focus on best-practice transfer, learning among their members and the representation of their members' interests at the national, European and international level. However, such networks tend to be networks of pioneers for pioneers. Vertical collaboration within nation-states includes various modes of governing, ranging from an enabling role of national governments (guidelines, awards, benchmarking and certification schemes) to funding schemes, such as the Dutch *Bestuursakkoord Nieuwe Stijl* (New Style Management Agreement) agreement (BANS) and Sweden's Climate Investment Programme (KLIMP), and authoritative modes of governing. In most countries, climate change policy is still a predominantly voluntary task for local authorities, and most national governments limit themselves to enabling modes of governing.

Introduction

Local governments have become major policy players in the area of climate change policy over the past 20 years.[1] During this period, many cities around the world have developed their own climate action plans and strategies. While mitigation was the main focus in the early phase of local climate change policy, both mitigation and adaptation measures can now be found on the local political agenda (Table A1, Annex). Moreover, many cities have become members of national and transnational city networks, ranging from the U.S. Mayors Climate Protection Agreement and the Swedish *Klimatkommunerna* network to the C40 Cities, an international network of the world's largest cities committed to tackling climate change.

Global climate change affects local governments in three different ways. First, a high and increasing portion of greenhouse gas (GHG) emissions is generated in cities. Second, the effects of global climate change have a direct impact on cities, which need to adapt to the changing situation. Third, linkages and synergies between climate policy and sustainable development become most obvious at the local level, and motivate cities to generate the social and technological innovations that help in the reduction of GHG emissions and adaptation to new challenges. This is particularly true for metro regions that have high innovative and creative capacities. Metropolitan regions do not only compete with each other, cities may also co-operate with their peers, at home and abroad, and may serve as a focal point for the development of best practices that can spread within and beyond such regions.

However, the actual response of local governments varies considerably, due to:

- The impact of global climate change at the local level (such as increased precipitation, flooding, rising sea levels, coastal erosion. etc.) (*cf.* Zahran *et al.*, 2008) and the perception of these regional vulnerabilities and risks by citizens and policy makers;

- A city's competences and authority to regulate climate-relevant issue areas, its commitment to fight global climate change and its capacity to do so;

- National programmes that support local initiatives, in particular initiatives of local authorities that lack the resources to follow the pioneers;

- The involvement of cities in national and transnational networks, which facilitate the exchange of experience, the transfer of best practice and the joint development of innovative solutions.

Although research on local climate change policy started more than ten years ago (Feldman/Witt, 1993; Alber *et al*., 1996; Collier/Löfstedt, 1997), the research conducted up to now has tended to focus on mitigation activities, adopting a case study approach, and concentrating on individual countries, such as the United States and Sweden (Betsill, 2001; Granberg/Elander, 2007; Aall *et al.*, 2007; Lundqvist/Borgstede, 2007; Kern *et al.*, 2005; Bulkeley, 2000) and on individual city networks, such as the "Cities for Climate Protection Campaign" (CCP) (Betsill/Bulkeley, 2004, 2006). In most countries, research on adaptation is still in its early stages (Lindseth, 2005; Næss *et al.*, 2005; Storbjörk, 2007; Zahran *et al.*, 2007). Studies that go beyond a limited number of city case studies are as rare as international comparative approaches (Bulkeley/Betsill, 2003; Bulkeley/Kern, 2006; Kern *et al.*, 2005) and comparative studies with a focus on all, or at least a considerable number of OECD countries, have not yet been conducted. Moreover, there are very few studies that take national programmes into account and analyse national multi-level systems and the conversion of national policy goals into local politics (Gupta, 2007). Finally, there is a lack of research comparing the various national and transnational city networks and analysing their relationships and impact on local action (Toly, 2008; Kern/Bulkeley, 2009).

Based on both the results of existing research and recent developments in OECD countries, this study focuses on two perspectives. First, we will concentrate on the local level and the urban governance of climate change (Section 2). Starting from the distinction of different modes of climate governance, we discuss the various sectors of activity and the complex relationship between mitigation and adaptation at the local level. In Section 3, we will change our perspective, turn to our second topic and discuss the modes of urban climate governance in multi-level systems, in particular the various forms of horizontal and vertical collaboration.

The urban dimension of climate governance

In the early stages of the debate on climate change, both scientific and public discourse focused primarily on ***mitigation,*** *i.e.*, the reduction of GHG emissions. At the local level, climate change policy includes, first, the definition of emissions reduction goals, which vary widely between local authorities and include cities with very ambitious targets, such as Växjö's vision to reduce CO_2 emissions by 50% by 2010 and become fossil fuel free in the long run (Växjö kommun, 2008; Granberg/Elander, 2007). A number of cities have adopted the Kyoto target to compensate for the inaction of their governments, because, for example, they have not ratified the Kyoto Protocol (*e.g.*, the United States) or are unlikely to achieve their Kyoto commitment (*e.g.*, Italy).

Second, many cities have conducted GHG emission inventories to analyse the potential for GHG reduction and subsequently, measure their performance. This development is evidenced in the initiatives of transnational city networks, such as the International Council for Local Environment Initiatives' (ICLEI**)** Carbon Disclosure Project. In August 2008, around 30 urban centres in the United States agreed to use the same methodology to monitor and disclose their emission data. Problems remain, in particular, when cities are compared, although they do not use the same methodology to measure their GHG emissions.[2]

Third, integrated climate change strategies and plans for specific sectors (energy, transport) constitute the next step towards the institutionalisation of climate change policy at the local level. The establishment of a special unit in the mayoral office may help to accomplish this important step.

Fourth, in terms of the implementation of climate protection action plans, two alternative approaches exist: first, a unit that is in charge of climate change policy can be established within each climate-relevant department. Given the limited availability of staff, a second approach, which relies on a climate policy steering group, a climate protection co-ordination office or an overarching unit with appropriate competencies for mainstreaming climate change policy, appears to be more promising. This needs to be combined with various task forces that co-ordinate the activities around specific issues and across all relevant policy areas within the city administration.

Such a comprehensive approach has been pursued by a number of cities. In the city of Zurich, for example, a special unit for environmental protection *(Umweltschutzfachstelle),* which, among other tasks, is in charge of supervising the city's climate policy and acts as a service agency with cross-departmental tasks within the city administration. This special administrative unit is responsible for assessing every planned development and construction project in terms of its impacts, and the departments responsible for the implementation of such developments need to account for the results of this assessment. To guarantee that this model works properly requires, first, strategic plans comprising sectoral targets, policies and measures (such as the combination of a general master plan for the environment and a specific master plan for energy in the city of Zurich); and, second, a project-based approach that prevents departmental segregation.

However, numerous cities that have adopted GHG reduction targets have failed to pursue a systematic and structured approach and, instead, prefer to implement no-regret measures on a case-by-case basis. Empirical evidence suggests that the responsibility for climate change policy is usually located in the environmental policy agency (for example, in approximately two-thirds of German cities; Kern *et al.*, 2005: 38). This may lead to co-ordination and integration problems if the environmental agencies do not have the capacity to implement comprehensive concepts and are in the same position as the environmental ministries within national governments. Although climate change policy is an issue that affects a variety of departments within local administrations (for example, administrative units dealing with finances, procurement, urban planning, economic development and education), expertise on these questions in many cities is still concentrated in the environmental department. In a majority of cases, climate-related issues

are not taken into account when decisions that could have an influence on climate policy are taken outside the environmental department. Given the urgency of the problem and the need to achieve significant cuts in GHG emissions in industrialised countries, this would appear to be insufficient.

More recently, the debate on climate change has shifted, and mitigation approaches have been complemented by a new paradigm, that of ***adaptation*** to the risks introduced by climate change. This paradigm shift can be observed at different policy levels, from the global to the local. One example can be found in the Green Paper on "Adapting to Climate Change in Europe – Options for EU Action", which was released by the European Commission in June 2007 (CEC, 2007). Adaptation has become necessary because the effects of climate change have already become apparent, but it is complicated by the fact that, depending on physical and socio-economic vulnerability, natural and human adaptive capacity, health services, and disaster surveillance mechanisms (CEC, 2007. 11), the impact of climate change varies from region to region. Although the local and regional level appear to be the optimal levels for adaptation, the development of local and regional adaptation plans started only recently, and research on local adaptation strategies is still limited.

