LSE Cities | ICLEI Local Governments for Sustainability | Global Green Growth Institute

Going Green

How cities are leading the next economy

A global survey and case studies of cities building the green economy
The 3GF Copenhagen edition

LSE Cities
AN INTERNATIONAL CENTRE SUPPORTED BY DEUTSCHE BANK

LSE Cities
London School of Economics
and Political Science
Houghton Street
London WC2A 2AE
United Kingdom

lse.cities@lse.ac.uk
www.lsecities.net

ICLEI
Local
Governments
for Sustainability

ICLEI World Secretariat
Kaiser-Friedrich Strasse 7
53113 Bonn
Germany

Global
Green Growth
Institute

GGGI Copenhagen Office
Frederiksborgvej 399, Building 110
4000 Roskilde, Denmark

LSE
THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE

Research Directors

Philipp Rode
Executive Director of LSE Cities and Senior Research Fellow, London School of Economics and Political Science

Graham Floater
Senior Visiting Fellow, LSE Cities and Director, The Climate Centre

LSE Cities Research Team

Jens Kandt
Researcher

Karl Baker
Researcher

Marina Montero Carrero
Researcher

Catarina Heeckt
Researcher

Duncan Smith
Research Officer

Michael Delfs
Researcher

ICLEI Coordinator

Richard Simpson
Research Analyst, ICLEI World Secretariat

The Climate Centre

Rocío Pérez Ochoa
Principal Consultant

Advisors

Ricky Burdett
Professor of Urban Studies and Director, LSE Cities, London School of Economics and Political Science

Nicky Gavron
Assembly Member, Greater London Authority

Dimitri Zenghelis
Senior Visiting Fellow, Grantham Research Institute, London School of Economics and Political Science and Senior Economic Advisor, Cisco

Mark Watts
Director, Energy and Climate Change Consulting, Arup

Production and Graphic Design

Tessa Norton
Communications Manager, LSE Cities

Jonas Schorr
Communications and Outreach Assistant, LSE Cities

Atelier Works
www.atelierworks.co.uk

Going Green is a report by LSE Cities at the London School of Economics and Political Science (LSE). The study team acknowledges the support of ICLEI regional membership offices, in particular Eva Madeira (ICLEI World Secretariat). Research support for this project was provided by The Climate Centre (www.theclimatecentre.com).

This report builds on the extensive knowledge of city-led transformation generated by the Urban Age programme, an investigation into the future of cities organised by the London School of Economics and Political Science with Deutsche Bank's Alfred Herrhausen Society. It has also been prepared under the guidance of the Economics of Green Cities programme chaired by Lord Stern, a collaborative programme led by LSE Cities and the Grantham Research Institute for Climate Change and the Environment. The sections on transport, land use and electric mobility build on LSE Cities research on the governance of new urban mobility and P Rode's study of integrating planning, design and transport in cities.

LSE Cities would like to thank the key stakeholders and experts in Copenhagen, Hong Kong, Stockholm, Portland, Belo Horizonte, Durban, Berlin and London who contributed their ideas and time to this report (see list on page 95).

Published by LSE Cities, London School of Economics and Political Science, 2012.

Cover photo credit: Kontraframe and City of Copenhagen

Contents

Executive summary

The report 'Going Green: How cities are leading the next economy' provides an up-to-date overview on the experiences of 90 cities around the world in the transition to the green economy. The report consists of two parts. The first, section A, is a global survey of city governments that was conducted by LSE Cities, ICLEI and GGGI in the run-up to the Rio+20 conference and the 2012 Global Green Growth Forum in Copenhagen, in order to increase awareness of the strengths and weaknesses of cities as key contributors to this global green transformation. Its principal aim is to offer a fresh perspective on the environmental challenges that cities face along with the opportunities, progress and barriers to going green and fostering economic growth. The survey covers key aspects of green policies and the green economy, smart city technology, green policy assessment and urban governance.

The second part, section B, investigates in greater detail the experience of eight case study cities in facilitating green growth. Given the importance of integrating policies for delivering green growth, four cross-cutting policy programmes were examined, including (1) land-use and transport; (2) eco-districts and buildings; (3) waste, recycling and energy; and (4) electric mobility and renewable energy. Two case study cities were selected for each theme, allowing for comparative analysis, and exploration of how similar objectives are being pursued in different contexts, with different policy tools, and using different types of public-private partnership (PPPs).

SECTION A: Going Green City Survey

Section A provides results from an analysis of 90 cities that responded to the survey on the green economy. The sample of respondents comprises a diverse set of cities from North and South America, Europe, Asia and Africa. The cities also represent a range of population sizes and are located in countries of varying income levels. The results highlight a number of common experiences shared by most cities. However, it also identifies significant differences not only in the type of challenges that cities face, but also the speed and ambition of different cities in moving to the green economy. Below follow the survey's main findings across three key areas:

- **Going green**: city challenges, green aspirations and triggers, progress to date
- **Building the green economy**: green economic objectives, opportunities and barriers, technology
- **Governance and the green economy**: strategy and stakeholders, government co-ordination, skills and capacity

A1 Going Green

1. CITY CHALLENGES

Environmental problems are deeply intertwined with many of the most critical challenges cities face today.

Road congestion, lack of affordable housing and urban sprawl are among the most important challenges facing cities today. The majority of cities also identify air pollution, severe storms and flooding, and solid waste management as key environmental challenges. Cities in middle- and low-income countries face a wider set of challenges, including water shortages, sewage treatment, over-crowding, informal land development, lack of infrastructure and insufficient public services.

2. GREEN ASPIRATIONS AND TRIGGERS

All cities in the survey aspire to be green, and green policies have become increasingly important since the Rio Summit in 1992.

In the majority of cities, green objectives have been introduced since the Rio Summit in 1992. A small group of leading cities have a longer history of prioritising green objectives, dating back 40 years or more. Public opinion, a change in local political leadership and pressure from stakeholders have been the most important triggers for going green. In middle- and low-income countries, public opinion and pressure from national governments/international organisations have been particularly important.

3. PROGRESS TO DATE

Substantial progress has been made in achieving green objectives related to recycling, green space and water pollution. Resource efficiency and energy security are more challenging.

Cities in high-income countries report more success in achieving green outcomes, and tend to make greater use of environmental indicators to measure progress. For example, greenhouse gas emissions are measured by 23 out of 25 European cities, 21 out of 26 North American cities, but only 11 of the 21 Asian cities in the survey. Cities that define themselves as 'green' report more success than others in addressing energy security. City governments highlight a range of tools for delivering green policy, including planning, raising public awareness, regulation and public funding. Taxation is regarded as an important tool by most Asian cities.

A2 Building the green economy

4. GREEN ECONOMIC OBJECTIVES

Overall, 93% of city governments expect their green policies to have a positive economic impact. But only 24% have a co-ordinated strategy for 'green growth'.

The three top aspirations of cities are economic development, transport improvements and responding to climate change. For most cities, green economic development is a key part of their overall political agenda, with 65% of cities describing economic growth as a primary goal of their green policies. The majority of cities expect economic impacts from green policies to include growth, job creation, inward investment, innovation, entrepreneurship and attracting skilled workers. However, only 22% of cities are aware of any economic impact assessment of their green policies.

5. OPPORTUNITIES AND BARRIERS

Urban transport, buildings and energy are key sectors for green economic growth, while the main barriers are lack of public funding and insufficient support from national government.

In the building sector, cities see growth potential from both new green buildings and from retrofitting existing buildings. In the energy sector, renewable energy production and distribution networks have potential for growth. Cities in middle- and low-income countries face a wider range of barriers, including lack of support from the general public and other levels of government. Lack of local skills and barriers to accessing international bilateral and multilateral funds are also frequently identified by these cities.

6. TECHNOLOGY

Overall, 74% of cities are willing to invest in new green technology to spur change, but almost two thirds of these cities are constrained by budgets.

New technologies are used or planned for use in the green transport, energy generation and distribution, green buildings, water and waste management sectors. In the transport sector, well-used new technologies include low-emission vehicles, integrated multi-modal transport systems, intelligent traffic management and electric vehicles. Building and energy technologies are also well used, but information and communications technologies (ICT) are generally regarded as 'enabling tools' rather than core components of cities' green agendas. The majority of Asian cities regard smart waste and water management systems as important.

A3 Governance and the green economy

7. STRATEGY AND STAKEHOLDERS

Overall, 94% of cities have a green strategy, but only 7% of these are legally binding.

Strategic plans are most commonly formulated through a strategic city development plan or through sector-specific action plans. However, one in ten cities simply has 'a general commitment to sustainability'. The majority of cities also identify the general public, non-government organisations (NGOs) and business or industry associations as important stakeholders. Cities in middle- and low-income countries place a greater importance on a wider range of stakeholders, notably international agencies, national government agencies, state or regional government as well as universities and other research institutions.

8. GOVERNMENT CO-ORDINATION

According to 51% of cities, national policy frameworks fall short of providing full support to the city's green agenda – particularly in North America and Europe. In 55% of cases, the municipal department of economics is not heavily involved in green strategy development.

Policy frameworks are most supportive of the city's green agenda at state level, less supportive at national level and least supportive at supranational level. Energy generation and energy efficiency are the policy areas most often supported by higher level policy frameworks, as well as a range of climate change, transport and air pollution policies. However, a number of other cities report that national and state governments undermine the city's green transport and energy objectives. Most municipal governments involve departments of environment, planning and transport in developing their overall green strategy. In contrast, departments of finance, economic development and technology are rarely involved.

9. SKILLS AND CAPACITY

While city governments have many of the capabilities for delivering the green economy, skills in innovation-based economic development could be improved – particularly for cities in middle- and low-income countries.

Over 80% of cities view their capabilities as 'good' or 'excellent' in urban planning or policy and a further 74% in legislative drafting. In contrast, 42% of cities regard their capabilities in innovation-based economic development as 'very limited' to 'moderate'. Monitoring and enforcement of policies is also an area where capabilities could be strengthened.

SECTION B: Green Growth Case Studies

Section B provides results from analysing eight case study cities in more detail: Copenhagen and Hong Kong (land-use and transport), Stockholm and Portland, Oregon (eco-districts and buildings), Belo Horizonte and Durban (waste, recycling and energy), and Berlin and London (electric mobility and renewable energy). The cities, representing a range of population sizes, geographic regions and income levels, are recognised as innovators in green growth policy programmes and many are first movers in their field. The analysis draws a number of common lessons from the case studies as well as highlighting different approaches and policy tools used for achieving similar aims. Below follow the main lessons across four key areas that emerged from the case studies:

- **Leadership**: city leadership, national frameworks, first mover advantage
- **Finance**: public funding, public-private financing, international funds
- **Regulation and planning**: compact city planning, regulation and standards
- **Partnership building**: city management, community innovation, national competitions, research partners

B1 Leadership

1. CITY LEADERSHIP

City leadership is essential for implementing green growth strategies.

Across all case study cities and policy programmes, leadership at the city level is essential for delivering change on the ground. To strengthen land-use and transport integration, city governments in Hong Kong and Copenhagen make use of density, land-use and parking regulation. Electric mobility programmes in London and Berlin have relied on city governments taking the lead in applying for national funding. Eco-districts in Stockholm and Portland have been created due to the vision and strategic direction of the mayor. While waste programmes in Belo Horizonte and Durban would not have been possible without strong commitments from city governments.

2. NATIONAL FRAMEWORKS

National level support and policy frameworks are essential.

Whether long-term and large scale developments related to land-use and transport or eco-districts, or whether implementing relatively rapid projects such as electric mobility charging infrastructure and waste-to-energy plants over a few years, the policy programmes examined have relied to a significant degree on leadership, policy frameworks and funding provided by national governments. While ambitious policy targets send important signals, they also need to be realistic, and this often requires the support of national and state governments.

3. FIRST MOVER ADVANTAGE

First mover green cities can increase reputation, brand and export opportunities.

The majority of case study cities have identified important advantages of being a first mover with their policy programme. Green growth strategies differ significantly across cities but a clear strategic priority and drive in each case has been essential for these pioneering cities. The benefits of a modern, green brand include attracting inward investment for innovation and delivery, as well as opportunities to export technologies and services developed locally to overseas markets. Some of the case study cities have dedicated export agencies for their green innovations.

B2 Finance

4. PUBLIC SPENDING

Substantial financial resources are needed for a green economy transition at city level but there are significant direct and indirect returns.

The scale of public funding necessary for many green growth programmes should not be underestimated. However, with the right financing mechanisms and strong partnerships, experience from the case studies shows that major shifts in technology and infrastructure can be achieved at low cost as long as upfront capital is available. For example, a comprehensive public transport network requires significant public investment or land value capture but can lead to high-value land development. When the wider economic benefits of a strong, clean tech brand and improved quality of life in the city are considered, then the economic returns are potentially great indeed.

5. PUBLIC PRIVATE FINANCING

Major public investments should be combined with private financing where appropriate to ensure private sector buy-in and to accelerate the green growth transition.

The roll-out of electric mobility in Berlin and London depends entirely on co-financing arrangements and joint commitments from the public and private sectors. Stockholm was able to leverage 85% of the investment from the private sector for one of their eco-districts, while new innovation projects on smart grids and information technology are benefiting from 50:50 matched public and private finance for research.

6. INTERNATIONAL FUNDS

Funds from the international community are often essential for cities to make low carbon projects financially viable in developing countries.

International funding, whether through grant aid or access to carbon markets such as the UN's Clean Development Mechanism, are essential for ensuring that the waste-to-energy projects in Belo Horizonte and Durban provide an investment return. Electricity generation from the grid is often lower cost than energy from landfill gas extraction unless the carbon price is included. At the same time, accessing CDM credits is heavily bureaucratic and requires upfront funding for registration and set-up costs. Consequently, seed funding is essential and for many developing country cities this needs to be raised nationally or from other international sources.

B3 Regulation and planning

7. COMPACT CITY PLANNING

Effective spatial planning promoting compact city development is a fundamental support system for green growth.

Importantly, the political powers for spatial planning generally reside with the city government. In all case study cities and across a diverse set of policy areas, green growth solutions have directly or indirectly benefited from compact urban form. Particularly in the cases for integrating land-use and transport in Copenhagen and Hong Kong and for implementing eco-districts in Stockholm and Portland, plan-led urban development supporting density, mixed use and public transport accessibility has been essential. Even the electric mobility strategies in Berlin and London are indirectly profiting from density thresholds allowing for more cost-effective implementation of charging infrastructure.

8. REGULATION AND STANDARDS

Strong regulatory frameworks at national and city level create new markets for innovation, deployment and export.

Increasing the uptake of electric mobility offerings in cities such as Berlin and London relies on the standards set for charging and battery equipment. Similarly, energy efficiency standards for buildings set by the national government in Sweden have been backed up with highly stretching standards for Stockholm's eco-districts and other city-designated land. These standards are now driving research partnerships and innovation that will put companies at the cutting edge of building technology and design, leading to export opportunities. Similarly, integrating transport infrastructure with urban development in Copenhagen and Hong Kong is based on a comprehensive range of regulatory instruments to guide land-use decisions in a strategic direction.

B4 Partnership building

9. CITY MANAGEMENT

City governments play the central role in establishing and supporting public private partnerships.

In all the case studies, city government was the central actor driving policy programmes and public private partnerships. The waste policy programmes of Durban and Belo Horizonte are coordinated and managed by city departments. In Portland, the mayor set up a central institute specifically to build partnerships for innovative eco-districts. In Stockholm, the city has been central to developing multiple partnerships around strategy, finance, innovation and communication, each designed to find new solutions for developing eco-districts. While in Berlin and London, the city governments have brought together the large range of actors needed to make electric mobility succeed economically and environmentally.

10. COMMUNITY INNOVATION

Local residents and workers are essential actors in the green innovation process.

In Berlin and London, electric mobility programmes rely on citizens exploring new technological opportunities and feeding back on usability, comfort and general acceptability. Compact city transport strategies in Copenhagen rely on citizens to take part in the city's dominant cycle culture. While in Portland, the success of their eco-district pilots relies heavily on the buy-in and creative ideas of the local community itself. Consensus building is a major challenge and if ignored, can lead to the delay or failure of projects. In Durban, information has been provided to local residents to explain the health benefits of extracting methane from old landfill sites.

11. NATIONAL COMPETITIONS

Competitive bidding of cities for national funding is important for fostering local partnerships.

In Germany and the UK, the national bidding process for establishing electric mobility programmes in cities and regions has established effective collaboration between public, private and third party stakeholders even at the bidding stage. Competitions not only foster partnerships but provide backing for new innovations that might otherwise face too many financial and administrative barriers to succeed.

12. RESEARCH PARTNERS

Universities and local research institutes are key partners in successful green growth policy programmes.

In most case study cities, local research institutes have been central or key actors in city partnerships, often alongside researchers from the private sector. Durban's waste-to-energy programme was kick-started by the World Bank through a local university which also went on to develop technological solutions for the plants. Berlin has established itself as an international innovation centre for electric mobility, which cuts across universities, research centres and a large group of private sector players. While in Portland, a local university is at the centre of one of their eco-district pilots.

Introduction

This report 'Going Green: How cities are leading the next economy' provides an up-to-date overview of the experiences of cities around the world in the transition to the green economy. The report consists of two parts.

Section A is a global survey of city governments, conducted by LSE Cities, ICLEI and GGGI in the run-up to the Rio+20 Conference and the 2012 Global Green Growth Forum in Copenhagen; and carried out to increase awareness of the strengths and weaknesses of cities as key contributors to this global green transformation. Its principal aim is to offer a fresh perspective on the environmental challenges that cities face, along with the opportunities, progress and barriers to going green and fostering economic growth. In particular, the survey investigates the degree to which 'green' or environmental policies have been adopted by cities and the extent to which cities are engaging with 'green economy' policies that aim to simultaneously strengthen environmental and economic performance.

Section B looks in greater detail at the experiences of eight case study cities in their drive to promote green growth. The cities selected are: Copenhagen, Hong Kong, Stockholm, Portland, Belo Horizonte, Durban, Berlin and London. Given the importance of integrating policies to deliver green growth, four cross-cutting policy programmes are examined: (1) land-use and transport, (2) eco-districts and buildings; (3) waste, recycling and energy; and (4) electric mobility and renewable energy. Two case study cities are selected for each theme, allowing comparative analysis and exploration of how similar objectives are being pursued in different contexts, with different policy tools, and using different types of public-private partnership (PPPs).

This report builds on the extensive knowledge of city-led transformation generated by the Urban Age programme, an investigation into the future of cities organised by the London School of Economics and Political Science with Deutsche Bank's Alfred Herrhausen Society. It has also been prepared under the guidance of the Economics of Green Cities programme chaired by Lord Stern. This initiative is a global collaborative programme led by LSE Cities and the Grantham Research Institute for Climate Change and the Environment. Research support for this report was provided by The Climate Centre (TCC).

1 Cities and the green economy

The United Nations General Assembly has referred to the green economy as a concept that "focuses primarily on the intersection between environment and economy" and on the "opportunities to advance economic and environmental goals simultaneously".[1] Cities will have a leading role to play if this concept is to emerge as a paradigm for the next economy. Less than 2% of the earth's surface is occupied by urban areas, but this land accommodates half the world's 7bn population and accounts for 70% of the world's GDP. Cities are natural units for driving innovative policy solutions in order to achieve sustainable growth. They combine a mix of specialisation and diversity, derived from a concentration of people and economic activity that generates a fertile environment for innovation in ideas, technologies and processes. Cities produce and distribute the resources that provide better livelihoods for urban and rural residents alike.

The green economy also requires cities to play a leading role in shaping urban form and new infrastructure platforms, in order to fully unlock the potential for a more prosperous, equitable and greener global future. Cities have a degree of self-governance, and city policymakers are often able to deliver integrated policy programmes that have a more direct impact on citizens. Examples include energy efficient buildings, renewable energy, efficient distribution of clean water and waste, green transport schemes, congestion charging and clean air zones. For these reasons, cities may have greater potential for making a significant impact on sustainable growth compared to higher tiers of government.[2] Since the Rio Earth Summit in 1992, cities around the world have made considerable progress toward developing sustainability programmes. Driven partly by the adoption of Agenda 21 in 1992 and its emphasis on the local implementation of sustainability programmes, cities have led the green transition in many sectors.[3]

But cities are also sites of wasteful economies that urgently need to invest in a transition towards green growth. For example, as centres of energy demand and industrial production, urban areas are responsible for up to 80% of anthropogenic greenhouse gas emissions. This not only has consequences for the environment, but also creates negative impacts on sustainable economic growth.[4] Furthermore, in the short term, poor resource efficiency can increase economic and social costs substantially, while environmental problems such as air pollution can act as externalities that affect population health and labour productivity.