Modes of urban climate governance

Four governing modes emerge as significant in the analysis of the dynamics of urban climate governance. These modes are distinct in terms of their governing capacities and range from soft forms of governing to traditional forms of state intervention (Bulkeley/Kern, 2006: 2242). First, ***self-governing*** can be defined as the capacity of local government to govern its own activities, for example by improving energy efficiency in government offices and other municipality-owned buildings. Self-governing relies on reorganisation, institutional innovation and strategic investments. Second, ***governing through enabling*** refers to the role of local government in co-ordinating and facilitating partnerships with private entities and encouraging community engagement. Tools such as persuasion and (positive) incentives are most important for this mode of governing. Third, ***governing by provision*** implies shaping practice through the delivery of particular forms of services and resources. This is accomplished through infrastructure and financial policy. Fourth, ***governing by regulation*** can be characterised as the use of traditional forms of authority, such as control and the use of sanctions. Although these modes of governing may overlap, and individual measures are often based on a combination of several modes, these distinctions provide a framework for the analysis of urban climate governance and the measures preferred by municipalities. In the following sections, we will discuss the relevance of these four modes of urban climate governance for both mitigation and adaptation policies and measures.

Mitigation: sectors of activity

In addition to identifying distinct modes of governing, it is also possible to observe key spheres of action regarding climate change. In the area of mitigation policy, four sectors appear to be crucial. First, new approaches to energy policy have become the most visible instruments in local climate policy and aim primarily to improve energy efficiency (*e.g.*, in public buildings) and promote renewable energy solutions. Second, in the transport sector, local authorities have become engaged in the "greening" of their fleets, improving public transport systems and promoting alternative forms of transport, such as walking and cycling. Third, waste policy, less frequently used as an integral part of local climate policy, concentrates on waste prevention, reuse and recycling. Finally, urban planning and land use feature among the central responsibilities of local authorities, providing many opportunities for local action, ranging from standards for new buildings to strategic planning for new neighbourhoods. Table 1 depicts both dimensions of this analysis, *i.e.*, the modes of urban climate governance and the sectors of climate change mitigation.

Table 1: Modes of urban climate governance and sectors of climate change mitigation

Self-governing	Governing through enabling	Governing by provision	Governing by regulation
		Energy	
Energy efficiency schemes and use of combined heat and power (CHP) within municipal buildings (*e.g.*, schools) Procurement of energy-efficient appliances Purchasing of green energy Eco-house and renewable energy demonstration projects	Campaigns for energy efficiency Advice on energy efficiency to businesses and citizens Promotion of the use of renewable energy	Clean energy service provision Energy service companies Provision of incentives and grants for energy-efficiency measures	Strategic energy planning to enhance energy conservation Ordinances on the mandatory use of renewable energy Energy efficiency requirements in zoning ordinances
		Transport	
Mobility management for employees Green fleets	Education campaigns Green travel plans Quality partnerships with public transport providers	Provision of public transport Provision of infrastructure for alternative forms of transport Logistics centres for freight transport	Transport planning to limit car use and provide walking and cycling infrastructure Workplace levies and road-user charges
		Waste	
Waste prevention, recycling, and reuse within the local authority Procurement of recycled goods	Campaigns for reducing, reusing and recycling waste Promotion of the use of recycled products	Waste service provision Installations for recycling, composting and "waste to energy" facilities Recycling, composting and reuse schemes	Regulations on methane combustion from landfill sites
		Urban planning and land use	
High energy-efficiency standards and use of CHP in new public buildings Demonstration projects – whether at the residential or neighbourhood level	Guidance for architects and developers on energy efficiency and renewables		Strategic land-use planning to enhance energy efficiency and the utilisation of renewables Planning of sites for renewable installations Strategic land-use planning to enhance public transport

Source: Based on Bulkeley, H. and K. Kern (2006), "Local Government and the Governing of Climate Change in Germany and the UK", *Urban Studies*, Vol. 43, No. 12, p. 2243.

Self-governing: the municipality as consumer

The implementation of climate protection measures is relatively simple in areas in which the municipality can make its own decisions and can control its own consumption. In many countries, the majority of climate protection measures concentrate on this type of initiative (Bulkeley/Kern, 2006; Kern *et al.*, 2005; Bulkeley/Betsill, 2003). However, changing the procurement policy of local governments may have a considerable impact on the local economy, because city governments demand a variety of goods and services.

Improving energy efficiency in municipal buildings has been the key area for action in many cities. In Sweden, 95% of the municipalities and all regions are engaged in improving energy efficiency in their own buildings (SKL, 2007: 3). Furthermore, municipalities can purchase a certain percentage of their energy from "green" sources. In Heidelberg, for example, the city council decided in 2001 to spend EUR 330 000 for a 25% share of renewable energy consumption in municipal buildings. Self-governing is also crucial for the transport sector. Today it has become very common for municipalities to purchase alternative vehicles, such as biogas or natural-gas cars and buses, for the purpose of "greening" their fleets. Operating alternative-fuel vehicles and constructing green buildings has helped Seattle's city government reduce its GHG emissions by 60% (Sierra Club, 2006: 2). In the city of Graz, for example, biodiesel from used cooking oil, which is collected systematically, is used for the city's fleet.

Such actions are most often driven by both environmental and economic concerns. In Munich, an assessment of 1 000 municipal buildings was conducted by the administration to identify the potential for energy savings; 3 000 individual measures were identified, amounting to annual savings of EUR 1 million. The city of Berlin pooled public buildings in order to be able to conclude better contracts with performance contractors. Motivated by a lack of economic resources, many German cities have cancelled their contracts with external energy service companies (ESCOs) and implemented performance contracting projects in the energy sector. Another approach employed in Germany involves the use of internal resources, based on revolving funds. Energy saving in schools and other public buildings is also encouraged by offering a share of the energy costs saved as a financial incentive to change energy-related behaviour (*e.g.*, 50/50 projects for schools).

Such initiatives are often driven by the financial benefits of energy saving but can, nonetheless, increase political support for climate policy at the local level. Local self-governing initiatives have certainly helped to put climate protection on the political agenda. However, in most countries, local authority energy consumption only accounts for between 1% and 5% of total CO_2 emissions within municipalities (although it can be higher if the cities own residential buildings, as in Austria and Sweden). Thus, significant effects can only be achieved when local climate change policy is complemented by other modes of governing (Bulkeley/Kern, 2006).

Governing through enabling: the municipality as facilitator

Apart from initiatives targeting their own consumption patterns, city governments co-operate with non-state actors, encouraging and facilitating voluntary action undertaken by businesses and citizens. The enabling mode has various dimensions, including public education and awareness campaigns and the promotional activities of local governments. For example, the city of Leicester (United Kingdom) conducted an energy education project that included the use of an electric energy-advice bus that tours local schools, and the development of best-practice case studies, which helped other municipalities identify the potential for and barriers to the development of renewable energy. Moreover, the efforts in Leicester have also had a regional dimension. In co-operation with other actors, the city has developed the East Midlands Community Renewables Initiative, which promotes the development of renewable energy on a regional level (Bulkeley/Kern, 2006).

In addition to promotional campaigns, governing through enabling requires local governments to develop external ties and facilitate co-operation between stakeholders. This includes the establishment of public-private partnerships for the provision of services and infrastructure. For example, the London Climate Change Agency (LCCA), which is owned and controlled by the London Development Agency, was established with the direct support of private companies. Its main mission is to deliver projects that reduce London's GHG emissions and implement the mayor's Climate Change Action Plan and the Mayor's Energy Strategy. In 2006, the LCCA and EDF Energy, one of the largest energy companies in the United Kingdom, set up a joint venture energy service company to develop decentralised energy schemes for London. Moreover, the London Energy Partnership (LEP), which consists of a consortium of private companies and public agencies, aims to stimulate energy actions, transform London's energy infrastructure and promote sustainable energy solutions by bringing together all relevant sectors and organisations. The partnership has created several task forces, *e.g.*, for low-carbon finance and community heating, to fulfil its mission more effectively.