Implementing environmental strategies can pay economic dividends. It can drive efficiency and allow cities to reduce waste and cut costs. Cities offer a unique environment in which to innovate, develop and scale-up new ideas and processes. These promote the growth of clusters of expertise in knowledge-intensive green production sectors. Cities have already become laboratories for the green economy, where learning and experience induce further innovation and falling costs in new technologies. Integrated recycling networks, methane capture and combined heat and power have relied on ready access to new technologies and skilled engineers and installation experts, all of which are easier to access in a compact urban environment. Scale economy benefits of urbanization mean that cities can capitalize on 'green' investments, such as integrated public transit, sewers and water systems, congestion pricing, smart grids, smart buildings and decentralized energy networks.[5] Urban regions already produce ten times more renewable technology patents than rural regions.[6]

With supportive policy, innovative businesses can avail themselves of new and growing opportunities in low-carbon investment, estimated to be worth US$500bn a year[7] and rising, with renewable energy investments totalling US$211bn.[8] A broad range of successful cities will increasingly specialize in higher-end business services, including activities such as environmental consulting and green finance. Clearly, opportunities will vary from city to city according to income levels, policy frameworks, industry composition and available options for the low-carbon transition. How cities develop is part of the environmental problem, but it can also be part of the solution. All cities have opportunities to guide urban planning and prevent the expansion and lock-in of high-carbon and resource intensive infrastructure. Fast growing cities are today planning and committing to long-lived urban structures, which affords either unique opportunities or unforeseeable risks, while old established cities will need to think about how to replace and retrofit existing infrastructure.

From a policy perspective, therefore, this is not only about the construction of infrastructure for roads, buses and railways; it is also about pricing and management, regulations applying to the location of homes, the use of cars and the design of cities. It concerns the structure of workplaces and practices affecting conventions for physical attendance. Many or most of these involve networks in some shape or form, in which the decisions of an individual on where to live, how to move, how to interact and how to commute have powerful effects on others. Policies need to be well designed, where possible using non-discriminatory market instruments to avoid inefficiencies and prevent rent-capture by wasteful vested interests. Cities are complex heterogeneous entities which share some common properties. There is no one size fits all solution, but all cities have scope to improve efficiency, make greater use of renewable resources and improve the environment for innovation, with significant economic as well as environmental returns. The investments and strategic decisions made over the next few years will determine where the winners and losers will be in responding to the challenge of a sustainable future.

2 Methodology

Below is an introduction to the overall research methodology used for this report. As these methods differed significantly for sections A and B, the overview is divided into two parts.

Methodology for Section A: city survey

The city survey was conducted in two phases. The first phase ran from January to June 2012, for which a general overview of key patterns was presented in the Rio+20 edition of this report. A second, more in-depth phase ran until September 2012. Of about 320 cities that were approached by the research team and ICLEI, a total of 107 cities participated in this survey. The survey covered a broad range of topics associated with the green economy and included 40 questions with sections on:

- Green policies
- Green economy
- Smart city technology
- Green policy assessment
- Roles, actors and governance

The survey was targeted at elected representatives, city government officials or local experts. It was conducted as an online survey available in English, Chinese and Spanish. Of all cities that responded to the survey, 17 were excluded due to a high number of missing answers. This resulted in a working sample of 90 cities.

The sample comprises a diverse set of cities located across different geographic regions, and includes cities of various population sizes positioned across a range of economic and political contexts. In most cases survey participants are officials working within local governments. Other respondents work outside municipal government as advisors or consultants. Responses generally reflect individuals' views of their city, and in interpreting the results it is important to bear in mind that responses may not be representative of general public perceptions, nor may they provide an accurate reflection of urban conditions or cities' policy experiences.

It is also likely that the sample is partially self-selected. It can be expected that cities considering themselves as 'green cities' or *en route* to being green are more interested in participating in this survey. Most cities are also ICLEI member cities and therefore have expressed a particular interest in global collaboration for environmental sustainability.

In addition to introducing the headline results of the most relevant survey questions, this report includes a more detailed analysis examining the associations between responses and (a) the level of income of the country in which a city is located, (b) the geographic region in which a city is located, and (c) the population size of the city.

The level of each country's income follows the classification developed by the World Bank, which differentiates between low, middle and high-income countries. It should be noted that the income level refers to the country within which each city is located, rather than the income of

Figure 1.1 Cities and the green economy survey

Cities included in Going Green Survey

the city itself which was not available for a comparative analysis. The survey sample consists of 57 cities from high-income countries, 32 cities from middle-income countries and one city from a low-income country (Kampala, Uganda). With only one city in a low-income country, the results distinguish between only two groups: those cities located in 'high-income countries' and those in 'middle- and low-income countries'.

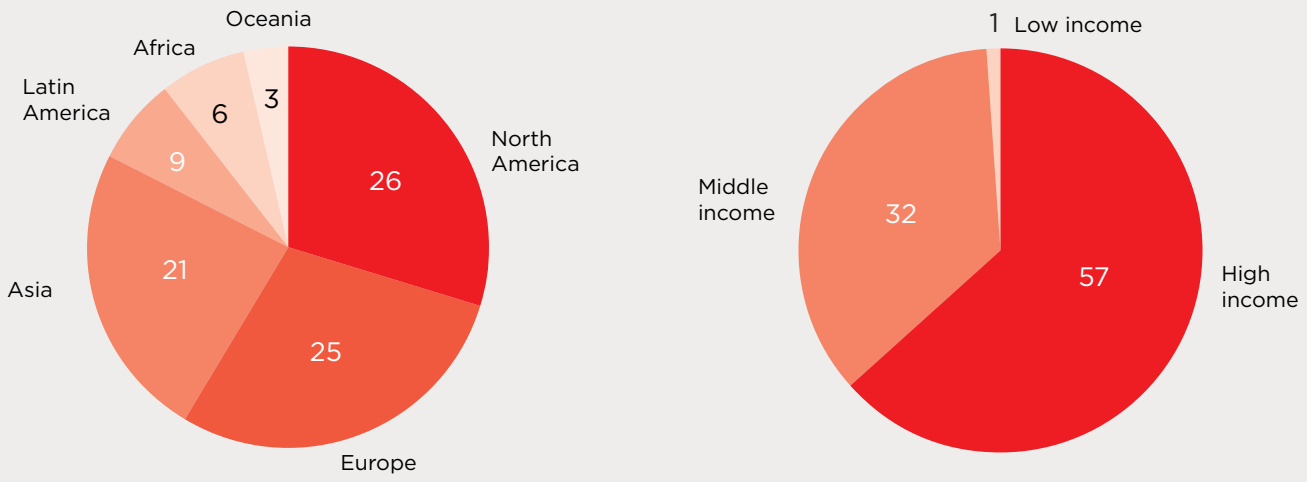
Geographic region refers to the continent in which the city is located. The survey sample consists of 26 in North America, 25 in Europe, 21 cities in Asia, nine in Central and South America, six in Africa and three in Oceania. It should be noted that cities in North America (particularly those in the United States) and Europe are over-represented, given their share of the world's population. The group of Asian cities is particularly heterogeneous and includes cities as diverse as Ahmedabad, Tokyo and Hong Kong.

Cities have also been grouped by size into cities with populations below/above 1 million people. Within the sample, 53 cities have a population of less than 1 million people and 37 have more than 1 million inhabitants.

Group-wise analysis has been undertaken using Chi-squared tests. Tables in the text summarise general trends (associations) that were found to be significant at the 5% level. There are a number of questions that use five-point rating scales that represent the degree to which respondents agree with statements ("strongly agree", "agree", "neutral", "disagree", "strongly disagree"). For the purposes of the analysis, five-point rating scales have been transformed into three-point scales, resulting in two-by-three matrices for income and size classifications of cities and three-by-three matrices for the geographic region. It should be noted that the two groupings of income level and geographic region are also linked: cities in high-income countries can be found in North America and Europe, while the majority of Asian cities belong to the middle- and low-income groups. Therefore, the results of statistical tests should be viewed with care; they indicate trends to be explored in future research rather than definitive results.

With regard to the reporting style, it should be noted that despite the small size of the sample, results are reported using percentages to enable intuitive comparison of the overall findings. In order to avoid distortions due to over-precision, percentages are rounded to the nearest 5% where they relate to sample subsets of the group-wise analysis. For both extremely small and high percentages, absolute counts are reported instead.

Figure 1.2 Sample cities by region (left) and population size (right)



Methodology for Section B: case study analysis

The case study section examines policy programmes in eight cities to investigate specific challenges, opportunities and lessons in transitioning to the green economy. The scope of this report was not sufficient to undertake a comprehensive economic cost benefit analysis of the cities' policy programmes. And the analysis is not intended to test whether the policy instruments used are the most economically cost effective. Rather, the aim is to examine the effectiveness of delivering the policy programme both in terms of impacts and in terms of the effectiveness of the partnerships created. The case studies are organised around four integrated policy themes of particular relevance for those city-level actors promoting green growth:

- Land-use and transport
- Eco-districts and buildings
- Waste, recycling and energy
- Electric mobility and renewable energy

Each policy theme is intended to demonstrate the opportunities for accelerating progress toward environmental and economic objectives by exploiting links between complementary sectors. The individual case studies were selected on the basis that the policy programmes had achieved notable success in meeting environmental, economic or social objectives, while also offering important lessons on effective leadership, financing, policy instruments and partnership building. Two case study cities were selected for each policy theme, allowing for comparative analysis and exploration of how similar objectives are being pursued in different contexts, with different policy tools and using different types of public-private partnership (PPPs). The selection was intended to present a diversity of experiences with green economy policy, pursued in a range of cultural, economic and geographic contexts.

Some case studies offer a new perspective on established best practice; for instance, comparing Copenhagen and Hong Kong's well-studied approach to land-use and transport planning. Others present research findings in cases where existing studies are more limited and knowledge is still emerging; for instance, Berlin and London's policy approach to electric mobility and renewable energy.

Information and data for all case studies relied on a mixed method, combining structured interviews, desktop analysis of policy documents and an extensive review of academic and municipal literature covering both the broader policy themes and specific policy programmes. The research process combined analysis of qualitative perspectives, gained through interviews with local experts, and quantitative time-series data which was obtained through city governments and earlier work conducted by LSE Cities.

Across the case studies, research focussed on how partnerships between public and private sector actors are working together in cities to pursue green growth. Over 28 interviews were conducted with a mix of public-sector policy-makers and representatives from private-sector businesses

involved in each of the policy programmes (a complete list of all interviewees is included on page 95 of this report). The interviews were designed to reveal differing perspectives and attitudes on the challenges and opportunities of establishing a policy environment conducive to green growth.

A further important element of the research methodology involved spatial analysis of urban areas. Combining spatially-defined demographic data with information on transport infrastructure and land-use patterns was particularly important for the land-use and transport case studies.

3 LSE Cities, ICLEI and GGGI

'Going Green: How cities are leading the next economy' is a research project conducted by LSE Cities at the London School of Economics and Political Science and supported by ICLEI (Local Governments for Sustainability) and the Global Green Growth Institute.

LSE Cities is an international centre that carries out research, education and outreach activities in London and abroad. Its mission is to study how people and cities interact in a rapidly urbanising world, focussing on how the design of cities impacts on society, culture and the environment.

The involvement of LSE Cities follows the centre's contribution to the United Nations Environment Programme's Green Economy Report and the coordination of the report chapters on cities and buildings.[9] The Going Green report extends this work through more detailed analysis of current local government policies and attitudes towards the green economy, as well as the latest experiences with delivering green growth related to specific sectors. Research support for this project was provided by The Climate Centre (TCC).

This report also contributes to the Programme on the Economics of Green Cities chaired by Lord Stern, a global collaborative programme led by LSE Cities and the Grantham Research Institute for Climate Change and the Environment. The Programme is examining the risk-adjusted costs and benefits of early-action green policy frameworks on the sustainable economic growth of cities in different parts of the world. The findings of this report will also inform preparations for the LSE Cities' annual Urban Age Conference, The Electric City, to be held in London in December 2012.

ICLEI – Local governments for sustainability is the world's leading association of 12 mega-cities, 100 super-cities and urban regions, 450 large cities as well as 450 small and medium-sized cities and towns dedicated to sustainable development. ICLEI has developed stable, long-term programs to support local-level sustainability and continue to develop innovative new programs to respond to issues of international concern.

ICLEI was founded in 1990 as the 'International Council for Local Environmental Initiatives'. The Council was established when more than 200 local governments from 43 countries convened at the inaugural conference, the World Congress of Local Governments for a Sustainable Future, at the United Nations in New York. ICLEI was strongly involved in the Rio+20 preparatory processes, acting as the Local Authority Major Group co-organizing partner, bringing local leaders together before and at the conference.

As happened at the Earth Summit 1992 with Agenda 21 and ICLEI's proposal for a Local Agenda 21, ICLEI seeks to translate the international agenda on the Green Economy to the local urban level with a Green Urban Economy agenda. ICLEI has already organized and collaborated on a number of events and publications to further this aim and in support of meeting its strategic goal on the Green Urban Economy.

The Global Green Growth Institute (GGGI) was founded on the belief that economic growth and environmental sustainability are not merely compatible objectives; their integration is essential for the future of humankind. GGGI was set up as a non-profit organisation under Korean law in June 2010, and is currently in the process of converting to an intergovernmental organisation. The organisation is dedicated to helping government and industry pioneer and diffuse a new model of economic growth, known as 'green growth', that simultaneously targets key aspects of economic and environmental performance. These include poverty reduction, job creation and social inclusion, as well as mitigation and adaptation to climate change, biodiversity loss and energy and water security.

Recycling collection in Belo Horizonte

Belo Horizonte operates a door-to-door collection for paper, metal, glass and plastic, which is picked up by the city's waste collection trucks once a week and delivered to waste picker-led cooperatives for sorting and processing. This partnership between city government and the informal sector has benefited more than 600 waste-pickers while increasing recycling rates. Door-to-door collection currently covers about 354,000 (14%) of the city's 2.5m inhabitants.

Photo credit: Superintendência de Limpeza Urbana

A GOING GREEN: CITY SURVEY

The global survey reports on the experiences of almost 100 city governments in order to increase awareness of the strengths and weaknesses of cities as key contributors to the green economic transformation. The results offer a fresh perspective on the environmental challenges that cities face along with the opportunities, progress and barriers to going green and fostering economic growth.

The results reveal insights on cities' motivations for adopting green policies, their progress in integrating economic and environmental objectives and their experiences with coordinating governance and involving stakeholders in green policy making. The findings show a range of challenges and aspirations shared across the world, while also identifying important distinctions in city governments' experiences associated with diverse economic and geographic contexts. The global survey contributes to an improved understanding of current progress toward city-led green growth.

A1 Going Green

Since the Rio Earth Summit in 1992, interest in green policies has increased considerably in cities around the world. Twenty years on from the Summit, we examine the broad challenges that cities still face today, their green aspirations for the future and the success or otherwise of policy responses that cities have already implemented.

1.1 Challenges for cities

Cities' responses to listing the 'three most significant general challenges' show that the type of challenges they face varies widely. Challenges in the transport sector are mentioned most frequently, followed by pressures of rapid urban population growth, employment, governance challenges, and limited financial resources.

Diagram 1: Top challenges

What are the three most significant general challenges facing your city today?

Transport

Increase in private vehicles

Incomplete public transport network

Congestion

Developing an integrated transport system

Accessibility

Urban mobility

Jobs

Creating jobs

Long-term unemployment

Local family wage jobs

Job retention

Quality job growth

Population Growth

Demands of rapid growth

Accommodating an increasing population

Rapid urbanization

Demographic challenges

The challenges of a fast growing city

Housing

Affordable housing

Homelessness

Building social housing

Slums

Building housing with good environmental standards

Meeting the housing needs of all income levels

Finance

Financial Budget limitations

Maintaining the revenue and tax base

Financial constraints due to high debt loading

Revenue shortfalls

Financing infrastructure

Taxes

Of the 90 cities analysed, 70% identify air pollution as a significant or very significant environmental challenge for the city and its region (see Figure 1.1). This is followed by severe storms and flooding (68%), stormwater management (64%) and solid waste processing and disposal (57%). The majority of cities also identify fly tipping of household waste, water pollution and lack of green space as significant challenges.

Asked about a selection of broader urban development challenges, two thirds of cities highlight road congestion and lack of affordable housing and 59% urban sprawl as the most pressing challenges.

Cities in middle- and low-income countries face additional challenges to those surveyed in high-income countries. With respect to environmental issues, water-related challenges, sewage treatment, solid waste and soil erosion are all reported significantly more often by cities in middle- and low-income countries (see Table 1.1a). Three in four cities surveyed in middle- and low-income countries identify solid waste processing/disposal, sewage treatment/disposal and dumped household waste as important challenges.

Figure 1.1 Cities' environmental challenges

How significant are the following green challenges for your city and its region?

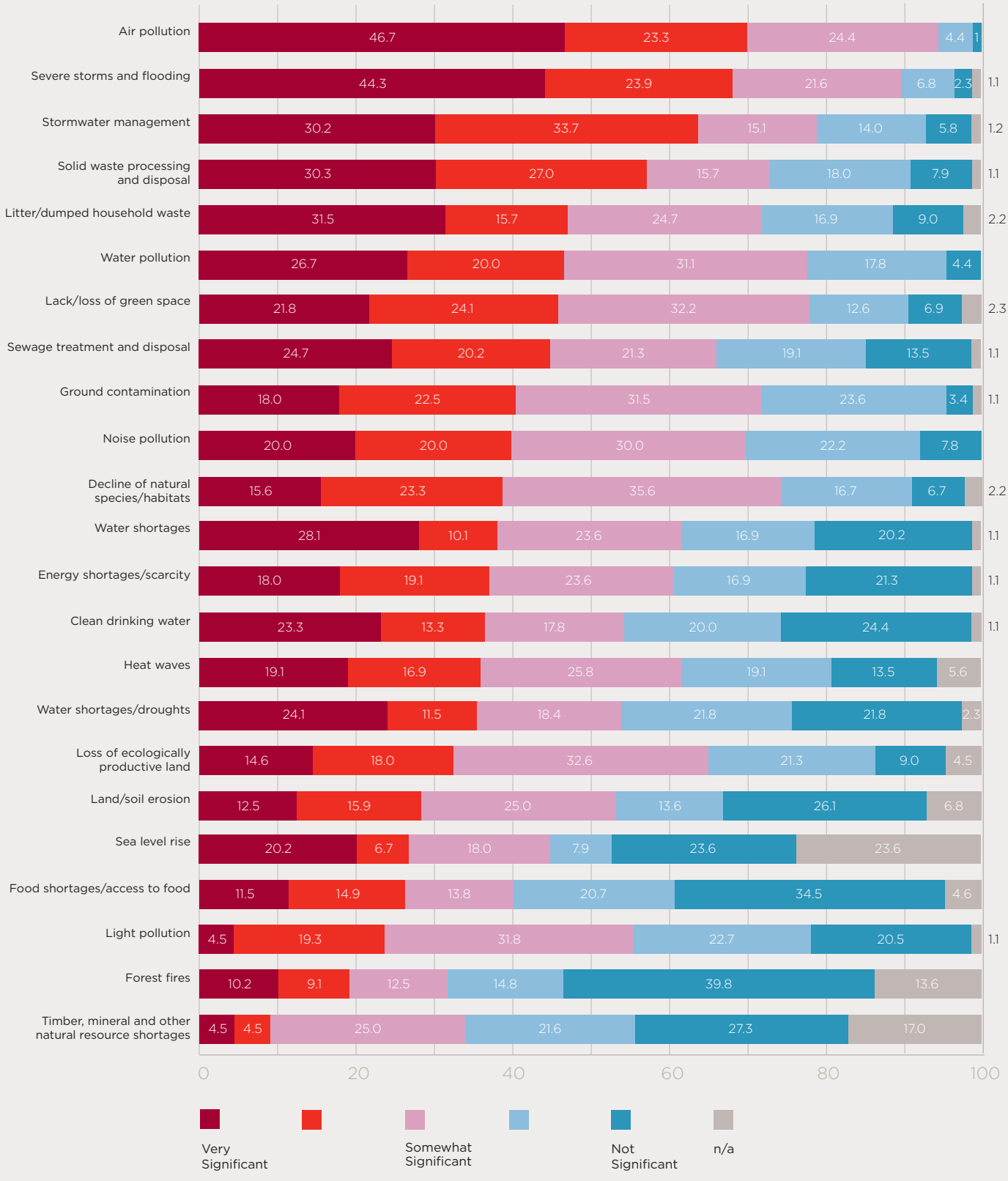


Table 1.1a Environmental challenges faced by different types of cities

Income level
Population
Region

Environmental challenge	Challenge reported significantly more often by...
Stormwater management	Cities in Asia, cities in North America
Solid waste processing and disposal	Cities in middle and low income countries
Litter/dumped household waste	Cities in middle and low income countries
Water pollution	Cities in middle and low income countries
Lack/loss of green space	Cities in middle and low income countries
Sewage treatment and disposal	Cities in middle and low income countries
Ground contamination	Cities in middle and low income countries
Noise pollution	Cities in middle and low income countries, cities in Europe
Water shortages/droughts	Cities in middle and low income countries
Clean drinking water	Cities in middle and low income countries
Loss of ecologically productive land	Cities in middle and low income countries
Land/soil erosion	Cities in middle and low income countries
Food shortages/access to food	Cities in middle and low income countries, cities with less than 1 million people

Environmental challenges also differ between geographic regions (Table 1.1a). Stormwater management is more important to city authorities in Asia and North America than to those in Europe. With regard to urban development challenges, overcrowding and informal land development are more frequently reported by Asian cities. European cities more often report social exclusion as a major challenge and noise pollution seems to be particularly acute in Europe: 18 out of 25 European cities identify noise as an important challenge, while only three North American cities regard noise as significant (Table 1.1a).