In Munich, the city has created not only an energy commission but established various other fora that directly involve private stakeholders. Two specialised working groups *(Fachforen)* were established, *i.e.*, Solar City Munich *(Solarstadt München)* and Energy-Saving in Residential Buildings, as part of the Extended Climate Protection Programme *(Erweitertes Klimaschutzprogramm)*. These working groups bring together potential investors and companies that have the necessary expertise for the realisation of innovative energy strategies.

A similar approach has been pursued in Venice, where the city council approved a municipal energy plan in 2002. This plan aims primarily, but not exclusively, to improve energy efficiency in the public and private sectors. It comprises a series of intention protocols that outline a number of joint venture projects between the municipality and other interested parties. Based on a formal framework for co-operation, a number of such protocols have been agreed on by the local administration and various stakeholders, for example an agreement between the city of Venice and the glassblower companies in Murano. These agreements include not only private companies but also municipal transport companies, the housing administrators' associations and the associations of planners, architects and engineers.[3]

Enabling activities, which are primarily based on persuasion and argument, seek to encourage other actors to establish climate protection initiatives. While awareness and promotion campaigns have become part of the general repertoire of most cities when it comes to climate change policy, the establishment of new partnerships for the transition of existing infrastructure and services is less common. Such arrangements appear to be better suited to the needs of large and competitive cities, such as London or Munich, which are highly committed to climate change policy and pursue ambitious GHG reduction goals, while also being driven by economic incentives and prospects.

Governing by provision: The municipality as provider

If a municipality is the majority shareholder in the local utility companies for energy, transport, water and waste services, it is in an excellent position to steer local action on climate change. Cities in this position can directly influence the generation of electricity, prioritise district heating systems and combined heat and power (CHP) and/or combined cooling and power systems, push for investments in energy efficiency and renewable energy technologies, and can even combine this with funding schemes for private investors. This means that the direct provision of services enables local governments to create infrastructure that generates fewer GHG emissions.

The internationalisation and liberalisation of the energy markets are putting such arrangements under increasing pressure. This applies in particular to European countries, which are obliged to implement the EU directives on the liberalisation of the European electricity market. In Germany, for example, the Power

Industry Act *(Energiewirtschaftsgesetz)* of 1998 restricted the influence of municipalities over the generation of electricity primarily to their options as shareholders. In the course of liberalising electricity markets, German municipalities have almost entirely lost their potential to influence the supply side of energy, because many public utilities have been partly or completely privatised, while most of the remaining municipally owned companies have restricted themselves to the distribution of electricity and buy electricity on the spot market, which is now generated by a limited number of big private companies. Demand-side management programmes, which were popular among local utilities, have been almost completely phased out since liberalisation. The liberalisation of energy markets has made the task of local climate change policy even more challenging, because these policy objectives are difficult to reconcile.

Despite the liberalisation of the European energy markets, some pioneering cities, such as Heidelberg and Munich, have managed to implement climate protection measures. In Munich, the *Stadtwerke*, now a private company owned by the city of Munich, charges a premium for electricity from renewable sources, which is transferred to a special fund for innovative projects such as photovoltaic (PV) installations. Using the proceeds from the sale of shares in their utilities has helped some other cities to set up funds for sustainable-energy projects, such as Hanover's *Proklima* fund. Although liberalisation has limited the governing capacities of European cities in the area of climate change policy, municipalities with their own utilities appear to be more successful in the field of climate change policy (Kern *et al.*, 2005; Weimer-Jehle *et al.*, 2001:4).

Moreover, because the cross-subsidisation of transport services is no longer possible, the liberalisation of the European energy markets has had far-reaching consequences for the transport sector in European cities. If public transport systems are privatised, local authorities are still able to influence the transport system through local public transport plans. However, these regulations change their role from governing by provision to a combination of enabling and the use of regulatory power. In North America, the situation is somewhat different because public transport systems are less developed than in Europe. However, they have experienced a revival in the last few decades, with cities such as Portland, Sacramento, San Diego and Minneapolis establishing new transport infrastructure, in some cases through public-private partnerships. Although transit use has increased, *e.g.*, in Portland by 75% since 1990 (USMCPA, 2008:20), the existing transport infrastructure poses considerable challenges for successful climate change policy in American cities, because a relatively high, and even increasing portion of GHG emissions originates from the transport sector.

Governing through provision affects the development and transformation of urban infrastructure, which, in turn, is decisive for consumption patterns and affects local climate change policy. From existing research, we can draw the conclusion that the significance of this mode of governing will further decrease with the increasing liberalisation of the energy markets. If local governments, in Europe at least, would like to address the issue of climate change, they will need to turn to other modes of governing (Bulkeley/Kern, 2006; Kern *et al.*, 2005; Le Gales, 2002: 256).

Governing by regulation: the municipality as regulator

In many countries, local governments have the legal power to govern urban climate change by regulation, in particular through strategic energy, transport and land-use planning. If such plans incorporate climate change mitigation goals, they have significant effects on GHG emissions. Although municipalities at large have the authority to include climate policy goals in their strategic planning, they are not obliged to do so. After all, climate change policy remains for the most part a voluntary task of local authorities.

The case of Barcelona's Solar Thermal Ordinance of 2000, which requires the installation of solar thermal collectors for hot water supply, clearly shows that governing by regulation can have considerable impact at local level, and that such regulations can become a model for similar initiatives in other

jurisdictions. Such ordinances were subsequently adopted in around 40 municipalities in Catalonia and in almost 30 municipalities in other parts of Spain (Ekelund/Sigurdson, 2007:12).

Municipalities in the United States established their initiatives in the area of climate change policy considerably later than their European counterparts, but pioneering cities have caught up fast and are now developing similar approaches. In 2007, the Mayor of New York announced that the Taxi and Limousine Commission will phase in new emissions and mileage standards for the more than 13 000 yellow taxicabs over a four-year period. This will lead to a fully hybrid fleet by 2012, reduce the carbon emissions of the taxicab fleet by 50% over the next decade and will also decrease the fuel costs for taxi drivers (Ward, *et al.*, 2007: 13). Moreover, in 2007, the city of Santa Barbara, California, passed an ordinance and adopted provisions for all buildings within the city. This local ordinance aims to reduce the fossil fuel standard for all new buildings in order to achieve carbon neutrality by 2030. This building regulation exceeds state standards for energy use by 20% for low-rise residential buildings, 15% for high-rise residential buildings and 10% for non-residential buildings (Ward *et al.*, 2008: 5).

In the United Kingdom, local authorities need to comply with certain regulations, such as specific requirements for new housing. In addition, they have discretionary powers for the introduction of supplementary guidance, for example on energy efficiency standards for buildings that exceed national regulations. However, empirical evidence suggests that only a few measures in strategic planning documents relate to energy conservation (Bulkeley/Kern, 2006; Bulkeley/Betsill, 2003; Bruff/Wood, 2000). In some countries, such as Germany, municipalities even face legal obstacles if they wish to incorporate climate change considerations fully into urban planning.

The same tendency is evident in the transport sector, in which emission reductions are difficult to achieve. Although the transport sector is frequently included in climate strategies and climate action plans, in German municipalities, even pioneering ones like Munich, the priority given to climate protection in the transport sector is relatively low. Although municipalities have the authority to enact comprehensive plans, transport measures aiming to reduce GHG emissions tend to be limited to smaller projects, such as the construction of cycle paths. Compared to the energy sector, it appears that it is considerably more difficult for most cities to reach a political consensus and broad acceptance for policies in the transport sector, in particular when measures aim to reduce and restrict the use of cars.