Table 1.1b Urban development challenges faced by different types of cities

Income level
Population
Region

Urban development challenge	Challenge reported significantly more often by...
Road congestion	Cities with more than 1 million people
Urban sprawl	Cities in middle and low income countries
Insufficient public services	Cities in middle and low income countries
Overcrowding	Cities in middle and low income countries, cities in Asia
Poor or lacking infrastructure	Cities in middle and low income countries
Informal land development	Cities in middle and low income countries
Social exclusion	Cities in Europe

A number of urban development challenges, including overcrowding, informal land development, lack of infrastructure, insufficient public services and infectious diseases are identified significantly more often by cities in middle- and low-income countries (Table 1.1b).

The size of cities seems to be little associated with environmental challenges, although food shortages tend to be more of a concern for smaller cities. In contrast, with respect to urban development challenges, road congestion and informal land development are identified more often by cities with over one million inhabitants.

1.2 The green transition

All cities in the survey define themselves as 'green', 'in transition' or 'aspiring to be green' (see Figure 1.2). 80% define themselves as either 'a green city' or 'in transition towards being a green city'. Cities in high-income countries are more likely to define themselves as 'green' (see Table 1.2), with almost all cities in these countries (51 out of 57) perceiving themselves to be either 'green' or 'in transition'. In contrast, two in five cities in middle- and low-income countries have yet to start the green transition.

Figure 1.2: Cities' perceptions of being green
How would you define your city in relation to the green agenda?

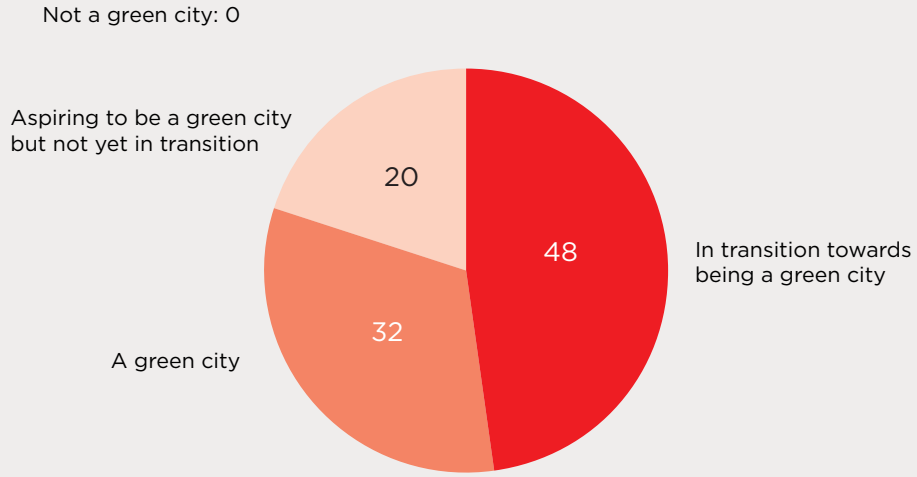


Table 1.2 Perceptions of being green in different types of cities

Income level Population Region	Self perception	Self-perception reported significantly more often by...
	A green city	Cities in high income countries, cities with less than 1 million people

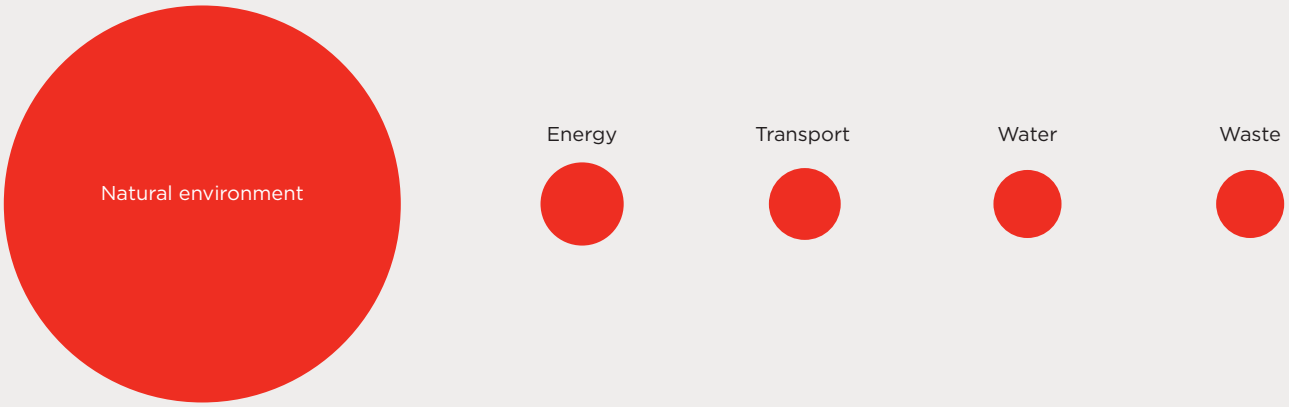
Cities were asked to identify their three most prominent green characteristics and assets. In response, green space, parks and natural landscapes were most frequently mentioned (105 times). This was followed by the quality of the city's transport system (31 times), energy systems (33 times) and water (20 times) and waste management systems (19 times).

Green objectives have become more widespread across cities in the last 20 years. All but two cities surveyed regard green objectives as an important component of their political agendas. Of the cities that could identify a specific time when green objectives became important to their political agenda, 65% report this occurring at some point since the 1992 Rio Summit. For the remaining 35%, green objectives emerged as a political priority before 1992. A small group of leading cities (15%) have been developing green priorities for 40 years or more.

The growing importance of green objectives for cities seems to be more driven by social and political changes than environmental tipping points. The majority of cities identify the most important triggers for adopting green objectives as public opinion and awareness (66%), changes in local political leadership (55%) and pressure from stakeholders (47%) (See Figure 1.3).

Diagram 2: Greenest characteristics of cities

In your opinion what are the three greenest characteristics/assets of your city?



Natural environment

A city covered by forest

A clean harbour where you can swim

Parks and open space

Good access to green and blue surfaces

Preserving and enhancing wetlands

Biodiversity

Gardens

Energy

Over 75% renewable energy base

Energy efficiency standards for buildings

Progress towards a zero energy district

District heating

Smart grid

Biogas emission reduction project

Transport

Growing green public transport

Transit-oriented development

35% of commutes by bike

Excellent public bus service

Bike lanes

Water

Good access to drinking water

Clean water supply

Water conservation

Green stormwater infrastructure

Sewage treatment

Waste

Comprehensive recycling programme

Strong waste diversion programme

Composting infrastructure

Banning plastic bags

Extended producer responsibility programmes

Cities in middle- and low-income countries report a different set of triggers compared with cities in high-income countries. Public opinion/awareness, specific non-environmental crisis events and pressure from national/supranational government are all identified significantly more often by cities in middle- and low-income countries (see Table 1.3).

Figure 1.3 Triggers prompting cities' adoption of green objectives

How important were/are the following triggers in making green objectives an important part of your city's political agenda?

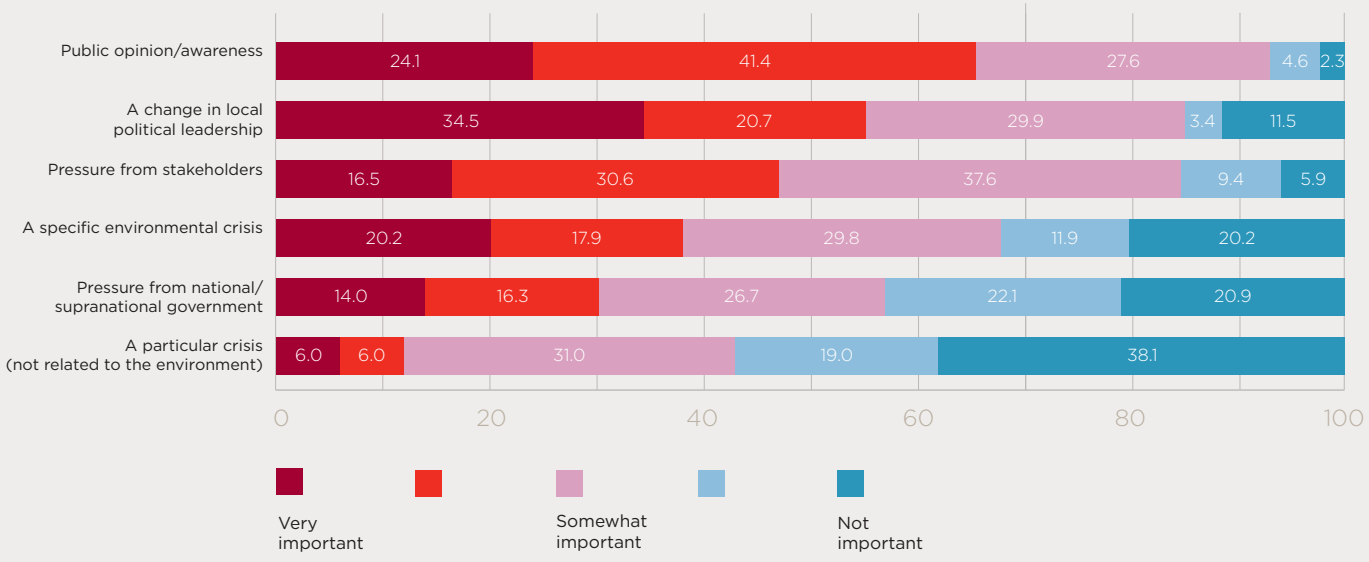


Table 1.3 Triggers prompting adoption of green objectives in different types of cities

	Trigger	Trigger reported significantly more often by...
Income level Population Region	Public opinion/awareness	Cities in middle and low income countries
	A change in local political leadership	Cities in Asia, cities in North America
	Pressure from national/ supranational government	Cities in middle and low income countries, cities in Asia,
	A particular crisis (not related to the environment)	Cities in middle and low income countries

1.3 Green policy – progress to date

In translating green aspirations into specific actions, city governments highlight various policy tools. The majority of cities identify development planning (91%), communication/raising awareness (88%), standards and regulations (84%) and public funding and subsidies (70%) as important policy tools for their green agenda. While taxation is generally not viewed as important across the overall sample, most Asian cities do regard it as an important green policy tool (13 out of 17).

Progress in developing green urban policies varies across different sectors. More than half of cities report that their policies are well-developed in the waste (67%), land-use (60%) and water sectors (58%). Of the listed green sectors, food policy is the least developed, with only 21% of cities regarding it as well-developed.

As Figure 1.4 shows, in terms of outcomes, cities report most success with increasing green space (59%), increasing recycling/composting (58%) and reducing water pollution (52%). Cities report least success in reducing resource consumption and increasing energy security; only one in five cities reports success with achieving these outcomes.

Figure 1.4 Cities' success in achieving green outcomes
To what extent have the following green policy objectives achieved successful outcomes in your city?

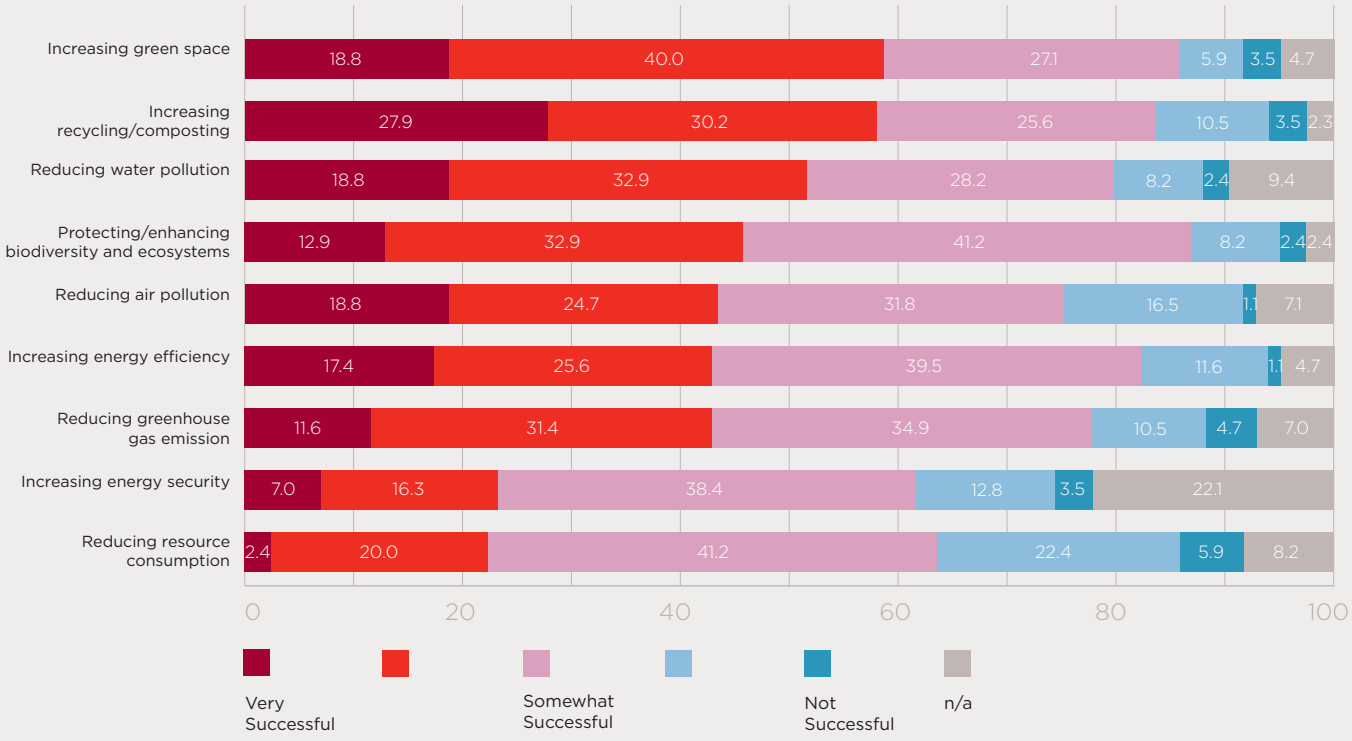


Table 1.4 Success with achieving green policy outcomes in different types of cities

	Green policy outcome	Successful outcome reported significantly more often by...
Income level Population Region	Increasing recycling/ composting	Cities in high income countries, cities with less than 1 million people
	Reducing water pollution	Cities in high income countries
	Increasing energy efficiency	Cities in high income countries

Cities in high-income countries tend to have more developed green policies across the transport, land use, energy and buildings sector. There is no significant association between income level and policy development in food and waste. Cities in high-income countries report significantly more success in reducing water pollution, increasing energy efficiency and recycling/composting (see Table 1.4). Smaller cities (with fewer than one million inhabitants) report more frequent success with increasing recycling/composting.

Cities rating themselves as 'green' report significantly more success in increasing energy security, reducing greenhouse gas emissions, increasing recycling/composting, increasing energy efficiency and, to a lesser degree, reducing resource consumption.

In assessing progress against green objectives, cities make use of a wide range of indicators; the most frequently used environmental indicators include measures of local environmental quality (air and water pollution, levels of green space), greenhouse gas emissions and energy consumption indicators. Air pollution is measured on a regular basis in 70% of cities. Direct economic assessment of green policies is, however, rare among cities in the survey, with only 20% of cities being aware of an economic study of municipal green policy.

Cities in high-income countries not only report more success in achieving green outcomes, but also tend to make greater use of environmental indicators to measure progress. These cities seem significantly more likely to monitor greenhouse gas emissions and energy consumption than cities in middle and low-income countries. Only 40% of respondents from middle- and low-income cities report measuring greenhouse gas emissions, while the great majority (85%) of high-income cities use the indicator.

Furthermore, there is a significant regional variation in the use of greenhouse gas emission measures. While this measure is used by 23 of 25 European cities and 21 of 26 North American cities, it is only used by 11 of the 21 Asian cities in the survey. In contrast to 'transition' cities, 19 out of 29 'green' cities report the frequent use of green goals as indicators to measure progress.

Bicycle parking at Amsterdam Central Station

Over a quarter of all trips in the city are made by bicycle thanks to an integrated policy approach. Since the mid-1970s Dutch city governments have reversed declines in cycling by building separated cycle lanes, restricting car use and promoting compact, mixed-use urban development.

Photo credit: Ocean/Corbis

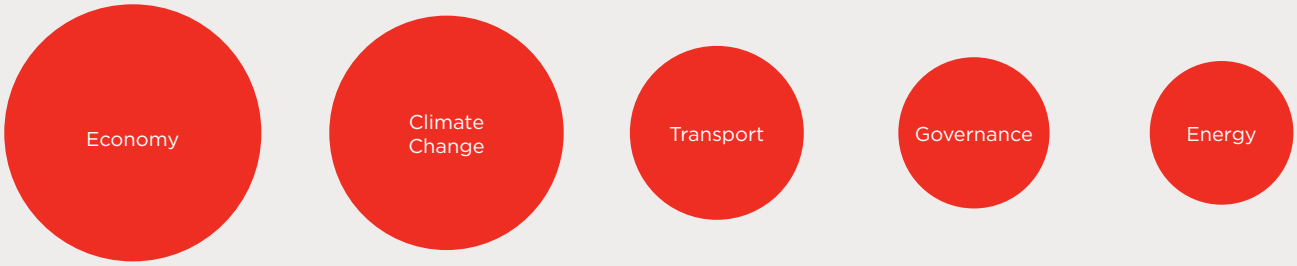
A2 Building the green economy

Over the last decade, the twin goals of green economic growth and building a green economy have become more common across countries and cities. This section examines the way in which cities have integrated green economic objectives into their policy agendas, as well as the process of green innovation including the most promising sectors, the role of municipal governments and financial barriers. We also examine the importance of new technologies and the types of technologies most used in the transition to the green economy.

2.1 Green economic objectives

Cities were asked to list their three main 'general aspirations'. Economic growth and stability is a frequently reported aspiration. For instance, many cities aspire to 'create economic stability', 'develop the innovation economy' and pursue 'job creation'. Besides economic aspirations, cities frequently identify aspirations related to transport and responding to climate change. These aspirations address some of the key urban and environmental challenges identified by cities (see previous section on 'Green Challenges').

Diagram 3: Top general aspirations
What are the three most significant general aspirations for your city today?