In the United Kingdom, municipalities can introduce demand management measures through local transport plans, including hard measures such as road-user charging (Bulkeley/Rayner, 2003). The most prominent example in this respect is London's congestion charging scheme, which was introduced in 2003 and led to a decrease of traffic in central London by 21% in five years. Other cities followed suit, for example, Stockholm, where a congestion charge was introduced in 2006, despite considerable resistance.[4]

These examples show that cities can use their authoritative power in very creative ways, even to generate funding for the implementation of their climate protection policy. The city of Boulder, Colorado, attracted media attention in 2006 when voters approved a city-wide carbon tax to fund Boulder's GHG emissions reduction strategy, laid down in its Climate Action Plan (Betsill/Rabe, 2008). In spite of the limited number of success stories, such as Boulder's carbon tax, Barcelona's Solar Thermal Ordinance and London's congestion charge, it appears that municipalities are reluctant to apply an authoritative mode of governing through regulative measures and strategic planning for climate protection. Instead, a lack of willingness to act locally in the face of political, business and public opposition can be observed – even if the capacity to intervene exists (Bulkeley/Kern, 2006). It may be added that far-reaching approaches, such as the introduction of a carbon-tax or congestion charge, are difficult to achieve because they may require not only a consensus in the city council but also a referendum.

Having discussed the different modes of governing in the area of mitigation, we will now turn to the question as to how cities have been dealing with the new challenges posed by the need to adapt to the effects of climate change.

Adaptation

Whereas cities had initiated mitigation policies and created networks even before the Intergovernmental Panel on Climate Change (IPCC) First Assessment Report was released, adaptation policies at the local level are still in their infancy. The forerunner cities in the area of mitigation accepted scientific uncertainty, focusing on "no-regret" measures and linking their activities closely to local and regional sustainable development. However, a sound scientific basis is imperative when developing an adaptation strategy (Lindseth, 2005:63). This is one of the reasons why cities tend to wait until they are actually affected by extreme weather events.

Cities receive input and guidance from scientific and governmental institutions at the national level in relation to adaptation. In many countries, such institutions have started to investigate potential impact and produce recommendations that show how actors at various levels can adapt to climate change. This stands in sharp contrast to the situation in the area of mitigation, where cities' mitigation activities were not recognised by national governments and the scientific community for several years. Learning by doing was the only option available to these cities to advance their knowledge in this area. Nevertheless, numerous local governments produced and adopted mitigation plans, whereas, at present, adaptation plans are only at a preliminary stage and range from preparatory studies on how to prepare an adaptation plan (*e.g.*, for Cape Town), and impact assessments (*e.g.*, for London), to the early stages of mere sectoral action plans (*e.g.*, for the health sector in the Toronto/Niagara region and for Stockholm, with an emphasis on biodiversity).

The first countries to take adaptation into consideration at the local level were the United States, Canada and the United Kingdom. In the United States, regional case studies were initiated in 1997 as part of the national assessment of climate variability and change. Subsequently, regional studies were carried out in Canada, including dialogue and participation processes with local stakeholders (Lindseth, 2003). In the United Kingdom, the United Kingdom Climate Impacts Programme (UKCIP) was set up in 1997 by the British government to help various organisations to adapt to climate change. The Local Climate Impacts Profile (LCLIP) methodology, which investigates vulnerability and further needs for scientific information was developed and disseminated among local governments. To date, some 25 local authorities (counties and cities) have compiled LCLIPs. Other relevant projects that provide guidance for local governments include the French *Campagne nationale de sensibilisation et adaptation,* which addresses local governments, among other actors, the World Bank's Primer on Climate-Resilient Cities, which focuses on Eastern Asia (World Bank, 2008), and the Tyndall Centre's "Tyndall Cities Programme". The latter aims to develop city-scale assessment capacities, simulate the evolution of climate impacts and emissions over the 21st century, compare alternative adaptation and mitigation strategies, and consider how cities grow whilst reducing emissions and vulnerability to climate change (Tyndall Centre, 2007).

Cities in high-income countries are considered to enjoy a relatively high adaptive capacity (Satterthwaite *et al.*, 2007). It may thus be assumed that they will be able to improve resilience and manage adaptation once a certain degree of awareness has been developed and guidance has become available. In contrast, the lack of adaptive capacity in middle-income and low-income countries calls for extensive support, both in terms of capacity building and investments in infrastructure and services.[5]

Transnational networks in the area of climate change, which concentrated on mitigation for a long time, began to extend their interest to adaptation around five years ago:

- In 2003, a working group "Global Warming – Local Warning" was created on the initiative of British cities and the European Commission and is co-ordinated by Eurocities;

- In 2005, the Climate Alliance of European Cities initiated the AMICA project to campaign for a combination of mitigation and adaptation and for an integrated methodology to address both;

- In 2006, the ICLEI added the topic of adaptation to its Strategic Plan.

In most cases, cities seek to adapt to current climate variability. In doing this, they are at least increasing awareness and preparedness, which is expected to be helpful in the management of future risks (Storbjörk, 2007) and can be a good starting point for adaptation to the impacts of climate change. Whereas such event-driven activities concentrate on a specific problem, *i.e.*, mainly flooding due to intense rainfall, some cities pursue a more comprehensive anticipatory approach, aiming to reduce vulnerability and improve resilience to climate variability. An increasing number of efforts in this area are seeking synergies between mitigation and adaptation (Tyndall Centre, 2007). Moreover, there is a broad range of basic options, ranging from defensive measures, such as dams, to preventive measures, such as avoiding the development of sites that are at risk from flooding, and "no-regret" measures that lead to synergies with other fields of action, such as the renaturation of rivers to enhance their water retention.

The more proactive and targeted the approach, the more crucial are, first, the validity of the underlying predictions and, second, a common understanding of the underlying science. This is important so that decisions can be made as to which investments and levels of risk are acceptable. Thus, close interaction between policy makers and scientists and the participation of citizens and stakeholders are required (Lindseth, 2005). Moreover, certain conflicts between goals must be resolved, such as the "conflict between safety and scenery" (Storbjörk, 2007: 461), *e.g.*, the attractiveness of settlements with proximity to water bodies versus the risks of flooding and the need for expensive investment in flood protection measures.

UKCIP, in collaboration with the Nottingham Declaration, promotes an integrated approach, which distinguishes between three forms of local governance, roughly in line with the modes considered in the previous section on mitigation: *i.e.*, municipalities and administrators are seen as *i)* estate managers, *i.e.*, as employers and major consumers of energy and other resources and as managers of transport and buildings; *ii)* service providers, which includes the responsibility for emergency planning and social care; and *iii)* community leaders, covering community strategies and partnerships. The authors identify the need and options for adaptation in all these spheres.

The ***self-governing*** mode implies that the planning and the management of public buildings should be adapted to climate change. Sites under risk from flooding should be avoided, sufficient cooling in cases of heat waves should be guaranteed, etc. ***Governing through enabling*** is the mode in which the least practical experience is available. In principle, local governments should influence private actors to do their share in the area of adaptation; however, it has been reported that a lot of persuasion is still required in this area, except in the direct aftermath of extreme weather events (Lindseth, 2005; Storbjörk, 2007). ***Governing by provision*** includes the above-mentioned service provider areas, in particular warning systems and emergency planning that take climate change and extreme weather events into consideration. ***Governing by regulation*** involves, for example, urban planning, which is a core area both for local mitigation and adaptation, since this has in most countries been a field where local governments play an influential role. Because adaptation has recently focused on flooding, it has become clear that urban development planning needs to ensure that the development of sites that are prone to flooding is avoided.

Urban climate governance in multi-level systems

Modes of urban climate governance in multi-level systems

Successful climate change policy at the local level depends both on internal factors, which were discussed in the previous section, and external influences. The latter are concerned with the fact that climate change policy needs to be implemented in multi-level systems, ranging from the international system and the European Union to nation-states and metropolitan regions. Effective multi-level arrangements depend on a fruitful combination of horizontal and vertical collaboration.

Horizontal collaboration, which can be regarded as a form of ***self-governing*** within multi-level systems, can take different shapes and forms. This includes, first, collaboration between cities and regions. In climate change policy this is, in many countries at least, crucial to the success of urban climate change policy. Cities and regions share competencies in many areas that play an essential role in climate change policy, for example in the spatial planning and the transport sector. Furthermore, formal city boundaries are often too narrow to make it possible to address urban development and transport issues adequately unless a significant effort is made to collaborate within metro-regions (OECD, 2006). Second, horizontal collaboration between cities can lead to the establishment of national and transnational city networks, which have gained in importance in recent years.

Apart from horizontal collaboration, various forms of vertical collaboration are also crucial to urban climate change policy. The municipalities' scope of action in this policy area depends primarily on their position within the national multi-level system. In most countries no direct link exists between national GHG-reduction goals derived from national climate protection programmes and international agreements (UN, EU), on the one hand, and the implementation of these goals at the regional and local level, on the other. Since mandatory provisions in the national legislation, which is relevant for local climate policy, is somewhat limited or lacking altogether in most countries, local climate action remains a voluntary task for local authorities. This explains why the debate on local action to curb GHG emissions started in some pioneering cities almost 20 years ago, while other municipalities remained passive or limited their actions to energy-efficiency projects that promised financial benefits. Even in Sweden, not more than 30% of local authorities have set reduction targets close to the national or regional target (SK, 2007: 13).

In accordance with the debate on urban climate governance in the previous section, it is possible to distinguish three different modes of vertical collaboration within nation-states that focus directly on local climate policy. First, national governments can use ***governing through enabling*** to stimulate and facilitate action on the ground. Most popular in this respect are guidelines for local authorities and the dissemination of information on best-practice cases. Second, ***governing by provision*** goes beyond the transfer of information and knowledge for capacity building and offers additional services for local authorities. These include positive incentives in the form of funding programmes for local projects in the area of climate policy. ***Governing by regulation*** is a third alternative for the organisation of local-state relations in the area of local climate change policy, although most countries have opted, at least up to now, for "softer" forms of governing and have abstained from intervening directly in local climate politics.

As in the case of the debate on the local dimension of urban climate governance, in terms of the multi-level dimension of urban climate governance, these modes may overlap and complement each other. National governments may therefore choose a combination of these modes. Voluntary agreements between national and sub-national governments, for example, combine the enabling and provision mode if the voluntary agreement includes a funding scheme. While national governments can apply all three modes of governing, the European Union, international organizations and transnational networks are far more limited in the choices available to them, and rely in particular on enabling local decision-makers to become more active in the area of climate change policy.

Horizontal collaboration: from the metro-region to transnational networks

Climate governance in metro-regions

The current debate on climate mitigation and adaptation measures at the local level shows that the key problem concerning the co-ordination of mitigation and adaptation measures appears to be a spatial mismatch, which necessitates horizontal collaboration within metro-regions. Municipal boundaries may pose serious problems for adaptation measures because a number of adaptation strategies need to be decided and implemented on a regional scale (for example, water management systems and precautionary flood-protection measures along rivers). In addition, some measures, such as early-warning systems, require effective communication and co-ordination mechanisms beyond city boundaries.

However, the problem of a spatial mismatch is not limited to adaptation measures. It can also be observed in the analysis of mitigation plans and strategies. In many cities, the county or regional government is responsible for climate-relevant issues, such as public transport, and even if the city is in charge, it is absolutely necessary to co-operate with the surrounding communities on a regional scale to find appropriate solutions. Successful climate policy often depends on technical infrastructure, which transcends city borders. Moreover, horizontal collaboration within metro-regions can avoid harmful competition between local authorities to attract developers and investors, which sometimes leads to a race-to-the-bottom in the area of environmental and efficiency standards (Lundqvist/Biel, 2007).

It may be assumed that collaboration within metro-regions will gain considerably in importance for climate change policy. In Europe, this development is supported by regional energy agencies, which are partially funded by the EU and have been established throughout Europe. Some 260 local and regional agencies already offer guidance and services on energy and transport policy. However, in most cases, decision-making remains the prerogative of local governments, and the influence of these agencies is limited, in particular if their funding is not ensured in the mid- and longer term.

The German metropolitan region of Hanover, a metro-region with about four million inhabitants, is an example of a regional approach to both mitigation and adaptation strategies. The Regional Climate Protection Agency *(Klimaschutz-Agentur Region Hannover),* which was established in 2001 by the Hanover City Council, the former regional association of local governments, the city's utility and various private partners, is in charge of co-ordinating all climate protection efforts throughout the region. In the meantime, the regional association of local governments and Hanover county have been transformed into a new authority covering the metro-region, *i.e.*, Hanover Region *(Region Hannover),* and major competences have been transferred to this body.

Another example is Metro Portland (Oregon), which serves the city of Portland, three counties and 25 cities in the region. It is now in charge of maintaining the Portland area urban growth boundary and is also responsible for the region's transportation system. This is crucial to avoid urban sprawl and is therefore a key element of regional mitigation efforts. The city of Portland was the first city in the United States to initiate a local climate action campaign. In 2001, Multnomah county followed Portland's lead and developed a regional strategy (Local Action Plan on Global Warming) covering the city and the county. This strategy includes 150 short- and long-term measures with the overall goal of reducing CO_2 emissions by 10% by 2010 (Ekelund/Sigurdson, 2008: 25). Both metro-regions, *i.e.*, Portland and Hanover, are governed by elected bodies, which may explain the strength of the regional collaboration and co-operation (OECD, 2006: 168).

National and transnational networks

Horizontal collaboration in local climate change policy depends not only on a co-operative approach to the management of urban affairs within metro-regions but also on the "foreign policy" of local authorities. The propensity of many pioneering cities to join national and transnational city networks can be regarded as a second type of self-governing local climate protection within multi-level systems. Innovative cities often join transnational city networks, whose aims include best-practice transfer, learning among their members at home and abroad, and the representation of their members' interests within the national, European and international multi-level system.

Various city networks focusing on climate change have emerged in recent years, based either on top-down approaches, such as C40 cities, membership of which is limited to big cities, based on invitation and supported by the Clinton Foundation,[6] or bottom-up approaches, such as the Cities for Climate Protection Campaign (CCP), the Climate Alliance and Energie-Cités. These three networks were created in the early 1990s, shortly before the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, which put climate protection policy on the political agenda at global, European and national levels. Whereas all three networks have climate protection policy as their mission, the reasons behind their creation differed considerably. CCP is a global city network, the Climate Alliance developed bottom-up as a network of European cities and Energie-Cités stemmed from a project funded by the EU Commission. Nevertheless, the general goals of these networks are almost identical. The networks seek voluntary commitments from municipalities for the reduction of GHG emissions, they try to enhance local capacities to address climate change, they promote the exchange of experience and transfer of expertise between their member cities, and they represent the interests of their constituents at national, supranational, and international levels (Kern/Bulkeley, 2009).

Cities co-operate not only at the international, but also at the national level. In the United States, the U.S. Conference of Mayors Climate Agreement, which was launched in February 2005 by Mayor Greg Nickels of Seattle, has already been signed by almost 900 American mayors. Mayors who join this campaign commit themselves to strive to meet, or even beat, the Kyoto target for the United States (minus 7% of the 1990 emissions levels) in their own communities.[7] Like their European counterparts, American cities have started to lobby for climate protection legislation in their state capitals, in Washington D.C. and even at the international level.

Based on an analysis of the various forms of governing capacities of national and transnational city networks, fundamental differences between active and passive member cities are apparent, in particular in big networks. Passive member cities are difficult to reach via networks. Although transnational city networks constitute a promising new form of climate governance, they appear to be primarily networks of pioneers for pioneers (Kern/Bulkeley, 2009).

City networks can try to counterbalance this gap between pioneers and laggards by setting tiered standards that attract members with differing levels of performance and ambition. For example, the certification scheme set up by *Energiestadt Schweiz,* a Swiss city network, is characterised by a membership structure that includes two groups of cities: *i)* member cities that have already completed the certification process and have been awarded the label; and *ii)* member cities that participate in and support the initiative but have not been certified because they cannot fulfil the requirements. This structure appears to offer an appropriate approach to bridging the gap between pioneers and laggards, because it attracts not only the best-performing organisations but also organisations that cannot play in the first league but are prepared to play in the second or third league.