Economy

Attract clean-tech businesses

An economic driving force in the region

A 21st century city of innovation

Create economic stability

Economic development

Economic prosperity and affordability

Attract companies

Promoting the green economy

Climate Change

Greenhouse gas reduction

The first carbon neutral capital by 2025

Climate change resilience and adaptation

20% carbon reduction by 2020

Reduce GHG emissions by 50% to below 1 tCO_2e per capita

Transport

Complete walkable, liveable communities

Increase electric mobility

Reduce road traffic by one third

Extend capacity of collective transport

Increase transport affordability

Efficient public transport

Governance

Responsive urban governance

Engage citizens

Transparency and efficiency in public administration

Community engagement

Good governance

Energy

Reduce energy consumption

Become the solar city

Become the most energy efficient city in the country

Reducing coal for industry

Independent, decentralised power supply

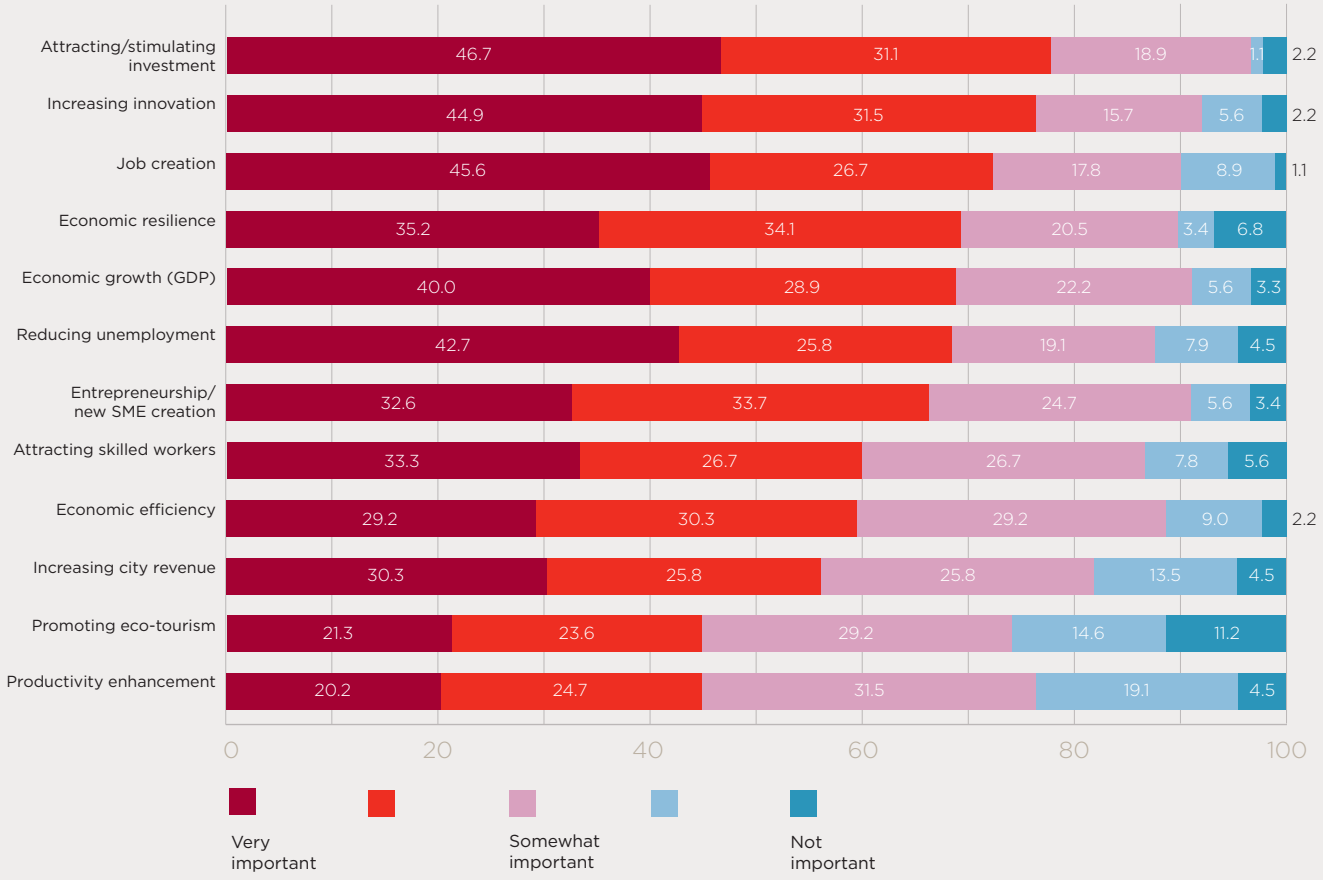
An overwhelming majority of cities (93%) expect their green policies to have a positive economic impact. Four cities expect 'zero' economic impact, and two cities expect modest net costs from their green policies.

Most cities report that green economic development is an important part of their overall political agenda. Almost 70% of cities state that green economic development is either an 'important' or 'very important' part of their political agenda. Economic and environmental objectives are seen to be closely interlinked. Overall, 65% of cities describe economic growth as a primary goal of their green policies, while a further 31% regard growth as a secondary goal. Although green and growth policies are regarded as closely linked, only one in four cities reports that they have a coordinated strategy for 'green growth'.

Alongside economic growth, cities report a wide range of other economic objectives in relation to their green policy agenda (Figure 2.1). The ones most frequently identified as 'important' or 'very important' include attracting investment (78%), increasing innovation (76%) and creating jobs (72%). Other economic objectives cited by the majority of cities include economic resilience, economic growth and reducing unemployment (all 69%).

Figure 2.1 Importance of economic priorities for cities' green policy agendas

How important are the following economic priorities for your city in relation to its green policy agenda?



As Table 2.1 shows, cities in high-income countries report more frequently that increasing innovation is an important economic priority in relation to their green policy agenda.

Table 2.1 Green economic priorities in different types of cities

Income level / Population / Region	Green economic priority	Green economic priority reported significantly more often by ...
	Increasing innovation	Cities in high income countries

2.2 Opportunities and barriers

Overall, 75% of cities regard green transport (e.g. public transport or electric vehicles) as a 'significant' or 'very significant' sector for the city's economic growth (Figure 2.2). The majority of cities also regard renewable energy, retrofitting existing buildings, new green buildings, energy distribution and management and green goods and services as key sectors for the economy. Cities in high-income countries place particular importance on green retrofitting of existing buildings (see Table 2.2).

Figure 2.2 Importance of green sectors for cities' economic growth
How significant are the following sectors of the green economy for your city's economic growth?

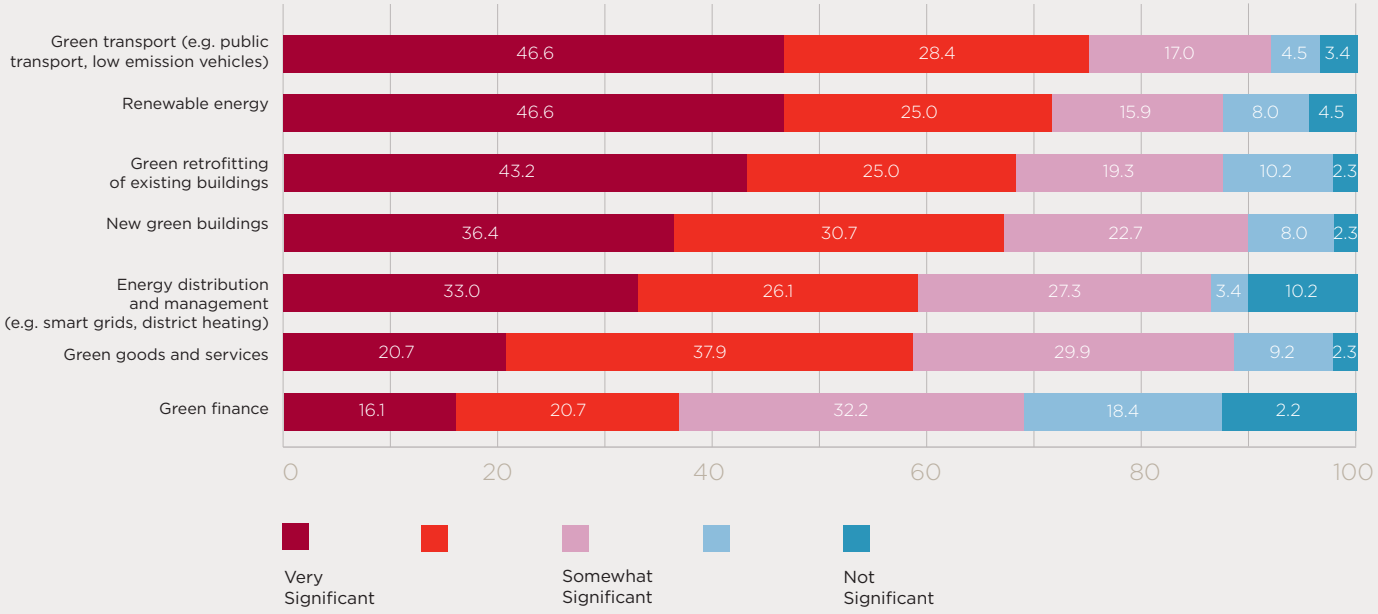


Table 2.2 Significance of green economy sectors for economic growth in different types of cities

Income level / Population / Region	Green economic priority	Sector reported significantly more often by...
	Green retrofitting of existing buildings	Cities in high income countries

While most cities have strong aspirations for green growth, they also report various barriers to the process. The most common barriers identified are insufficient public funding (55% of cities) and insufficient support from national government (50% of cities).

Cities in middle- and low-income countries face more barriers to going greener. In particular, lack of public support, lack of private support, and lack of skills in local government and the local workforce are all identified more frequently as barriers by these cities. Barriers to accessing international bilateral, multilateral funds and international private sector finance are important for 60 to 70% of cities in middle- and low-income countries– significantly more important than for high-income countries.

Inadequate local government skills, insufficient public support and lack of skills in the local workforce are regarded as barriers by significantly more Asian cities than cities in North America or Europe. Cities that define themselves as 'green' cite barriers such as lack of private sector support, lack of skills in the local workforce or government and lack of public support significantly less often than cities that are still in transition or aspiring to be green.

2.3 Technology for a green economy

Overall, 84% of cities place a high level of importance on the role of new technology for the green economy. Furthermore, new technologies are reported to be important across a wide range of green economy sectors, including green transport (80% of cities), energy generation and distribution (80%), green buildings (78%), waste management (74%), water management (73%) and government and administration (70%) (see Figure 2.3). Cities also regard new technology as more important for these green sectors than other sectors in the economy including education, health and public security. However, cities in middle- and low-income countries see more opportunities for new technologies in many of these sectors, including public security, education and land management and planning.

Figure 2.3 Importance of new technology across sectors
How important is the role of the new technologies in the following sectors of your city?

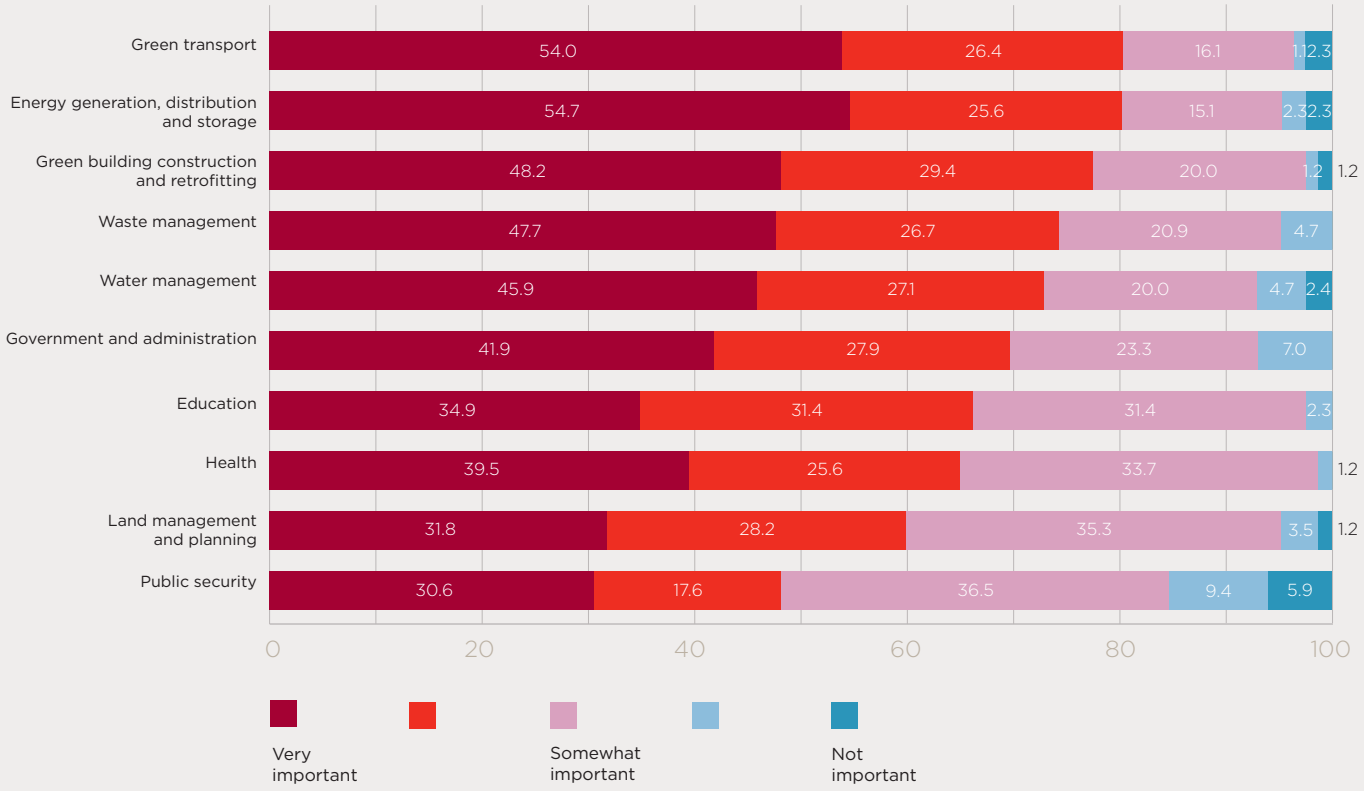


Table 2.3 Importance of technology across sectors in different types of cities

Income level
Population
Region

Sector	Sector reported significantly more often by...
Water management	Cities in Asia
Education	Cities in middle and low income countries
Land management and planning	Cities in middle and low income countries, cities in Asia
Public security	Cities in middle and low income countries

Cities identify a number of specific technologies as relevant for their green economy strategies. The technologies most commonly reported by cities as in use or intending to be used relate to the transport sector and include intelligent traffic management (76%), low emission vehicles (74%), integrated multi-modal transport systems (74%) and electric vehicles (70%). Building and energy technologies are also well-used, while information and communications technology (ICT) is generally regarded as less important for cities' green agendas. Instead, ICT is regarded

as an enabling tool rather than a core component of green city strategies. Overall, 59% of cities describe the role of ICT as 'enabling' their green economy strategy, while only 31% say that ICT plays a 'core' role.

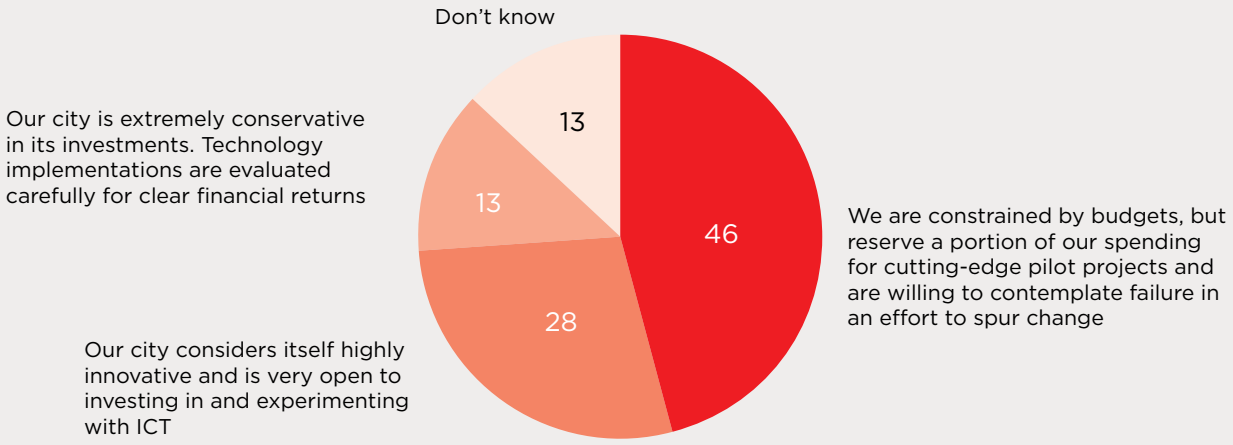
Building-related technologies and integrated multi-modal transport systems are more important for cities in high-income countries than those in middle- and low-income countries. A clear majority of all cities in high-income countries (48 out of 57) regard integrated multi-modal transport systems and electric vehicles as important to their green economy.

Almost all European cities (22 of 25) in the survey use or intend to use mobile apps for public transport – a significantly higher number than in North America or Asia. Three in four Asian cities regard both smart waste and water management systems as important – a significantly higher proportion than in North America.

Cities see a strong role for municipal governments in driving green innovation. 81% of cities agree that government should 'lead by example' and introduce innovations within their own operations. 66% of cities also agree that municipal governments should play a more active role by directly funding pilot programmes. Nearly all cities (94%) did not support the view that municipal government should play no role in driving innovation and that it should be the sole responsibility of the private sector.

Overall, 74% of cities report that their governments are willing to invest in green technology to spur change (see Figure 2.4). 28% of cities consider themselves highly innovative and very open to experimenting and investing in green technology. Almost half of cities, however, are constrained by budgets. Only 13% of cities report that they take a conservative approach to technological innovation and investment.

Figure 2.4: Cities attitudes towards green innovation and investment
Which of the following statements best describes the way your city approaches green technology innovations and investments?



Hydro-electricity in Munich

The installation of a new turbine for a hydro-electric plant in the heart of the city demonstrates the municipal utility company's commitment to renewable energy. Stadtwerke München aims to generate enough energy through wind, hydro, solar, biomass and geothermal sources to meet the needs of all the city's 1.4 million residents by 2025.

Photo credit: SWM

A3 Governance and the green economy

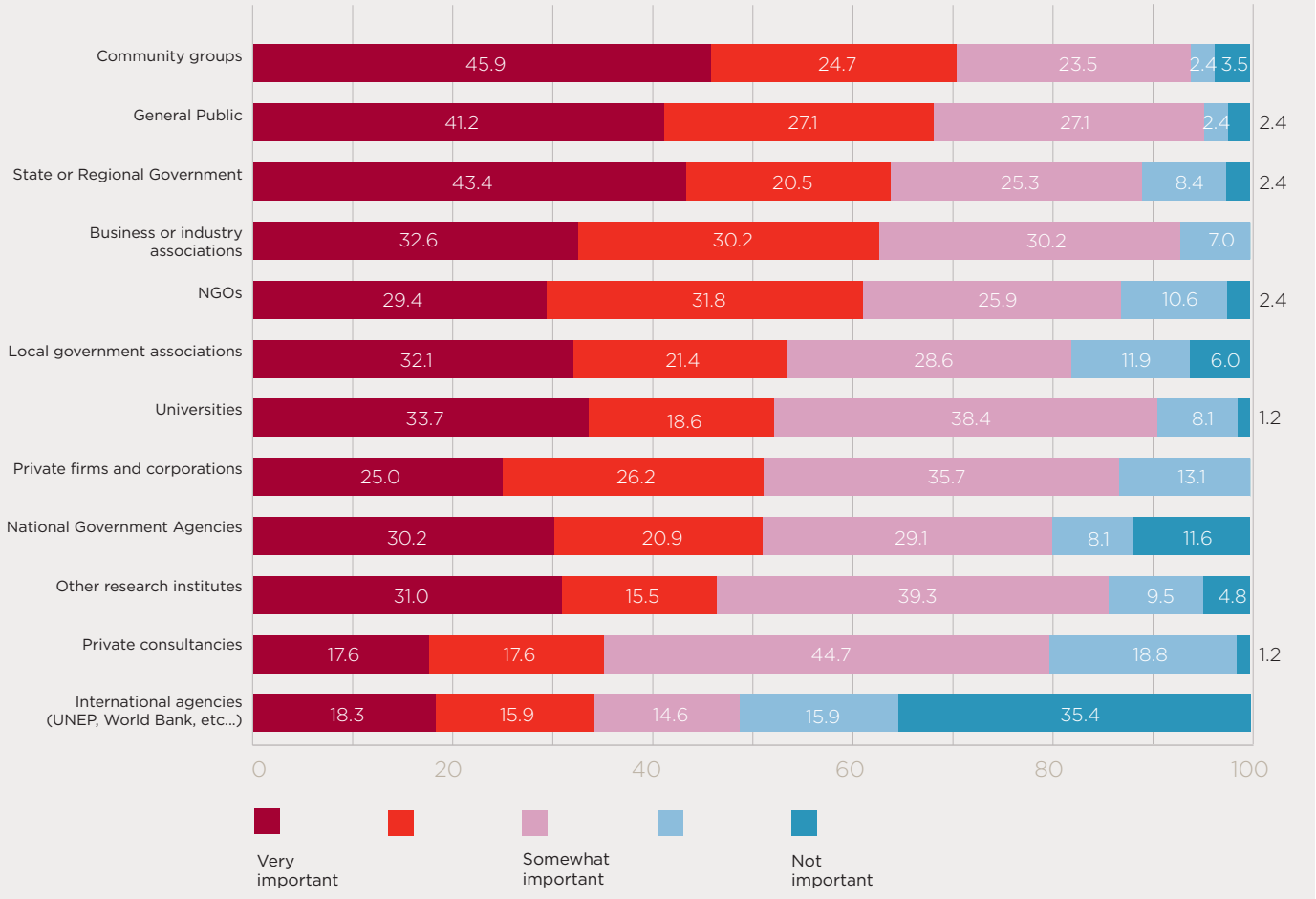
An effective transition to a green economy requires appropriate governance. For cities, this demands coordinated policies at national, regional and municipal levels. This section examines strategic planning processes undertaken by policy makers, including the participation of a range of external stakeholders. We also examine the effectiveness of government co-ordination, both vertically through different levels of government and horizontally within municipal governments, as well as the level of skills and capacity that exists in cities today.

3.1 Strategy development and stakeholder participation

Almost all cities (95%) in the survey have, or are intending to have, some form of green strategy. Strategic plans are most commonly formulated through a strategic city development plan (48%), while a further 10% of cities have sector-specific action plans to communicate their green strategy. Only a few cities (5%) report having a legally-binding city plan to guide their overall approach to green policy.

Cities generally involve a wide range of external stakeholders in the development of green policy (see Figure 3.1). The majority of cities consider that the involvement of a broad range of stakeholders is important, particularly community groups (71%), the general public (68%), state or regional government (64%), business and industry association (63%) and NGOs (61%).

Figure 3.1 Involvement of stakeholders in cities' formulation of green policy
Please rate the importance of involving the following stakeholder groups in formulation your city's green policies.



Cities in middle- and low-income countries place importance on a greater range of stakeholders than cities in high-income countries (see Table 3.1). International agencies, national governments, state or regional governments, local government associations, universities, other research institutes and private consultancies are all regarded as more important in middle- and low-income countries (see Table 3.1). In Asia, all 20 cities place high importance on state or regional-level governments as stakeholders and 17 out of 21 Asian cities, place high importance on national government agencies. International agencies (such as UNEP, World Bank) are important in 14 out of 20 Asian cities, while the majority of European and North American cities regard them as not important. Cities that define themselves as 'green' place importance significantly less often on higher level governments.

Table 3.1 Involvement of stakeholders in green policy formulation in different types of cities

Income level
Population
Region

Stakeholder	Stakeholder involvement reported significantly more often by...
State or Regional Government	Cities in middle and low income countries, cities in Asia
Local government associations	Cities in middle and low income countries
Universities	Cities in middle and low income countries
National Government Agencies	Cities in middle and low income countries, cities in Asia
Other research institutes	Cities in middle and low income countries
Private consultancies	Cities in middle and low income countries
International agencies (UNEP, World Bank, etc...)	Cities in middle and low income countries, cities in Asia

3.2 Government co-ordination

Cities perceive their green agendas as being most supported by state level policy frameworks and least supported by supranational level policy (see Figure 3.2). Almost half of cities believe that state level policy frameworks are 'supportive' or 'very supportive'. Slightly fewer cities (43%) view national level policy as supportive. Cities find international policy frameworks least supportive, with only one in four cities regarding supranational frameworks as 'supportive'. The national government is considered to be supportive more often in cities in middle- and low- income countries. Asian cities, too, report support from national and state governments more often.

Figure 3.2 Support of state, national and international governments for cities' green strategies
How supportive are state and national green policy frameworks of your city's implementation of its green strategy?

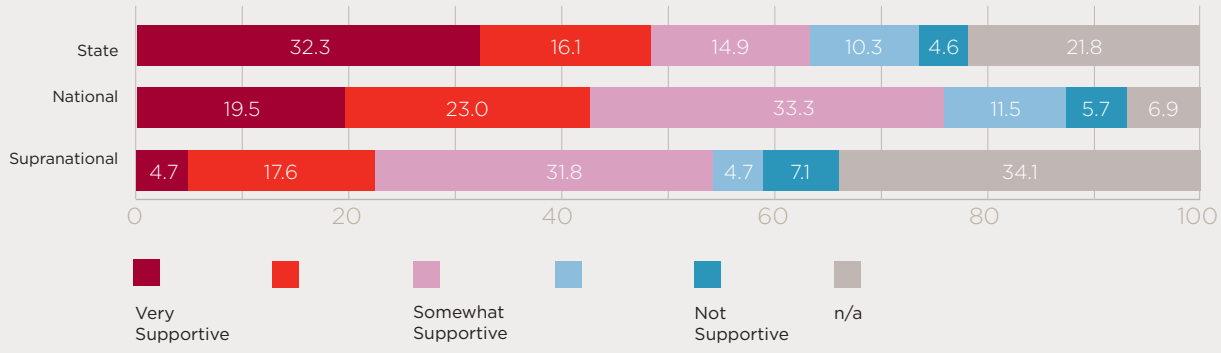


Table 3.2 Support of state, national and international-level policy frameworks in different types of cities

Income level / Population / Region	Level of government	Support reported significantly more often by...
	State	Cities in Asia
	National	Cities in middle and low income countries, cities in Asia

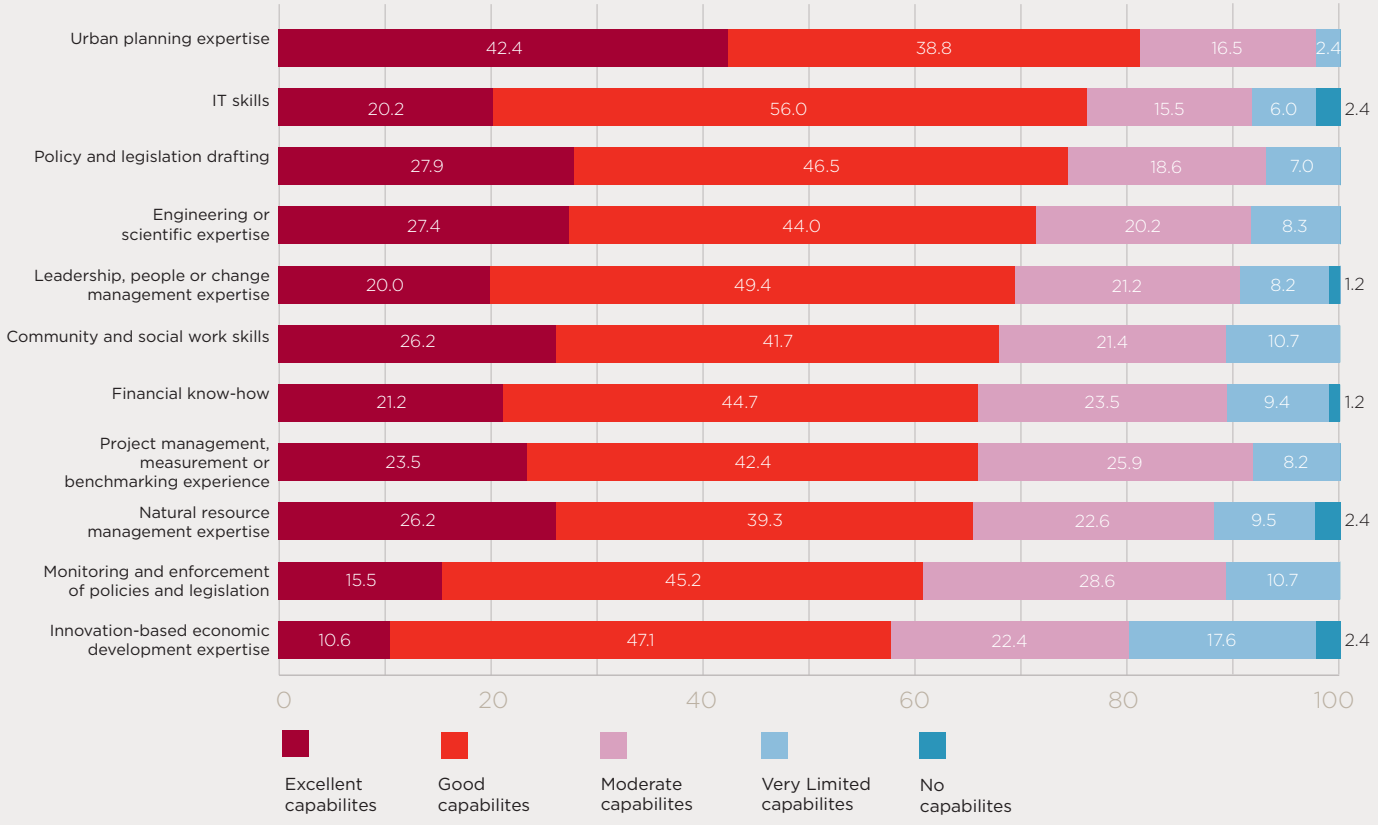
Questioned on the specific state, national, or supranational policies that support their green agenda, cities most frequently identify energy generation and energy efficiency policies. A number of climate change, transport, air pollution and land use policies are also identified as supportive. Questioned on higher level policies that undermine the city's green agenda, cities also identify transport and energy-related policies.

Most municipal governments involve departments of environment (93%), planning (84%) and transport (82%) as well as the office of the mayor (78%) and energy/utility departments (76%) in the formulation of their overall green strategy. Departments of finance, economic development, technology, health and education are involved in less than half of cities. Around 60% of cities in middle- and low-income countries involve health and education departments in the development of green strategies.

3.3 Skills and capacity

Cities rate their capabilities reasonably highly across a broad range of green economy sectors (see Figure 3.3). The majority of cities view their capabilities across all the listed sectors as either 'good' or 'excellent'. Four in five cities view their capabilities as 'good' or 'excellent' in urban planning and three in four in IT skills and policy and legislation drafting. Least often reported are capabilities in monitoring and enforcement and innovation-based economic development.

Figure 3.3 Cities' capabilities and green expertise
How would you rate your city's capabilities in the following areas related to green expertise?



Skills and capabilities also vary significantly depending on cities' wealth, size and regional location (Table 3.3). Capabilities in all areas except leadership and natural resource management are more often viewed as 'excellent' or 'good' in cities in high-income countries. Asian cities report less expertise than North American and European cities in information technology and natural resource management. Of the 29 cities that rate themselves 'green', 26 report the existence of local expertise in natural resource management and 22 in innovation-based economic development.

Table 3.3 Green expertise in different types of cities

Income level
Population
Region

Area of green expertise	Capability reported significantly more often by...
Urban planning expertise	Cities in high income countries
IT skills	Cities in high income countries, cities in Europe, cities in North America
Policy and legislation drafting	Cities in high income countries, cities with less than 1 million people
Engineering or scientific expertise	Cities in high income countries
Community and social work skills	Cities in high income countries
Financial know-how	Cities in high income countries
Project management, measurement or benchmarking experience	Cities in high income countries
Natural resource management expertise	Cities in Europe, cities in North America
Monitoring and enforcement of policies and legislation	Cities in high income countries
Innovation-based economic development expertise	Cities in high income countries

A4 Conclusions and implications for policy

This survey of city governments suggests that cities have started to embrace the transition towards a green economy, with almost all cities identifying strong links between economic and environmental goals. Cities show a strong willingness to foster the green agenda, and green aspirations exist in cities across a range of different economic and geographic contexts. However, the triggers for 'going green' differ significantly. For cities in high-income countries, green policies have generally been pushed by public awareness and a change in local political leadership, while urban greening efforts in middle- and low-income countries tend to have been led more by national governments.

The survey also confirms that environmental problems represent some of the most important challenges facing city governments today. For cities across income groups, transport and associated problems – including air pollution and urban sprawl – emerge as major challenges. While many cities in high-income countries have successfully achieved reductions in solid waste and water pollution, tackling air pollution has been less successful.

In tackling environmental problems, cities are seeing the opportunity for considerable co-benefits. In terms of economic co-benefits, cities identify the greatest potential in the transport, energy and building sectors, where energy cost savings are often most obvious. In terms of social co-benefits, providing minimum standards in the provision of drinking water, sanitation and solid waste services represent an opportunity for addressing social and environmental problems simultaneously. Furthermore, cities that define themselves as 'green' seem to be more advanced in improving energy security and protecting biodiversity and ecosystems. This may be explained partially by their more developed skills and capabilities in natural resource management.

While city authorities are confident that green policies can lead to economic gains as well as environmental benefits, economic impact assessments of these policies are rare. This presents a major gap. City governments could strengthen their case for more effective and efficient green economic policies by building a rigorous evidence base for the economic impacts delivered. Cities' positive response towards funding cutting-edge projects indicates that many are willing to be first-movers and accept some degree of risk in fostering green innovation. At the same time, lack of support from national governments is one of the most often cited barriers to achieving green objectives, and the survey results suggest that this could be an important area for greater alignment and effective collaboration between multiple levels of governance.

Cycling for reduced congestion costs

In the City of Copenhagen 36% of journeys to work and education are by bicycle. This remarkably high rate of cycling is estimated to save the city US$43m annually in reduced congestion, infrastructure and accident costs – the result of a comprehensive policy package including constructing cycle ways, restricting car parking and regulating land-use to encourage accessible workplace location. Part of the City's Carbon Plan, Copenhagen has an ambitious target to increase cycling rates to 50% of journeys to work and education by 2015.

Photo credit: Kontraframe

B GREEN GROWTH: CASE STUDIES

The case studies investigate the experience of eight cities in helping to drive green growth. Policy programmes in Copenhagen, Hong Kong, Stockholm, Portland, Belo Horizonte, Durban, Berlin and London have all achieved notable success in pursuit of both economic and environmental objectives. Given the importance of integrating policies for delivering green growth, four cross-cutting policy programmes are examined, including land-use and transport, eco-districts and buildings; waste, recycling and energy; and electric mobility and renewable energy. Two case study cities are presented for each theme, demonstrating how similar objectives are being pursued in different contexts, with different policy tools, and using different types of public-private partnership.

The case studies provide inspiration by reporting on the success of integrating policy sectors and contributing to green growth. Each city's experience also offers important lessons about on-going challenges for building effective partnerships between business and government, delivering on environmental targets and integrating economic and environmental policy. The cases all emphasise the vital role that cities will play in leading the transition to a green economy.

B1 Land use and transport

Land-use and transport planning is arguably the most influential policy framework for urban spatial development, and is associated with particularly long-term structural impacts.[1, 2] The co-dependence of the two sectors can hardly be overstated: transport infrastructure is the strongest single determinant of urban expansion while land-use patterns, in turn, directly inform mobility behaviour.[3-7] In fact, given their relationship, it is perhaps surprising that cities and metropolitan regions have traditionally dealt with land-use and transport as two separate sectors.

Integrating land-use and transport policy is often cited as a central pre-condition for more sustainable urban development and green growth.[8-14] It is a policy area that creates significant path-dependencies and lock-ins in the long run, cutting across the social, economic and environmental dimension of cities. For instance, road congestion is often the result of insufficient land-use and transport integration; and the subsequent economic costs are enormous, estimated at 0.75% of GDP in the largely urbanised European Union[15] and in the UK amounting to annual costs of up to £20bn (US$32bn).[16] In many developing world cities, the costs of congestion are even higher: an estimated 3.4% of GDP in Buenos Aires, 2.6% in Mexico City and 3.4% in Dakar.[15]

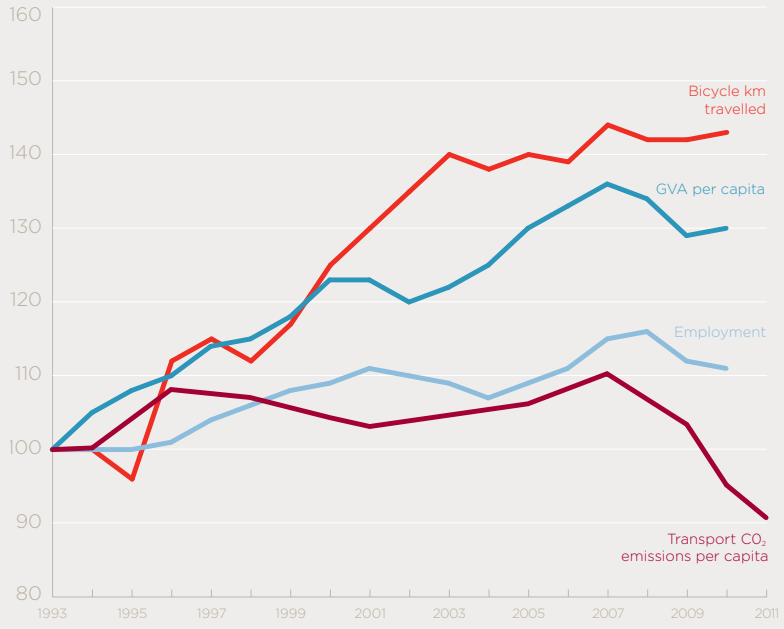
Land-use and transport policy is a central tool for city governments, whether for enabling agglomeration economies through better job matching, knowledge sharing and networking opportunities,[17-19] or reducing carbon emissions and resource use with efficient public transport or improving social inclusion with more accessible urban form. While both sectors are shaped directly by government actions, the enormous scale of interventions and resources required makes it one of the most challenging areas of policy making, particularly given the multiple geographic scales and levels of government involved and the long-term planning horizons that far exceed typical election cycles.

Broadly speaking, the central objectives of land-use and transport policy relate to the compact city model, which aims to improve city accessibility based on proximity.[20-26] This approach relies on spatial planning and investment strategies that involve three top-level policy targets: higher urban densities, mixed-use and urban design quality. These are usually considered at the scale of the functional urban region and are synchronised with transport strategies that focus on expanding the provision of public transport and improving walking and cycling opportunities while mitigating the adverse effects of vehicular traffic. Both Copenhagen and Hong Kong are often referred to as key examples of compact city developments.

1.1 Copenhagen: integrated regional planning for green growth

The City of Copenhagen has placed green growth and quality of life at the centre of its latest Municipal Plan.[27] The City has an ambitious goal to be "the world's first carbon neutral capital" by 2025 and at the "leading edge on technology and innovation in Europe."[27, 28] Copenhagen has a vision of being a key hub for business in Scandinavia and at the centre of the cross-border Oresund region. Growth is forecast in sectors including clean-tech, life sciences and business services and the city aims to be a laboratory for testing green innovations.[27] The City of Copenhagen expects an additional 90,000 residents by 2025, increasing the population from the current level of 550,000 to 640,000.[27] Although the population declined sharply from the 1950s, since 1990 the municipality's population has grown by 18%.[29]

Fig. 1: Green Growth



Copenhagen in Numbers

Population of metropolitan region (2010)[34]/ City of Copenhagen (2012)[29]	**1,822,000/ 549,000**
GVA per capita – metropolitan region (2010)[35]	**US$48,300**
Employment – metropolitan region (2010)[35]	**956,000**
Area – metropolitan region/ City of Copenhagen (including Frederiksberg)	**2,778 km²/ 97 km²**
Built-up portion of metropolitan region[36]	**26%**
Average (peak) residential density for built-up portion of metropolitan region[37]	**2,564 people/km² (30,659 people/km²)**
Carbon emissions per capita - city (2011)[29,31]	**3.4 tCO_2**

Fig. 1
The Copenhagen metropolitan regional economy, measured by Gross Value Added (GVA) per capita, grew by 30% from 1993 to 2010.[35] Over the same period, transport-related carbon emissions in the Municipality of Copenhagen decreased by 9% to 0.76 tCO_2 per capita.[38] All variables are indexed 1993=100.