Vertical collaboration within nation-states

Governing through enabling: national government as facilitator

Governing through enabling is primarily limited to the collection of information and the dissemination of knowledge on best-practice cases. The main aim of this approach is to build capacity at the local level. Guidelines and guidebooks for local authorities have been developed in various countries. In Germany, for example, the federal government provided municipalities with guidelines for local climate protection *(Leitfaden Kommunaler Klimaschutz)* in 1997. These guidelines contain sections on general aspects of local climate protection, steps for the development of local concepts, the exchange of experience, funding of climate protection activities and recommendations for all relevant sectors (energy, transport, urban planning and land use, and waste). More recently, such guidebooks contain recommendations for actions concerning mitigation and adaptation at local level, *e.g.*, the guidebook "Climate Change: A Guidebook for Local, Regional, and State Governments", which was published recently by King County (Washington) and written in co-operation with ICLEI and the National Oceanic and Atmospheric Administration's Climate Resilience Communities Program (Ward *et al.,* 2008).

Governing local climate change policy through enabling appears to dominate in federal states such as Germany. In such political systems, the states, such as the German federal state of North-Rhine Westphalia, constitute an additional layer of government, which may run more comprehensive programmes for local authorities than the federal government. This may explain why local climate change policies may differ between unitary and federal states. National (funding) programmes, which will be discussed in more detail in the next section, are often developed at a later stage in countries with a federalist structure, such as Germany (Kern *et al.,* 2007; Kern, 2008).[8]

Enabling is a form of voluntary governance that could be further developed, because even in the absence of regulation and subsidisation, it is possible to create incentives to institutionalise climate change policy at the local level. Best-practice transfer can be expanded in two directions: first, benchmarking certainly helps to generate more action on the ground. Competitions and awards can be used to recognise the best-performing local authorities. An example is the "Competition for the capital city in climate protection" *(Wettbewerb Bundeshauptstadt im Klimaschutz)* which was initiated by the German federal government. Benchmarking is also crucial for the Local Governments Climate Partnership, a research and development project funded by the German Federal Environmental Agency and run by the Climate Alliance, which is based on a benchmarking system for the analysis of climate protection activities in Germany, Japan and the United States.[9] In addition, NGOs frequently use benchmarking as a tool to promote local climate policy. The Swedish Society for Nature Conservation, for example, has ranked the climate policy of Swedish local authorities, and presented its first climate index for Swedish local authorities *(Klimatindex för kommuner)* in 2005 and its second in 2007 (SK, 2005, 2007). In 2007, more than 70% of all Swedish municipalities participated in this exercise on a voluntary basis. A similar approach has been developed by the Dutch NGO *Milieu Defensie* with its Climate Map (*Klimaatkaart),* which presents the *per capita* carbon dioxide emissions of Dutch local authorities and a score for their key GHG reduction-activities on a map.

Second, in addition to benchmarking systems, voluntary certification schemes can also be established, an approach that has been chosen by the city network *Energiestadt Schweiz.* Under this system, more than 160 Swiss municipalities have been certified by an independent commission and have been awarded a label.[10] The spread of this label is remarkable, because this certification scheme is not market-driven. Energy labels for cities may however, improve the reputation and image of a city as compared with that of other members of their peer group. Although the Swiss scheme is managed by an NGO, such a system could also be based on a voluntary agreement between the national government and cities.

Governing by provision: national government as provider

However, in many countries, certification schemes cannot solve the most urgent problem that many local authorities face when considering climate protection initiatives, *i.e.*, the lack of financial resources (Collier/Löfstedt 1997; Betsill, 2000; Bulkeley/Kern, 2006). As local government finance varies widely among OECD countries in terms of total revenue (as a percentage of national GDP) and fiscal autonomy (*cf.* Caulfield, 2000), the financial capacity of cities to set up climate protection programmes depends not only on city-specific factors but also on national preconditions. Funding schemes that support capacity building and the preparation of climate action plans and low-carbon investments at the local level have been established in various states. Programmes of this type, which have been active for many years, can be found primarily in unitary states with relatively strong local authorities, such as the Netherlands and Sweden. National funding schemes, such as the Dutch BANS agreement and Sweden's Climate Investment Programme (KLIMP), can help to create local capacities and put climate change policy on the political agenda.

The Dutch *Klimaatcovenant* is a multi-level arrangement involving local government, provinces and several ministries at the national level. In order to receive funding provided by the BANS (*Bestuursakkoord Nieuwe Stijl* – New Style Management Agreement) agreement, local authorities have to undergo an initial scan and need to present and implement a comprehensive climate action plan using a common methodology. This is based on a performance card *(Prestatiekaart)*, which comprises targets, policies and measures, grouped according to the relevant fields of work (municipal facilities, housing, mobility, business etc.). Cities can choose between three activity levels: active, advanced and innovative. The active level is more or less identical with the implementation of the Kyoto target at the local level, *e.g.*, energy management and the enforcement of national guidelines for sustainable buildings. The advanced level requires activities that go beyond the national targets and norms, *e.g.*, concerning the share of renewable energy and the standards for buildings. The innovative level requires even higher targets and standards. The programme was developed in the context of a negotiation process involving the government and the national association of local authorities.[11]

The funding of local measures depends on the number of inhabitants or the municipal area. It cannot be used for investments but for the implementation of local climate plans, *e.g.*, costs for personnel, research, communication and education. It is complemented by specific sectoral programmes supporting and guiding local action in core areas such as mobility and housing. The scheme started in 2002, with subsidies of about EUR 36 million for a five-year period, and resulted in several hundred local climate scans and more than 250 municipal implementation plans. The second phase of the scheme was launched in 2008, and includes another EUR 35 million of subsidies up to 2011, with EUR 31.5 million reserved for municipal authorities and EUR 3.5 million for provincial authorities (NOVEM, 2003; VROM, 2007; Gupta, 2007; Gupta *et al.*, 2007).

Local climate protection policy in Sweden has been supported by two investment programmes. While its Local Investment Programme (LIP) was a general environmental subsidy programme, KLIMP is a programme for climate projects. The requirement of municipal co-funding is a common factor of these two subsidy programmes. LIP started in 1998 and aims both to increase ecological sustainability in society and create new jobs. The KLIMP programme, which replaced LIP in 2003, specifically targets the reduction of GHG emissions. From 1998 to 2008, approximately SEK 25 billion, of which about SEK 6 billion was provided by the government, was spent on environmental and climate protection projects. A total of 126 climate investment programmes and 211 local investment programmes, consisting of some 2 700 projects, have been funded by the programme. Most projects approved under KLIMP were energy and transport projects (Langlais *et al*., 2007: 18). The Swedish Environmental Protection Agency evaluated both programmes in 2008 and established that they had resulted in a reduction of 2.1 million tons of GHG emissions per year, which corresponds to 3% of all Swedish GHG emissions (Naturvårdsverket, 2008; *cf.*

Baker/Eckerberg, 2007; Johansson, 2007; Granberg/Elander, 2007; Baker/Eckerberg, 2008; SOU, 2008: 244-245).

Other funding schemes include, for example, Canada's Green Municipal Fund (GMF), which was established in 2000. This funding programme, which is managed by the Federation of Canadian Municipalities (FCM), provides loans and grants for municipal governments. The Government of Canada endowed FCM with CAD 550 million to establish the GMF and to provide a long-term sustainable source of finance for municipal governments. Compared with their Canadian counterparts, American cities face a rather difficult situation, because there is still a lack of federal and state support for local initiatives in the United States. The new Energy Independence and Security Act of 2007 authorises USD 2 billion a year for energy efficiency and conservation block grants for local governments. However, these resources must be appropriated by Congress (Ward *et al.*, 2008: 17-18).