Copenhagen's ambitions for green growth build on its strong environmental credentials. The metropolitan region's green business sector is already substantial, incorporating over 25,000 employees and 6,000 companies in a highly-competitive, export-intensive cluster[30] with annual revenues of over DKK50bn (US$8.7bn).[31] Copenhagen is widely regarded as one of the greenest cities in the world and recently came top in the Economist Intelligent Unit's European Green City ranking.[32] The city's environmental policy leadership spans renewable energy, district heating, waste management, the cleaning of its former industrial harbour and promoting cycling, for which it has become best known.[33] The latter is a result of the most fundamental underlying green policy agenda in Copenhagen: an integrated transport and land-use strategy, initiated more than six decades ago and which has led to the development of dense, walkable urban centres connected by rail-based public transport.

1.1.1 The Policy Programme

Copenhagen's integrated transport and land-use strategy is a key element in the city's green growth agenda. Initiated more than six decades ago with the regional-scale 'Finger Plan' and continuing today with investment in the metro and the successful promotion of cycling, Copenhagen's approach to land-use and transport has established dense, walkable urban centres connected by rail-based public transport. The resulting compact urban structure has primarily relied on effective land-use regulations and extensive transport infrastructure investments, underpinned by a clear regional spatial strategy.

The 'Finger Plan' promotes urban growth along rail corridors radiating from the city centre, while protecting 'green wedges' from development (see Figure 2). First proposed in 1947, it remains a powerful spatial concept and has been given renewed regulatory support at the national level

Fig. 2: Population and employment density along major transit routes in Copenhagen.

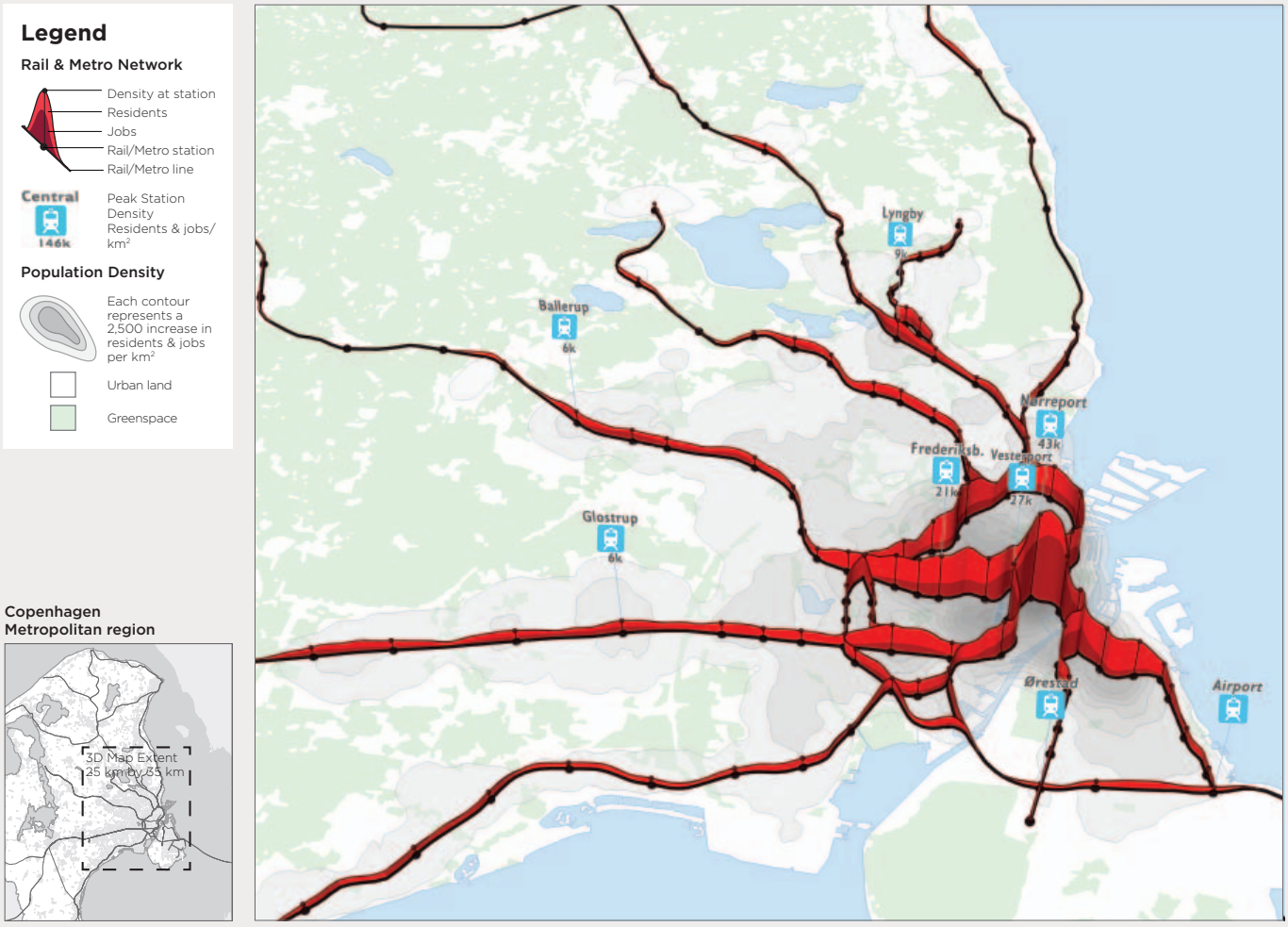


Fig. 2
Population and employment density along major transit routes in Copenhagen. The map shows the concentration of activities in the city centre and along rail corridors. The radial links separated by green wedges give shape to the city's metropolitan structure. LSE Cities graphic based on multiple data sources.[41,42]

through the 2007 Danish Planning Act.[33,39] This includes the 'Station Proximity Principle', which generally requires new large offices of more than 1,500 m² to be located within 600 m of a railway station.[39,40] Regulation of retail developments promotes the location of shops in town centres by restricting the size of shops and specifying the location of town centres where retail development is permitted.[39] In addition, city-level land-use planning stimulates mixed-use, high-density development around stations and limits parking provisions.[40]

Investment-driven policies focus on public transport, cycling and urban design. In addition to the historic S-train rail network which forms the backbone of the Finger Plan's linear corridors, a smaller metro system has been built over the last decade. It has established a public transport spine for Copenhagen's latest 'development finger', the Orestad New Town, and improved public transport provision in the urban core. Costing approximately DKK12.3bn (US$2.1bn), the first two metro lines were partially financed by capturing increased land-values adjacent to the line.[43,44] Cycling has been promoted since the 1980s and the city now has almost 370 km of dedicated cycle lanes.[45] Cycling is integrated with the public transport network and the city has implemented various information, training and safety initiatives.[45] Furthermore, broader urban development investments cut across urban regeneration and city centre densification, alongside significant investments in public realm improvements.[40]

Current policy targets for transport build on the legacy of decades of infrastructure investment and efforts in integrated land-use planning. The Municipality of Copenhagen aims to be the "world's best bicycle city"[46] and has a target for 75% of all trips to be by foot, bicycle or public transport by 2025.[28] Improvements to the city's transport system are seen as key contributors to green growth, with the sector expected to cut 135,000 tonnes of carbon by 2025, or 11% of Copenhagen's overall carbon reduction goal.[28]

1.1.2 Impacts

Environmental impacts
Direct measures of the environmental impacts arising from Copenhagen's approach to land-use and transport are difficult to gather. However, a number of proxy indicators are useful for assessing the long term impacts of the policy programme. Measures of transport accessibility suggest a good level of integration between urban development and public transport infrastructure. In Copenhagen over 56% of the residential population and 61% of jobs within the metropolitan region are within 1 km and 25% and 29% respectively within 500 m of a railway station (Figure 3).[36] Partly because of the relative ease of access to public transport, the share of car use for commuting in the City of Copenhagen is low, dropping from 42% in 1996 to only 26% in 2004 (compared with 37% in London and 33% in Stockholm in 2004). In contrast, the share of those commuting by bicycle is extraordinarily high, accounting for 36% of work trips (compared with 2% in London and 7% in Stockholm).[47, 48, 49] Per capita carbon emissions from transport have declined by 9% between 1991 and 2011, from an average of 0.82 tCO_2 to 0.76 tCO_2 per person.[38]

Despite the progress made, environmental challenges remain – particularly with regard to continuing traffic growth and increasing car ownership at both the city and metropolitan level.[31, 54] In particular, highway construction in suburban locations has offset sustainability gains[55] and over the past decade traffic on peripheral ring roads grew by 40%.[33]

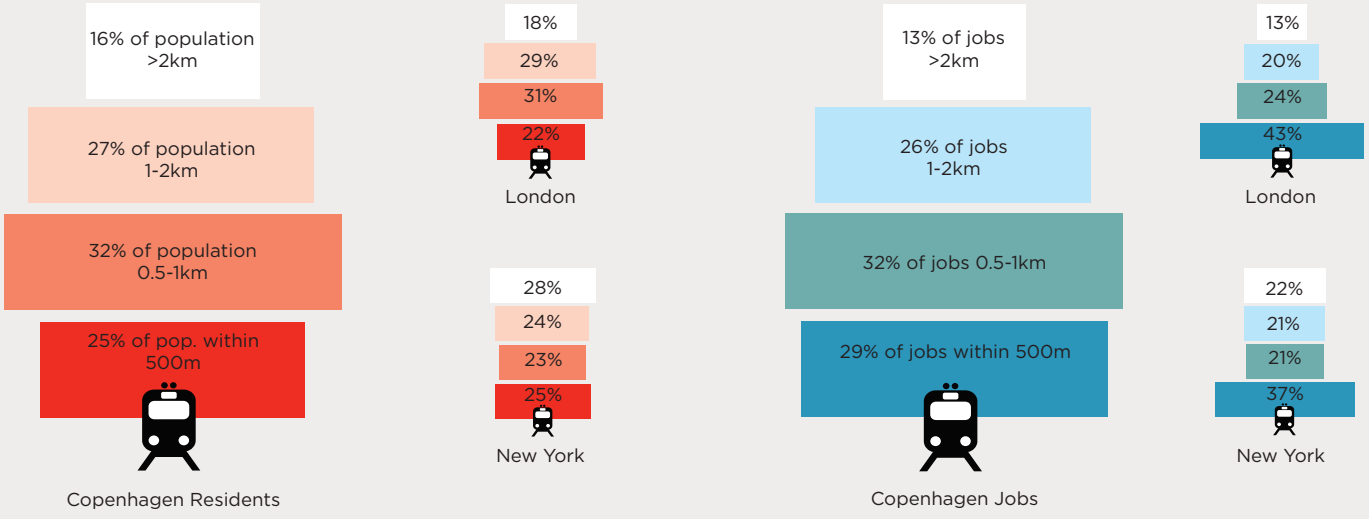
Economic impacts
Copenhagen's efficient transport system and compact urban form has resulted in various economic impacts. Relatively short travel distances and high use of inexpensive forms of transport such as cycling have created cost savings for individuals and for public infrastructure works. For example, Copenhagen spends an estimated 8% of its GDP on transport, compared with about 14% in sprawling, car-dependent Houston, USA.[56, 57] Savings attributed to the city's high level of cycling are estimated at US$43m per year from reduced congestion, accident, noise and infrastructure costs.[58]

The integrated approach to land-use and transport has also created business growth opportunities. A local construction company reported that the on-going metro construction is creating benefits for a number of local and international businesses.[59] New development sites at Orestad and Nordhavnen that are well connected to the inner city are creating opportunities for real estate investment. In addition, Copenhagen's focus on strengthening the inner-city through public space improvements has benefited local expertise and innovation, with companies such as Gehl Architects exporting the city's urban design model around the world.[60]

Copenhagen's transport system and urban form and the high quality of life associated with this are likely to be attractive to firms and skilled workers, though more research would be required to determine a significant link with wider economic benefits. The metro has improved accessibility while the Orestad development has created highly accessible office locations close to international transport links in an expanded central business district.[43]

Fig. 3
Public transport accessibility for residents and jobs in Copenhagen. This chart shows the share of the residential population (left) and share of jobs (right) within given distances to rail and metro stations. While Copenhagen's residential transport accessibility compares well with London and New York, job accessibility is markedly lower due to London and New York's highly concentrated inner-city employment centres. LSE Cities graphic based on multiple data sources.[41, 42, 50-53]

Fig. 3: Pedestrian accessibility to rail and metro stations



1.1.3 Policy Actors and Partnerships

The Danish national government has been the most significant actor for both strategic metropolitan-wide land-use planning and investment in public transport infrastructure. In recent years, the role of national government has become even more important following the re-assignment of regional-level planning powers to the national level through the 2007 Planning Act.[33, 39, 40] National transport investments and an overview of policy are facilitated through the Ministry of Transport, since it has responsibility for the regional highway network and has full-ownership of the DSB railway company, which operates all regional rail services and controls infrastructure.[61]

In addition, over 30 individual municipal governments across the metropolitan region influence detailed land-use policy such as parking, building density regulations and investment in local roads and bicycle infrastructure. The City of Copenhagen is the most important municipal government in the region and, as a partner with national government in the recent construction of the metro, it has played an increasingly significant role in influencing urban development.[44]

While the inner-city Municipality of Copenhagen is well-aligned with the direction of national policy, this view is not shared by some more suburban municipalities: "Of course, the National Spatial Planning Act is very much in accordance with what we want in Copenhagen and what we are doing. For some of the suburban municipalities these relatively strict land-use regulations sometimes conflict with local development wishes". Tue Rex, Planning Consultant, City of Copenhagen

This two-tier system of municipalities and national government and the multiple agencies overseeing spatial development and transport in the metropolitan region has also led to significant coordination challenges. Regardless of the relative policy success, institutional fragmentation has, for example, compromised integrated public transport planning and operations.[33] With responsibility for roads, rail, metro, bus and cycling infrastructure and services distributed between various institutions there is a risk of misaligning strategic transport investments. At the same time, new institutions recently established for integrating land-use and transport development have been generally regarded as a success. For example, the publicly-owned Orestad Development Corporation operating between 1993 and 2007 was responsible for both construction of the metro and development of surrounding land.[62]

Local experts further emphasise the role of non-government actors in developing Copenhagen's land-use and transport policies, with high levels of participation by interest groups and local residents. Alongside formal consultation processes, there is an emphasis on dialogue with key partners: "that's just the way it works in Denmark where we have a lot of dialogue, and somehow interest groups' ideas are built into the projects ... maybe it's not so antagonistic." Tue Rex, Planning Consultant, City of Copenhagen Similarly, business interests are recognised and zoning plans only implemented after dialogue with the land owner and/or real estate developer.[40] An interviewee from NCC, one of Scandinavia's largest property development companies, acknowledged that when objectives are aligned, the planning process works well for business: "for a recent inner-city project the planning process has been very rapid." Claus Skytte, Head of Project Development, NCC Property Development

Funding green infrastructure with real-estate development

Copenhagen's latest urban development area, Orestad follows the city's 60-year tradition of orienting development along rail-based public transport corridors. Orestad has attracted over 1 million m^2 of commercial and residential construction in the past 10 years. Built on formerly publicly-owned land, the metro line serving the district was partly financed by selling building sites and capturing land-value increases around new stations.

Photo credit: Thomas Ibsen

Photo credit: Peter Sørensen

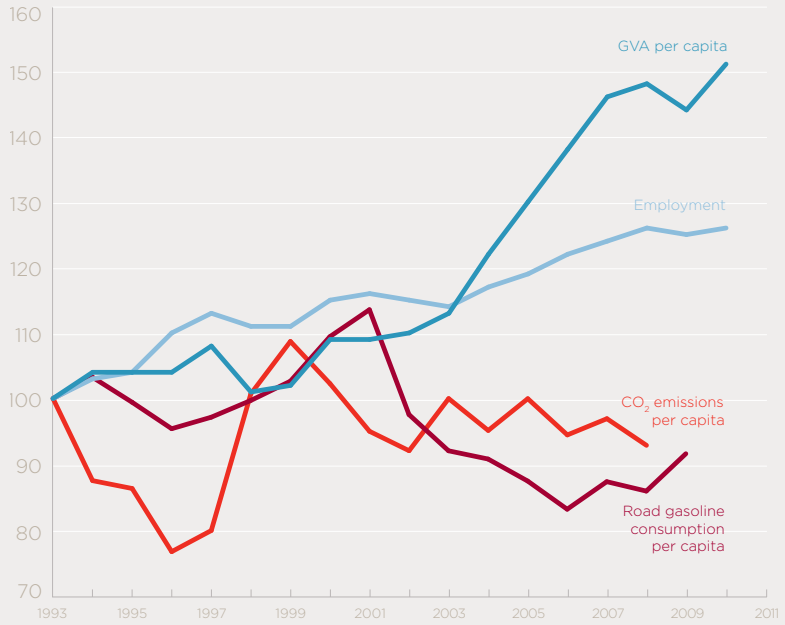
Table 1: Public private partnerships. Land-use and transport in Copenhagen

Partner	Supportive actions	Challenges
City Government	**Leadership and strategy.** Promoting transformation of Copenhagen's transport system with planning for Metro. Using the 310 hectares of former port land at Orestad for new development served by metro.[43] **Finance.** Funding construction of metro lines 1 and 2 (55% of DKK12.3bn (US$2.1bn) cost of construction)[43] and continuing investment in city-ring line currently under construction (total cost of DKK21.3bn (US$3.7bn)).[63] Increasing the attractiveness of the inner city with public realm improvements, traffic-calming and pedestrianising streets. Building 370 km of cycle lanes. **Regulation.** Using land-use rules to encourage mixed use and dense development around rail stations.	Strict planning processes and regulations discouraging real estate investment on inner-city brownfield sites. Orestad development and metro planning process criticised for 'closed' governance arrangements and too little community participation in decision-making.[44]
National Government	**Finance.** Funding construction and operation of rail network over past 60 years (currently 480 km of track across the metropolitan region). Funding construction of metro lines 1 and 2 (45% of cost of construction)[43] and continuing investment in city-ring line currently under construction.[63] **Regulation.** Strengthening compact city land-use regulation as part of Finger Plan 2007: station proximity principle encouraging workplace location within 600m of a rail station, retail regulations encouraging shops to locate in town centres. Providing supportive legislation for CPH Port and Development Corporation to develop former-port land.	Constructing suburban ring-road motorways undermining rail-based Finger Plan. Policy uncertainty over whether or not a congestion tax will be implemented.
Other municipalities in the metropolitan region	**Finance.** Supporting metropolitan-wide cycle initiatives.	Lobbying for development at odds with Finger Plan land-use regulation.
Business	**Finance.** Investing in over 1.1m m^2 of completed or under construction real estate projects served by metro at Orestad and other inner-city brownfield sites.[43]	Developing suburban and low density workplace projects.
Community and NGOs	**Partnership building.** Citizen activism advocating for improved facilities for cyclists, including mass demonstrations during the 1970s.	

1.2 Hong Kong: building a compact city economy

Hong Kong aims to be "Asia's World City",[64] cementing its position as a global hub for trade and finance. The city's economy is based around logistics, trade-related services, finance and tourism[65] and has experienced rapid growth in recent years, with per capita GVA increasing by 51% between 1993 and 2010.[35]

Fig. 4: Green Growth



Hong Kong in Numbers

Population of metropolitan region (2010)[66]	**7,072,000**
GVA per capita (2010)[35]	**US$31,300**
Employment - metropolitan region (2010)[35]	**3,529,000**
Area of metropolitan region	**1,089 km²**
Built-up portion of metropolitan region[36]	**29%**
Average (peak) residential density for built-up portion of metropolitan region[67]	**21,886 people/km² (123,318 people/km²)**
Carbon emissions per capita - metropolitan region (2008)[68]	**5.5 tCO_2**

Fig. 4
The Hong Kong economy as measured by GVA per capita, grew by 51% from 1993 to 2010.[35] Over the same period, per capita emissions decreased by 7% to 5.5 tCO_2 while per capita road gasoline consumption declined 8% to 50 litres per year.[38] All variables are indexed 1993=100.

Hong Kong's economic strengths as a logistics and financial centre rely on efficient transport networks and good regional and international links. The extremely high densities of both residences and workplaces in the city have allowed for easy opportunities for face-to-face interaction required in financial centres and efficient connections between businesses and global networks.

Although green growth is not an explicit objective of the Hong Kong government, the city has been held up as an archetype of 'transit-oriented development' and has been the subject of international study since the 1980s.[49] The orientation of dense urban development around efficient public transport networks allows for very low per capita transport-related carbon emissions and extremely low car ownership. While the economy has grown strongly in recent years, both per capita road-sector gasoline consumption and total carbon emissions have fallen slightly between 1993 and 2010 – demonstrating a decoupling between economic growth and environmental impact (see Figure 4).

1.2.1 The Policy Programme

Hong Kong's policy approach to land-use and transport combines extensive investment in public transport infrastructure and services with complementary land-use regulations in order to tightly integrate urban expansion at high density public transport nodes and along linear rail-based corridors (see Figure 5). Above all, public ownership of most land enables the government to have direct control over spatial development.[69,70] Hong Kong's mountainous landscape limits urban expansion, and reinforces the orientation of development around public transport corridors. The latest planning strategy shows an evolution from the ambitious new town developments of the 1970s through to the 1990s, towards brownfield development and urban regeneration.[71]

Spatial planning is currently guided by the Hong Kong 2030: Planning Vision and Strategy, a broad framework that generally follows an approach developed over the past 30-40 years.[64,71] Key concepts include a 'rail-based pattern' of development, and a commitment to 'doing more with less' – prioritising regeneration of existing urbanised territory rather than expansion into

Fig. 5: Population and employment density along major transit routes in Hong Kong.

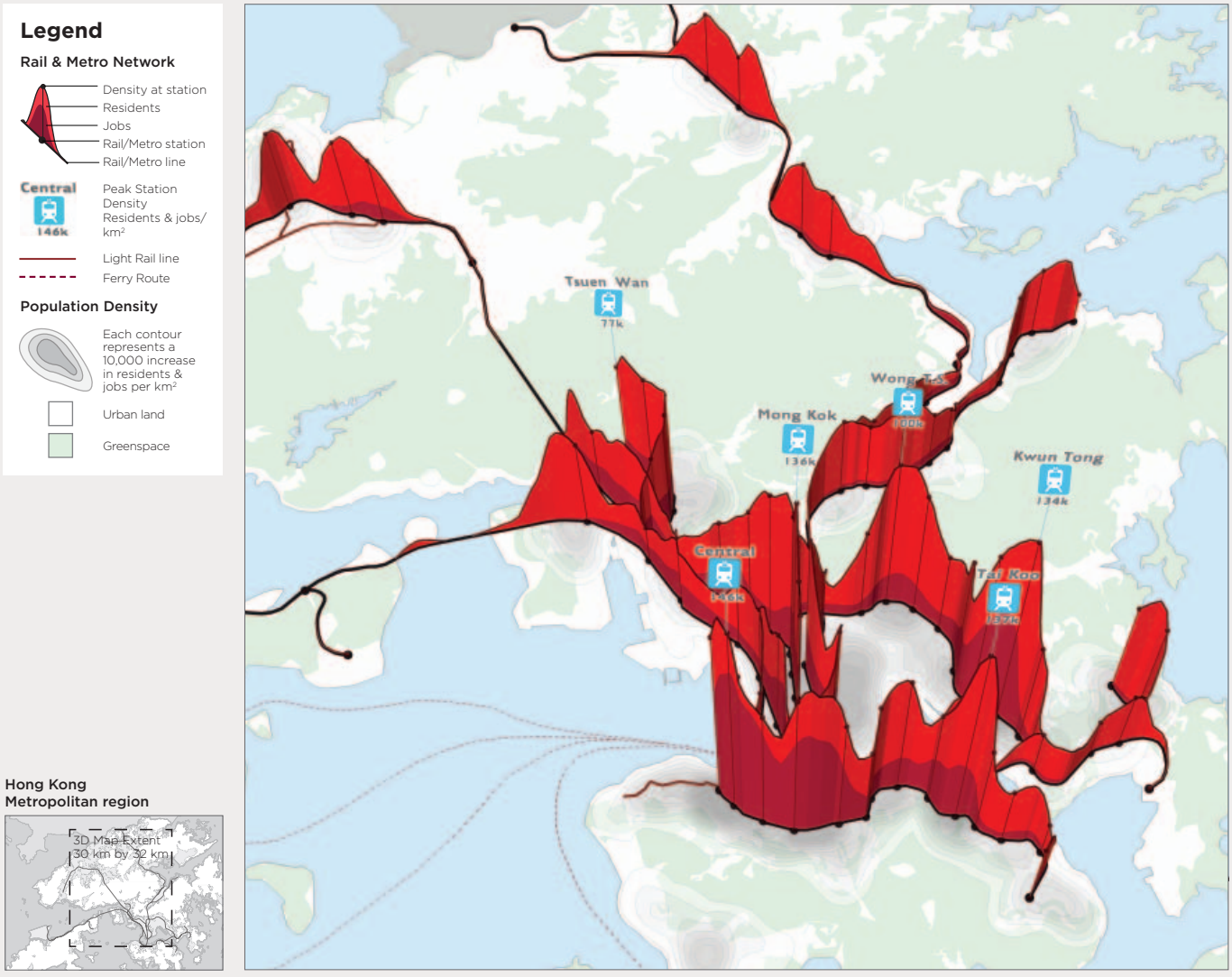


Fig. 5
Population and employment density along Hong Kong's MTR network. The map shows a very close integration of land-use and transport, with extremely high density centres built around major rail stations. Peripheral centres also display high density clustering, and there is a near complete absence of low density suburbs. LSE Cities graphic based on multiple data sources.[73, 74]

greenfield areas.[64, 71] Related regulation and guidelines specify where development can occur and at what density levels, while limiting car-parking provision. Urban expansion occurs in strictly defined areas, since 46% of Hong Kong's territory has been legally protected by 'Country Park' status since the 1970s.[71] A further 30% of land remains undeveloped and subject to various degrees of protection under a 'hierarchy of no-go areas'.[71] Land is zoned according to maximum floor-area ratios, with extremely dense building permitted directly above and adjacent to rail stations.[72]

Since the 1970s the government has invested heavily in passenger rail so that the rail and metro network now encompasses 210 km of track and 84 stations.[75] The government-controlled Mass Transit Railway Corporation (MTRC) operates a unique business model that captures the property value uplift resulting from new railway infrastructure, using revenue from property development to fund the railway's construction and operation.[76-78] While high-quality high-density development focussed around rail stations is essential for the success of Hong Kong's transport system, policies restricting car ownership and use are also important in determining outcomes. High vehicle registration tax (from 40% on the first HK$150,000 (US$19,000) to 115% on car purchase prices above HK$500,000 (US$64,000)), high annual licensing fees (from HK$4,000 – HK$11,000 (US$500 – US$1,400 depending on engine size) and limited parking availability restrict private car ownership while contributing to the success of public transport.[71]

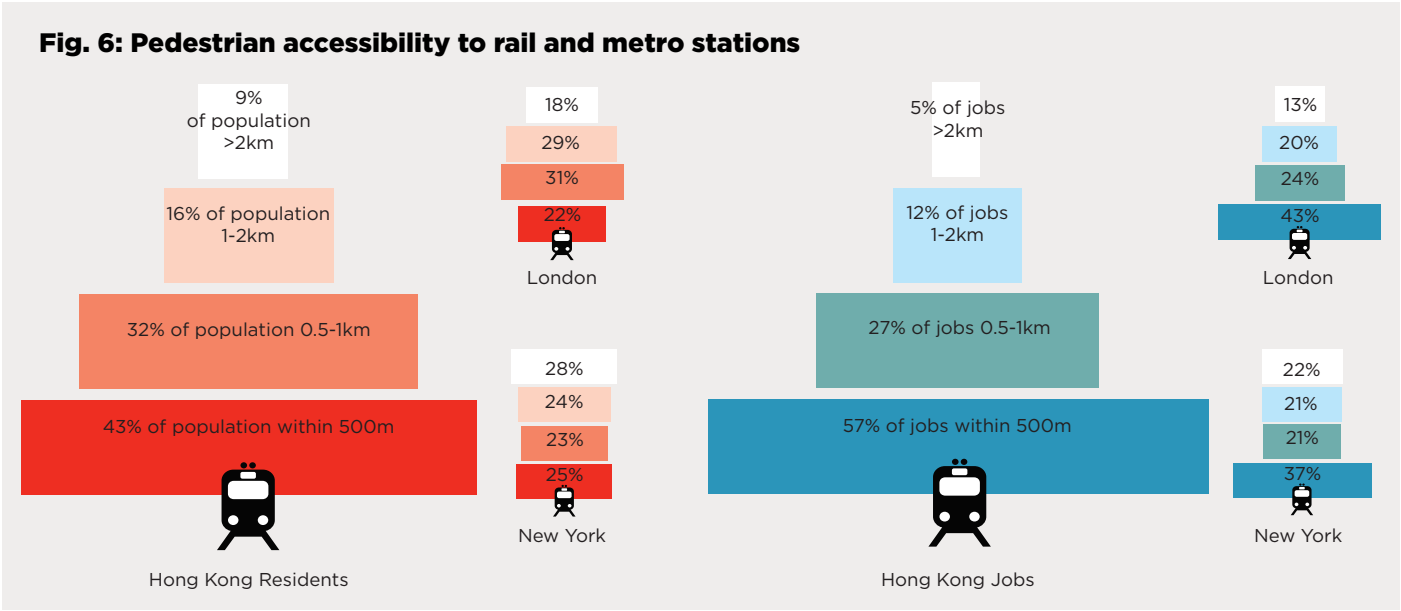


Fig. 6
Public transport accessibility for residents and jobs in Hong Kong. This chart shows the share of the residential population (left) and share of jobs (right) within given distances to rail and metro stations. Hong Kong's transport accessibility is highly competitive with London and New York, with job accessibility markedly higher than in other global financial hubs such as London and New York. Hong Kong's excellent accessibility may contribute to strengthening efficient knowledge sharing and other agglomeration economies. LSE Cities graphic based on multiple data sources.[50-53, 73, 74]

1.2.2 Impacts

Environmental impacts
As a result of Hong Kong's approach to integrating transport and land-use planning, 43% of the population (3 million people) live within 500m of an MTR station and 75% live within 1 km of a station (Figure 6). Public transport is used for 90% of all motorised journeys[79] and the car ownership rate (56 per 1000 people) is lower than any other city of similar wealth (as a comparison, the average rate in OECD countries is 404 per 1000 people).[54, 80]

The city's exceptionally high levels of residential density – averaging 21,900 people per km² within the built-up area, 6,300 people per km² across the entire territory and peaking at 123,300 people per km² at North Point – has also created one of the most walkable cities in the world. Not surprisingly, 45% of trips are undertaken by foot.[81]

These transport patterns have resulted in very low transport-related energy use and carbon emissions. It is estimated that annual carbon emissions from passenger transport are 378 kg per person, compared with around 1000 kg in European cities and over 5,000 kg in Houston, USA.[82] However, other potential environmental benefits such as reduced air pollution are not highlighted by local policymakers.[76]

Economic impacts
Hong Kong's efficient transport network creates various economic benefits for the city, including agglomeration, competitiveness, and cost-saving benefits. Thanks to its well-used and efficient public transport network, Hong Kong spends around 5% of GDP on motorised travel, compared with 12-14% in motorised cities such as Melbourne and Houston.[56, 77]

The city's dense urban form and efficient transport system supports agglomeration economies, including access for firms to a large pool of skilled labour within easy commuting distance, and a high density of firms in the inner-city which improves networking opportunities and face-to-face interaction. The latter is known to be particularly important for service-sector industries, and assists Hong Kong in the goal of securing its position as a global financial hub.[17-19, 83]

Hong Kong's integrated 'Rail plus Property' model allows the MTRC to operate as a profitable enterprise, resulting in cost savings for taxpayers from an unsubsidised public transport system. Despite receiving no subsidies, passenger fares are low by international standards and fare increases have been below inflation during the past five years.[76] The MTRC calculates that direct financial benefits to the Hong Kong government resulting from the 'Rail plus Property' have totalled HK$210bn (US$27bn) since the establishment of the company in the 1970s. While the government provided initial investment funds for the first MTR lines, the value of the company (publicly listed in 2000) has since grown considerably and payments from developers for the land value premium resulting from the building of rail infrastructure have totalled almost HK$100bn (US$12.9bn). In 2011 alone, the MTRC made profits on its property developments of HK$4.5bn (US$580m).

Despite the benefits of the Hong Kong approach, interviews suggest that the land-use and transport system do come with some costs. Some have argued that Hong Kong's very crowded living environments takes its toll on quality of life which in turn threaten the city's ability to retain skilled workers and thus its position as a global hub.[84] Despite relatively low car use, air quality from road vehicles remains a concern, exacerbated by the wall effect of tall buildings which reduces ventilation. Low levels of urban open space and heat-island effects from a high density built fabric also impact on quality of life. In addition, high property values associated with scarce land present problems of housing affordability.[71]

1.2.3 Policy Actors and Partnerships

The most significant actors in Hong Kong's approach to land-use and transport are the Hong Kong government, the MTRC (a publicly listed company 76% owned by Hong Kong and 26% by other shareholders) and property developers.

Hong Kong's unique governance arrangements create a less stratified political system, which essentially excludes any major involvement of lower or higher tiers of government to achieve its transport and land-use objectives. Together with public ownership of most land in Hong Kong, this political arrangement establishes a significant level of control over spatial development in comparison with many other cities around the world. Two government departments are centrally involved in this policy programme, the Department of Transport and the Department of Planning.

MTRC's role in achieving transport and land-use goals is based on its 'rail plus property' model and requires strong partnerships with government. Interviewees from MTRC described this relationship as "friendly" and that from their perspective "government is fully aligned with our business model." David Tang, Property Director and Steve Yiu, Head of Town Planning, MTRC The MTRC sees itself as "an enabler of public policy" and high-level objectives are shared with the government.[David Tang and Steve Yiu] At the same time, "as a listed company MTR today is guided by good, sound commercial principles; like all listed companies, we are concentrating and looking at shareholders returns. The only difference here is we have a shareholder called Government with a very substantial shareholding."[David Tang and Steve Yiu]

Private property developers generally pay for the costs of development after purchasing land adjacent to railway stations and seem to be profiting as well: "we have proved that we are able to work in a win/win/win situation for the Government, MTRC shareholders and the developers." [David Tang and Steve Yiu] While the government and MTRC profit from initial increases in land-value created by new railway infrastructure, private developers also see benefits from the 'Rail plus Property' model that enables funding of the railway and thus new development opportunities.[76]

Hyper density in Hong Kong

The city's integrated approach to transport and land-use planning has created a highly accessible city, with 84% of jobs located within 1 km of a rail station and 90% of motorised trips using public transport. This efficient and accessible urban form may strengthen agglomeration economies based on knowledge sharing, labour market efficiencies and easy face-to-face interaction, helping to secure Hong Kong's position as a global financial hub.

Photo credit: Wei Leng Tay

Table 2: Public private partnerships. Land-use and transport in Hong Kong

Actor	Supportive actions	Challenges
Government	**Leadership and strategy.** Strong spatial vision for Hong Kong based on a 'rail-based pattern' and high density development. Widespread land ownership which offers potential for land-value capture for infrastructure investment. **Regulation.** Regulating land-use to encourage high-density development around rail stations. Requiring floor area ratios as high as 9 around stations.[71] **Other.** Discouraging car ownership with high first registration tax (between 40-115% of vehicle value) and annual licensing fees.[71]	No clear targets or objectives for energy and carbon emissions reductions arising from transport and land-use system.
Business	**Finance.** MTRC investing in metro rail network. Now totals 210 km and 84 stations.[75] Developers building high density mixed-use buildings well integrated with rail stations. MTRC profits from property development total US$580m.[85] **Innovation and skills.** MTRC excelling in operations and construction of urban rail projects. Exporting expertise.	Developers wishing to stretch land-use regulations by building to very high densities that 'may compromise living environment' and create local congestion problems.[71]
Community and NGOs	**Stakeholder engagement.** Government and community working together to identify community needs to integrate with station developments.[76]	Local residents opposing development and densification.

1.3 Lessons

Both Hong Kong and Copenhagen are pursuing effective policy programmes aimed at integrating transport infrastructure provision with land development. The historic legacy of these long-standing programmes is recognisable in the cities' urban form, where development follows railway corridors radiating from a strong city-centre in which jobs and residents are concentrated at relatively high densities. Both cities have well-developed public transport systems based on railways, but also supported by integrated bus services. Railway stations serve as focal points for urban development. The result is a transport system with relatively low energy use and low overall costs to the community. Both cities have used the close integration of transport and land development to help fund infrastructure construction by attempting to capture land value premiums on publicly-owned land around new railway stations.

While Hong Kong and Copenhagen share parallel experiences in the transport and land-use sectors, there are also key differences. Most importantly, the absolute levels of urban compaction differ significantly, with Hong Kong being on average eight times denser than Copenhagen. The cities' governance arrangements for the sectors are very different, with both national-level government and multiple municipal local governments requiring coordination in Copenhagen – while in Hong Kong a somewhat simplified political structure allows for a greater degree of control. Hong Kong's land-ownership system, with most land owned by the government, allows for a more successful model of land-value capture. The integrated 'Rail plus Property' model of the MTRC also contributes to this success. The transport systems of the two cities differ significantly, with Hong Kong's based heavily around public transport (90% of motorised trips), while cycling plays an important role in Copenhagen.

Key lessons emerging from the study of land-use and transport integration in Copenhagen and Hong Kong across topics of leadership and strategy, finance and regulation and planning include the following:

1.3.1 Leadership

Land-use and transport integration relies on strategic top-down policy and planning processes.

Copenhagen has benefited from a strong spatial vision in the form of the Finger Plan, which has provided some consistency in approach to land-use planning over the past sixty years. The integrity of the original vision has, however, faced considerable challenges, particularly arising from fragmented governance of land-use regulations and transport infrastructure, and from on-going changes to the legislative and institutional context for regional land-use and transport planning.[33, 40, 43] In Hong Kong, strong centralised government control has ensured tight integration between transport infrastructure and urban development. With effectively one layer of government administering land-use and transport planning for the metropolitan region, Hong Kong has been able to exert an uncommonly high level of control over the transport and land-use sectors.

Lacking metropolitan governance is a liability for coherent land-use and transport policies, even for regions with strong city-level leadership.

The current regional planning system in Copenhagen relies on strong central government direction to coordinate over 30 municipalities and has replaced regional-level land-use planning authorities. One area of inconsistent policy is regional road building in Copenhagen which has compromised compact city policy and the shift towards greener transport. Traffic growth has continued to be a problem in Copenhagen during the past twenty years, despite compact city planning and investment in public transport and cycling. Uncoordinated investments in both road and public transport networks has threatened to undermine green transport objectives.[55] Regional coordination of land-use and transport in the case of Hong Kong is even more complex as it involves cross-border collaboration with China's Guangdong Province.

Compact city transport strategies differ significantly across cities but a clear strategic priority in each case is essential for pioneering cities.

Copenhagen demonstrates that cycling is a central component of a modern urban transport system. Despite the very high rates of cycling that exist already, the city continues to invest in this sector, with the Municipality of Copenhagen targeting an increase in journey to work mode share from 36 to 50% by 2015.[46] Hong Kong's priority for implementing a rail-based network provides the backbone of a highly efficient urban passenger transport system with significant economic and environmental benefits. Hong Kong's experience shows that concentrating urban development along public transport corridors, combined with a policy context that discourages car-use, can establish a transport system with low levels of energy use and low costs for the community.

1.3.2 Finance

Establishing a comprehensive public transport network requires significant public investment or land value capture and can prompt high-value land development.

In Copenhagen, investment from national-level government in the S-train network established the backbone of the rail-based Finger Plan. Recent investment in the metro has continued to rely on funds from national government, despite attempts at self-financing through capturing land-value increases and partnerships with Municipal government. Hong Kong's integrating property development and railway construction functions provide an effective way of funding large-scale public transport infrastructure. The MTRC 'rail plus property' business model is a successful example of where infrastructure can be financed through capturing increased land-values on surrounding publicly-owned land. Most importantly, both cities show that rail infrastructure needs to be developed prior to developing and activating new urban developments.