Similar to national governments in a federal state, EU institutions do not have direct links to European cities, but the European Commission has nonetheless started to establish its own system, the "Covenant of Mayors". This scheme is based on a voluntary agreement, but goes beyond the enabling mode of governing because it includes a funding scheme. The European Commission initiated this programme in January 2008. The initiative aims to bring together the mayors of Europe's most pioneering cities to improve energy efficiency and promote cleaner energy production. This includes a formal commitment by the cities to reduce their CO_2 emissions by more than 20% by 2020. Almost 100 cities throughout Europe, including 15 capital cities, such as London and Berlin, have expressed their willingness to join. The local authorities will have to present regular reports and provide action plans. The European Commission plans to set up a "benchmark for excellence" mechanism. A Covenant secretariat, funded through the Intelligent Energy Europe programme, will facilitate monitoring, networking and promotion. Cities that do not comply with the rules will be excluded from the plan, which will provide EU funding to local authorities to promote energy efficiency or renewable energy in the region.

The development of these programmes suggests that governing by provision depends, primarily at least, on the structure of the political system (unitary systems, federal systems) and the preferences of policy makers at the national (and European) level, which in turn determines the allocation and availability of resources at the local level. Relatively rich unitary states with a good environmental record, such as Sweden, tend to become forerunners in this area. Moreover, the example of the Dutch BANS agreement clearly shows that such schemes are most successful when local authorities have a say in the development and set-up of such programmes. Thus, it does not come as a surprise that associations of local authorities in other countries, such as Sweden, are seeking greater inclusion in and influence on national climate change policy and the programmes decided at the national level (SKL, 2008).

Governing by regulation: national government as regulator

Apart from capacity building through enabling and funding, national governments can also use their state authority to set mandatory requirements for local climate change policy. It may be assumed that in countries in which local authorities are strongly influenced by national regulations, the national government can steer local climate protection action better than in countries in which local authorities enjoy a stronger and relatively independent position. In contrast to countries where municipalities are relatively independent, research on the United Kingdom suggests that planning has been traditionally characterised by a strong hierarchical relationship between local authorities and the national government. This relationship can ensure that local decision makers fulfil national demands. From 2008, councils are assessed on their performance in reducing *per capita* carbon emissions in their area (Collier/Löfstedt, 1997; Cowell/Murdoch, 1999: 663; Bulkeley/Kern, 2006; Granberg/Elander, 2007; LGA, 2008).

Although comparable regulations tend to be less stringent in other countries, local authorities may be obliged by national legislation to develop strategic plans in sectors of relevance to climate protection policy. Swedish local authorities, for example, which are far more independent of national government than their British counterparts, must fulfil mandatory requirements in the energy sector. The Swedish law on municipal energy planning requires that municipal councils develop an energy plan, including strategies for the supply, distribution and the use of energy. However, in 2005, less than 60% of the Swedish municipalities had an energy plan in place (SK, 2005: 20). Moreover, there is even uncertainty among Swedish municipal administrators about their responsibilities in relation to climate change policy (Langlais *et al.*, 2007: 15, 17).

Furthermore, more specific regulations can be found in some countries: in Denmark, the municipalities are required to carry out energy labelling of all public buildings between 60 and 1 500 square meters in size (Sperling, 2008: 10-11); in Spain, Barcelona's Solar Thermal Ordinance eventually led to the incorporation of a similar, but less stringent, provision in the Spanish building code (Ekelund/Sigurdson, 2007: 12); and legal obligation exists in Italy whereby municipalities with more than 50 000 inhabitants must integrate a specific provision on the extension of renewable energy into their development plans.

Governing by regulation is certainly facilitated when state-local relations are organised in a predominantly hierarchical manner, as is the case in the United Kingdom. However, in federal states such as Germany, Canada and the United States, climate change policy also depends on the (federal) states and provinces and the relationship between this additional layer of regional governments and their municipalities (Betsill/Rabe, 2008; Lutsey/Sperling, 2008). Furthermore, in many countries besides the United Kingdom, local governments enjoy a higher degree of autonomy, state-local relations are more co-operative, and the national government is in a considerably weaker position in terms of its influence on the implementation of climate change policy at a local level.

Conclusions

Based on both the results of existing research and recent developments in OECD countries, this study has focused on two issues: *i.e.*, the local and the multi-level dimensions of urban climate governance. In terms of the modes of urban climate governance, our analysis revealed that authoritative governing can be observed less frequently than might be expected, at least when taking the salience of the climate issue into account. Many cities do not take advantage of their options for implementing climate protection measures through "hard" regulation and strategic planning. Due to internal problems of co-ordination and a lack of political support within local government, local authorities appear to be reluctant to use their statutory power, even if they could use traditional forms of state authority to implement climate protection strategies. This problem is evident even in pioneering cities and even in the absence of a spatial mismatch, for example in the area of urban planning. However, the recent dynamic development in the United States also shows that American city pioneers, such as New York or Boulder (Colorado), are less reluctant to use their statutory power in creative ways. Nonetheless, this applies only to the pioneers, and most cities in the United States and many other parts of the world have not yet initiated their own climate change policy.

Instead of governing by regulation, the majority of measures undertaken in relation to climate protection concentrate on the self-governing and enabling mode, in which municipalities have most discretion and decision-making power. While modes of governing through provision appear to be in decline due to the increasing liberalisation of the energy markets, and forms of traditional regulation and planning are avoided because of popular resistance and possible conflicts, even pioneering cities appear to prefer self-governing and enabling other actors as alternatives for achieving emissions reductions. However, the trend not to exploit all options to govern by regulation has serious consequences. Urban planning is crucial for the structural shape of cities, and determines the intensity of CO_2 emissions.

Successful climate change policy calls for new forms of urban planning that take into account the differing spatial needs of public transport systems, renewable energy installations and so on.

Moreover, climate change policy appears to concentrate primarily on activities in the energy sector, in particular the energy management of municipal properties. This is most evident in countries such as Germany, the United Kingdom, Sweden and the United States (Bulkeley/Kern, 2006; Langlais *et al.*, 2007: 14). Furthermore, energy issues are also the key area for the Covenant of Mayors, the EU's new initiative on local climate change policy. When climate change policy focuses primarily on energy issues, it tends to become fragmented, and the integration of the different dimensions of climate change mitigation and adaptation policy becomes very difficult or even impossible.

Effective climate change policy needs appropriate forms of institutionalisation: preferably a climate policy steering group, a climate protection co-ordination office or an overarching unit with appropriate competences for mainstreaming climate change policy, combined with issue-specific task forces. This would appear to be desirable because such an institutional setting seems to be a precondition first for the integration of different sectors of mitigation policy; second, the co-ordination and combination of mitigation and adaptation plans and strategies; and third, the improvement of the standing of climate policy compared to key issues of urban governance, including social issues, public health, economic growth and competitiveness. An appropriate form of institutionalised policy co-ordination within local government helps to avoid potential conflicts and trade-offs between climate change policy and other policies at the local level.

In terms of horizontal and vertical collaboration in multi-level systems, we can conclude, first, that, in most cities, local climate change policy is characterised by a spatial mismatch between the local and regional level. Both mitigation and, even more, adaptation measures, require strong co-operation within metro-regions, because competences are divided among local and regional authorities. Another form of horizontal collaboration is the establishment of national and transnational city networks. Although such networks do not have the capacity to govern by regulation and do not have enough resources to run their own subsidy programmes, these self-organised networks of cities play a crucial role for local climate change policy. They can provide guidelines, like the U.S. Mayors Climate Protection Agreement, particularly if the federal government does not provide such documents. Furthermore, national and transnational city networks can commit their members to GHG emission goals, stimulate actions to reach these goals and monitor progress; they can even set up benchmarking systems to assess their progress. However, research reveals that national and transnational city networks consist mainly of pioneering cities.

Furthermore, local initiatives in the area of climate change policy depend on the local authorities' position within the national multi-level system. As direct links between national GHG emissions goals and local politics do not exist in most countries and national governments tend to abstain from mandatory requirements, local climate action relies for the most part on voluntary initiatives. Voluntary approaches to local climate change policy can however, benefit from voluntary agreements between national governments and the cities, which may include benchmarking and certification schemes, and provide additional incentives to improve a city's climate policy record. As the *Energiestadt Schweiz* certification scheme shows, climate change policy can be successful even if "hard" governing modes do not exist.

Funding problems can be regarded as one of the most serious barriers impeding the efforts to integrate the different realms of climate change policy. As climate change policy remains – in most OECD countries at least – a voluntary task of local governments that have limited mandatory responsibilities in this policy area, climate change policy is in a difficult position when it comes to funding, because it competes with other demands that may appear to be more pressing from the perspective of citizens and policy makers. Furthermore, cities only have limited opportunities for generating funding for climate protection measures. Although a city-wide carbon tax was introduced in Boulder (Colorado) in 2006 to fund Boulder's GHG

emissions reduction strategy, such far-reaching approaches are beyond the reach of most cities. Existing alternatives include revolving funds, which are generated by the benefits of energy efficiency projects and can be used, in turn, to fund new projects. National funding programmes, such as Sweden's LIP and KLIMP programmes and the Dutch BANS agreement, represent a second alternative here.

The governing of state-local relations in a hierarchical manner does not play an essential role in most countries. With the exception of the United Kingdom, local climate action is not driven by mandates set at the nation-state level. This fact is most pronounced in federal states such as Germany, Canada and the United States, in which federal governments are even more restrained when it comes to steering local action than their counterparts in unitary states. However, national regulations may even impede effective local climate change policy if they constitute legal barriers, for example concerning the necessary provisions for energy efficiency in urban planning.

In terms of the future perspectives of ***local and regional governments***, it may be concluded that subnational governments should make better use of "governing by regulation", *i.e.*, they should exploit their existing powers better, in particular in the area of spatial planning and regulation. They also need to make major efforts to achieve better policy integration, in particular the integration of energy policy with other climate-relevant policy areas. The appropriate institutionalisation of climate protection at a local level is crucial for the implementation of climate policy programmes. Local and regional authorities need to design mechanisms and schemes to avoid spatial mismatch. There is a particular need to improve co-operation within regions and to set up regional energy and climate agencies with adequate financing and competencies.

National governments should check their own policies towards local governments. This will help to combine mitigation and adaptation measures and to achieve a more coherent policy across sectors, *e.g.*, spatial planning for housing and transport. Moreover, national governments need to assess and redesign existing finance instruments for local infrastructure so as to make them "climate proof" in terms of both mitigation and adaptation. In addition, new forms of co-operation between subnational and national governments should be formally institutionalised (covenants, regular meetings between representatives of local authorities and national ministries, etc.). National governments should conclude arrangements with local governments to design funding mechanisms and performance-based incentives. Performance can be measured either in the form of robust local policies and measures put in place by local governments, or in the form of their contribution towards the fulfilment of targets (GHG reduction or performance indicators). National or, if appropriate, regional governments should set up funds for local investments in low-carbon technologies. This can be done in a budget-neutral way in the form of revolving funds. Moreover, national funding schemes for efficient devices or heating systems, which target energy end users directly, should be channelled through local governments and combined with advice programmes at local level.

City networks should stimulate monitoring on a regular basis and should also harmonise their approaches and methodologies, in particular their methods and tools for the inventorying of GHG gases, including monitoring and reporting. This represents a good opportunity for counteracting existing tendencies towards competition between city networks, irrespective of whether they are organised primarily at national or transnational level. Although city networks tend to be networks of pioneers for pioneers, city networks can try to counterbalance the gap between pioneers and laggards by setting tiered standards that attract members with varying levels of performance and ambition. The role of city networks, in particular their function in motivating cities and supporting capacity-building in the area of climate change policy, is crucial and should be rewarded by recognition and reliable funding from national governments or international agencies.

Table A1: Mitigation and adaptation in selected cities

City CO_2 emissions in tonnes/capita	Mitigation			Adaptation	
	Reduction target	Inventory	Strategy	Inventory	Strategy
Apeldoorn, Netherlands	Energy neutrality		X		
Barcelona, Spain 3.4 (2004)	20% 1999-2010	X	X		
Berlin, Germany 7.4 (2002)	25% 1990-2010	X	X		
Cape Town, South Africa	Sectoral targets, *e.g.*, energy supply: 10% 2005-2010	X	X	X (Framework)	X (Framework)
Graz, Austria	50% 1987-2010	X	X		
Hanover, Germany	40% 1990-2020	X	X	X	
London, UK 5.7 (2004)	60% 1990-2025	X	X	X	X (in process)
Munich, Germany 10.0 (2000)	50% 2002-2030	X	X		
New York, USA 8.9 (estimation 2004)	20% 1995-2010	X (in process)	X (new 2008)	X (new 2008)	X
Portland, USA 14.4 (2005)	10% 1990-2010		X	X (water maintenance)	X
Rotterdam, Netherlands 55.0 (2005)	50% 1990-2025	X	X	X (water management)	X (water management)
San Francisco, USA 12.2 (2004)	20% 1990-2012 80% 1990-2050	X	X		
Seattle, USA	7% 1990-2010	X	X	X	X
Stockholm, Sweden 4.0 (2005)	3.0 t/capita (2015) Fossil free (2050)	X	X	X	
Vancouver, Canada 6.0 (1990)	6% 1990-2010	X	X	X	X
Woking, UK	60% 1990-2050 80% 1990-2100	X	X	X	X
Zurich, Switzerland	10% 1990-2010	X	X (energy plan)		

Source: Based on: Ekelund/Sigurdson (2007: 5-6).

NOTES

1. Please note that this article focuses primarily on cities in high-income countries.

2. No uniform methodology currently exists, although climate-policy city networks are striving to establish methodologies and provide tools. ICLEI has agreed on a GHG emissions analysis protocol and provides a multinational tool, *i.e.*, the "Harmonised Emissions Analysis Tool" (HEAT), while the Climate Alliance adopted rules and guidelines on GHG emissions monitoring, developed the online tool ECO2-Regio and has created benchmarks, including additional indicators that allow for an improved assessment of performance and progress in the various areas of action.

3. Similar, but less formalised, voluntary agreements between the city government and private actors can also be found in numerous other cities, for example, Seattle (Seattle Climate Partnership) and Stockholm (Klimatpakten).

4. However, in the case of Stockholm, this was not an integral part of Stockholm's climate action programme but a decision made by the Swedish government.

5. This must be taken into consideration during the preparation of National Adaptation Programs of Action (NAPAs) and the arrangements for spending, in particular from the Adaptation Fund under the international climate regime.

6. In May 2007, the city of New York hosted the C40 Large Cities Climate Summit, which was supported by the Clinton Foundation. Former President Bill Clinton launched the Clinton Climate Initiative (CCI) in August 2006. This initiative supports programmes that result directly in substantial GHG emissions reductions. CCI provides direct assistance to individual cities for the development and implementation of a range of actions that reduce GHG emissions.

7. The U.S. Conference of Mayors Climate Protection Center was established in February 2007 to provide mayors with information, guidance and assistance.

8. Although German cities have been among the forerunners in local climate policy, the German federal government has only recently set up a subsidy program and service agency for local climate protection as part of its national climate protection initiative.

9. Starting from the varying national preconditions, the project has developed a benchmarking system for the classification of local climate protection activities by field (energy, transport, urban planning) and by type (use of administrative, fiscal, soft instruments, etc.). Moreover, it includes qualitative (policies and measures that have actually been implemented) and quantitative (GHG emissions and additional sectoral indicators) indicators.

10. In addition, national experiences in Switzerland, Austria and the German Federal State of North-Rhine Westphalia have led to the development of a European scheme, the European Energy Award (EEA). The European Energy Award was developed within the 5th EU Framework Programme for Research and Technological Development (RTD). The IEE (Intelligent Energy Europe) project BALANCE currently extends the implementation of the programme to include other European countries and regions.

11. There are separate schemes for the cities and provinces.

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