Even innovative financing approaches such as land value capture schemes require on-going revision and updating to respond to constant urban change

While Hong Kong's 'Rail plus Property' model was initially used to fund urban expansion and new railways on greenfield sites, Hong Kong has recently shifted its emphasis to urban regeneration opportunities and the potential for property development around existing stations.[76] The 'Rail plus Property' model also increasingly relies on urban design quality, integrated feeder

bus services, and pedestrian connectivity around stations. Creating new developments adjacent to railway stations that are attractive for residents and businesses requires not only a high quality railway network, but close attention to the integration of stations with surrounding pedestrian networks and feeder bus services. These features can have a significant impact on railway patronage.[76] In Copenhagen, the experiences with capturing land-values for the new metro provided important information for improving such schemes in the future.

1.3.3 Regulation and planning

Integrating transport infrastructure with urban development requires strong regulatory frameworks.

Both Copenhagen and Hong Kong use a comprehensive range of regulatory instruments to guide land-use decisions. The 'station proximity principle' for the Copenhagen metropolitan region ensures workplaces are easily accessible by public transport and other green transport modes. Hong Kong also promotes development near rail stations by specifying very high density requirements for new buildings: ne interviewee highlighted that "floor-area ratios are a key policy tool for us in encouraging high density development." Both cities further regulate car-parking provision to discourage private vehicle use and support public transport patronage. Hong Kong and Copenhagen are distinctive in using regulations to clearly demarcate rural and urban zones, resulting in 'hard edges' between high density development and green agricultural and recreational areas; Copenhagen's 'green wedges' and Hong Kong's forested mountains protected as 'country parks'. While both cities have strong regulatory frameworks, Hong Kong's widespread public land ownership and centralised governance system enables more direct public-sector coordination of land development.

Hammarby Sjöstad, Stockholm

Stockholm's first eco-district was built during the 1990s with ambitious environmental targets. New technologies and skills developed for Hammarby are now being rolled out across wider markets in Sweden and abroad, with economic benefits for the city. Stockholm is capitalising on the export potential of ideas and technologies developed for eco-districts through Symbiocity, a Trade Council agency.

Photo credit: Marina Montero Carrero

B2 Eco-districts and buildings

The construction sector contributes 5-15% of GDP globally and generates 5-10% of employment at the national level.[1] However, buildings also account for an estimated one third of global greenhouse gas (GHG) emissions. Carbon emissions from buildings are mainly generated during their operational phase – primarily for heating, cooling and lighting – due to the use of fossil fuels.[2] In addition, the building sector is responsible for 40% of global energy consumption[2] and about 20% of global water consumption.[3]

According to the Intergovernmental Panel on Climate Change (IPCC),[4] buildings constitute the sector with the highest potential for mitigating GHG emissions, accounting for up to 29% of the projected baseline emissions for 2020. Energy efficiency measures such as insulation, renewable micro-generation, conversion of heating energy to electricity (e.g. through air and ground source heat pumps) and renewable-sourced district heating are all being developed and deployed in many countries around the world.

Emissions savings can be met while also reducing costs. Based on a range of studies, investments of US$300bn-US$1tr per year could reduce global energy consumption in buildings by around one third, while yielding a cost saving of US$35 per tCO_2. This compares with a net cost of US$20 per tCO_2 for the power sector.[5] As such, this sector more than any other provides substantial opportunities for going green and benefiting the economy directly. Other economic benefits of the green building sector include substantial employment opportunities in the construction sector and higher productivity levels resulting from the lower health risks of better quality buildings.

Some cities are now starting to innovate towards eco-districts, which allow the scaling-up of sustainability benefits from the individual building to whole neighbourhoods. Eco-districts are underpinned by the idea that integrated solutions, e.g. in construction, heating, water and waste, are best delivered at the scale of entire districts.[6] Some also argue that the size of districts allows more rapid action than city-wide policy, while still having a significant impact.[7]

Hammarby Sjöstad, Stockholm

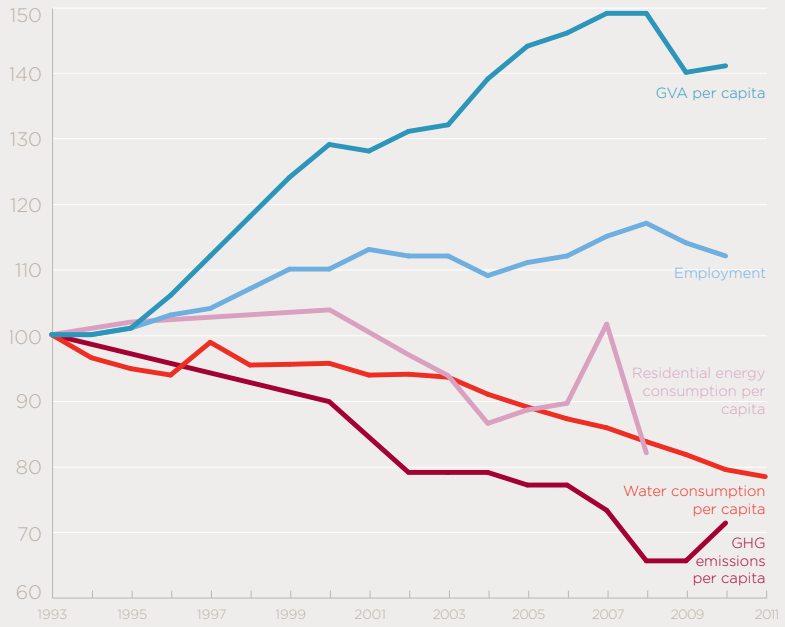
Initially built as part of Stockholm's candidature for the 2004 Olympic Games, the city has invested around US$1bn in Hammarby Sjöstad, but will recoup costs through leasing and selling property. If realised, the wider economic and environmental benefits of the project will be achieved at relatively low cost.

Photo credit: Lennart Johansson

2.1 Stockholm: Innovation and the next generation of eco-districts

In the words of Stockholm's Mayor, Sten Nordin, "In 2030, we will be the green capital of the world". This goal is part of the City's Vision 2030,[14] designed to make Stockholm and its economy 'world class'. The vision includes extensive opportunities for work and education, a thriving business environment, regional growth, an efficient transport system and the development of a world-class knowledge region of universities, vocational programmes and entrepreneurship.

Fig. 1: Green Growth



Stockholm in numbers

Population of metropolitan region (2010)[8]/ City of Stockholm (2010)[9]	1,876,654 847,073
GVA per capita – metropolitan region (2010)[10]	US$52,267
Employment – Stockholm County (2011)[11]	1,098,000
GHG emissions per capita - city (2010)[12]	3.7 tCO_2e
Target for energy consumption in buildings (since July 2012)[13]	55 KWh/m²

Fig. 1
Green growth. Stockholm's metropolitan economy, measured as Gross Value Added (GVA) per capita, grew by 41% from 1993 to 2010.[10] Over the same period, greenhouse gas emissions per capita in the City of Stockholm decreased by 31% from 5.4 tCO_2e to 3.7 tCO_2e.[12] Water consumption per capita has also decreased by 22% in the city from 292 litres per capita in 1993 to 229 litres per capita in 2011.[61] Despite a sharp rise in 2007, residential energy consumption per capita has fallen by 18% from 1993 to 2008.[62] All variables are indexed: 1993 = 100.

Stockholm has a history of green growth (Figure 1) and was named European Green Capital in 2010. Following a substantial fall in the population after 1960, the City of Stockholm has recently grown to over 850,000 people and is predicted to reach 1 million residents in the next 15 years.[9] The population of the surrounding county is already over 2 million.[9] The economy has also grown: GVA per capita in the metropolitan region increased by 41% from 1993 to 2010, with employment rising in parallel with the increase in population. At the same time, greenhouse gas emissions per capita have fallen by 31% in the city, while water and energy consumption have both decreased over the last few years (Figure 1).

The buildings sector has contributed to Stockholm's green growth credentials. A national energy tax and national building standards limit energy consumption in new buildings, and around 80% of the energy used for district heating is renewable fuel or energy from waste or residual heat. More recently, Stockholm has led the innovation of new-build eco-districts, integrating clean tech solutions at the district level.

2.1.1 The Policy Programme

Stockholm, and Sweden more generally, has a long history of energy efficiency in the buildings sector. Over 50 years ago the City began creating the infrastructure for district heating, which now accounts for nearly 80% of all heating in Stockholm.[17] Originally owned by the City, the system is now owned and operated by Fortum, a private corporation. Today, 80% of the energy used for district heating in the City is renewable fuel, energy from waste or residual heat.

National building regulations – which are some of the most stringent in the world[18] – have also driven the energy efficiency of new buildings in the Stockholm region. Energy use must comply with a standard of 90 kWh/m² for district heating and 55 kWh/m² for electric heating.[19] These standards have been taken further by energy efficiency targets under the City of Stockholm's Environmental Programme 2012-2015.[13] Using contractual obligations on land designated by the City, developers will need to meet a standard of 55 kWh/m² for district heating.

Fig. 2: Stockholm's eco-districts

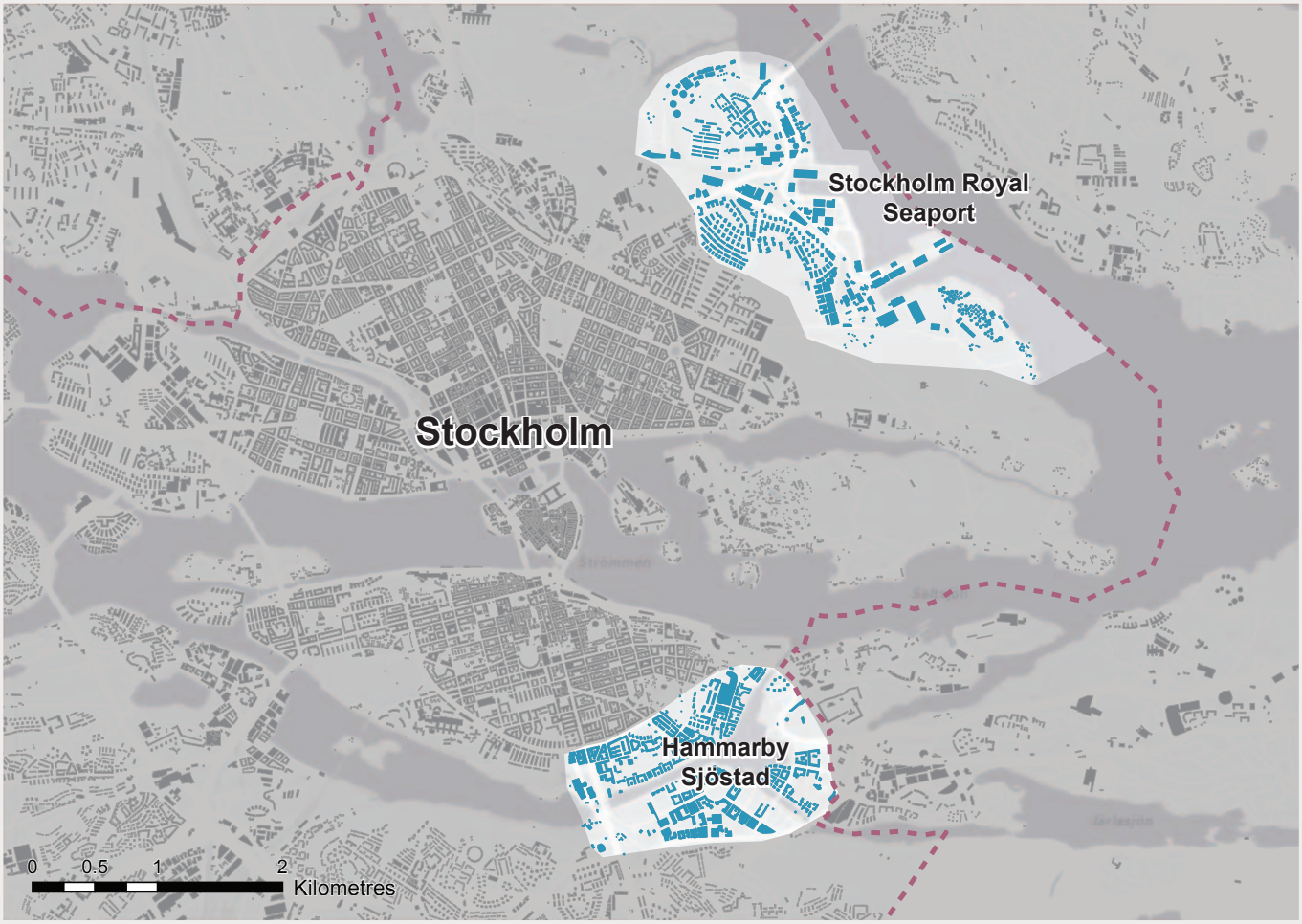


Fig. 2
Stockholm's eco-districts. Redevelopment in Hammarby Sjöstad, an old industrial area, started in 1996 as part of Stockholm's bid for the 2004 Olympic Games. Upon completion this eco-district will occupy an area of 2 km² with 11,000 residential units, over 25,000 inhabitants and 10,000 jobs. Works at the Stockholm Royal Seaport, an old industrial and harbour area, commenced in 2010. In 2030, the district will cover an area of 2.4 km² and will offer 10,000 new dwellings and 30,000 new jobs. LSE Cities graphic based on multiple data sources: [15, 16]

National policy instruments have also been used in the last five years to retrofit existing buildings with energy measures. Examples include an energy tax and grants that incentivise the take-up of renewable technologies. The city also aims to retrofit its own existing building stock to reduce energy use by at least 10% by 2015. The aspirational aim is also that these various energy efficiency measures will contribute to Stockholm's target of limiting greenhouse gas emissions to 3 tCO_2e per person by 2015.[13]

Stockholm is at the cutting edge of developing eco-districts. In 1996, the City decided to redevelop the area of Hammarby Sjöstad in the south-east of Stockholm as part of its bid for the 2004 Olympic Games. Hammarby was an old, highly polluted industrial and harbour area. With the aim of housing over 25,000 residents in around 11,000 apartments by 2017, all political parties agreed to make the redevelopment an example of environmental best practice.[20] The overall environmental goal – far reaching for its time – was to create a residential zone with half the environmental impact of other comparable districts built during the 1990s. Targets included total energy use of 60 kWh/m², 50% less water consumption compared to the average water use in new housing in the inner city area, and the entire energy supply to be based on renewable sources.[21]

Building on the lessons from Hammarby Sjöstad, the City authorities have embarked on a new type of eco-district at Royal Sea Port – a former container port, oil depot and gasworks covering 236 hectares and now one of the largest urban development projects in Europe. Royal Sea Port will integrate residential buildings with commercial properties, ranging from port trade to IT, finance, and media companies. Using modern, sustainable architecture and planning, the aim is to integrate 10,000 household dwellings and 30,000 office spaces with parks and green open spaces.[22]

The area will be supplied with a smart grid, benefit from a biofueled combined heat and power (CHP) system (including recovery of waste and heat) and use on-site renewable microgeneration of electricity. Overall, energy use will be limited to 55 kWh/m² through contractual obligations (a

lesson learnt from Hammarby, where energy targets were not met). The goal is to limit carbon emissions to 1.5 tCO_2e per person by 2020, and for the entire site to be fossil fuel free by 2030.[22]

2.1.2 Impacts

Environmental impacts
Stockholm has been highly successful at reducing environmental impacts in the buildings sector. The city has experienced a 33% reduction in greenhouse gas emissions from heating and electricity over the last few decades, with emissions falling from 3.8 tCO2e to 2.3 tCO2e per person between 1990 and 2010 (see Figure 3).

Much of this change has been nationally driven. Following the oil crisis in the 1970s, the use of natural gas and oil in Swedish households has dropped to extremely low levels, making up only 0.6% and 2.2% respectively of the total energy use in 2007. This compares to 40% and 15% for the European Union as a whole.[23]

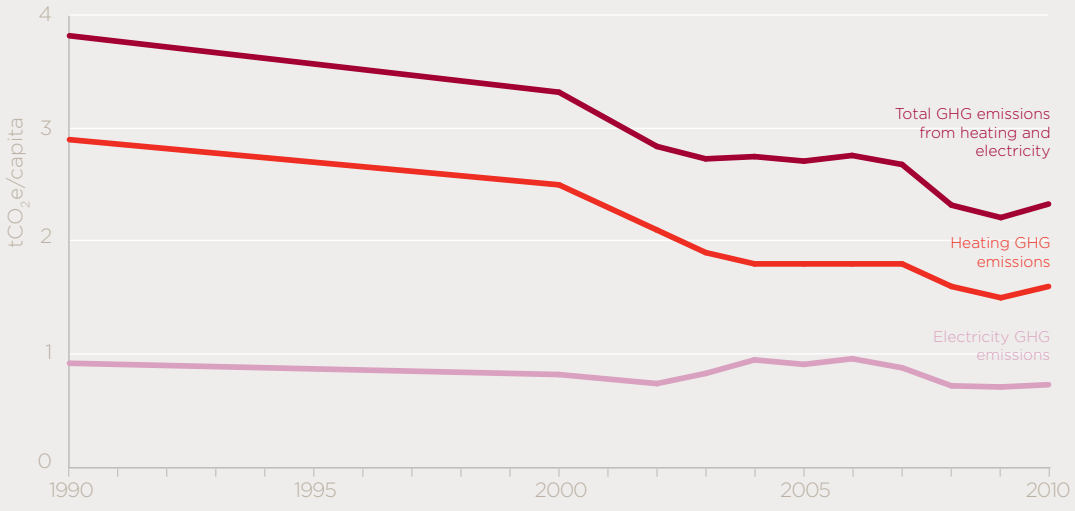
Hammarby Sjöstad eco-district is now 75% complete,[24] with around 18,800 residents occupying 8,250 apartments.[24] In terms of waste, wastewater and transport emissions, the project has been an environmental success. Overall, 95% of the waste from the district is combusted at the local Hogdalen CHP plant, utilising 90–100% of the energy content of the waste.[21] Wastewater is treated at the local Henriksdal treatment plant, where biogas is generated from the extracted wastewater sludge. The purified wastewater passes through Hammarby Sjöstad's thermal power station, where the heat is regenerated as district heating. In terms of transport, 79% of commuter residents of Hammarby Sjöstad walked, cycled or used public transport in 2007.[21]

Meeting Hammarby Sjöstad's energy efficiency goals for buildings has been less successful. The original goal was to limit the total supplied energy to 60 kWh/m². However, the goal was perceived by developers at an early stage as unrealistic and was adjusted to 100 kWh/m² in 2005 by the City.[21] As a result, levels of energy use at Hammarby Sjöstad are similar to those in comparable districts in Stockholm.[25] Nevertheless, Hammarby Sjöstad has acted as a useful learning exercise for the City, which is now working more actively with developers and researchers on methods to reach the energy goal of 55 kWh/m² at Royal Seaport and new developments across Stockholm.[13, 22]

Economic impacts
The economic impacts of Stockholm's eco-districts have been wide-ranging. In terms of business growth, Hammarby Sjöstad has provided opportunities to 30-40 developers.[24] Green tech companies have also benefited, from those producing control systems to solar cell companies to consultancies.[25] In addition, those interviewed in the private sector[26, 27] report that new technologies and skills developed for Hammarby Sjöstad are now being rolled out to wider markets in Sweden and abroad.

Fig. 3: Stockholm City. GHG emissions per capita

In Stockholm City, GHG emissions per capita from electricity decreased by 21% between 1990 and 2010. Over the same time period, per capita GHG emissions from heating decreased by 45%. Overall, GHG emissions from electricity and heating have decreased by 39% during the last twenty years.[12]



The Royal Seaport has substantial business growth potential as an innovation hub, with companies such as Ericsson, ABB, Fortum and Electrolux getting involved locally.[28] The district is also set to become a new hub for Sweden's financial industry, with Nasdaq agreeing to be one of the founding private sector partners, while development of cruise and ferry transport should boost tourism and regional business links.[22]

Developers and other companies[26, 27] report that they have also benefited from Stockholm's brand as a green leader, and from participating in the Hammarby Sjöstad project because of its large and continued exposure internationally as an example of best practice. Stockholm is capitalising on the export potential of ideas and technologies developed for eco-districts through Symbiocity, a Swedish Trade Council agency.[29]

The economic benefits of Stockholm's eco-districts have required substantial investment. For example, about SEK6bn to 7bn (around US$0.9bn to 1.1bn) has been invested in Hammarby Sjöstad to date by the City of Stockholm, representing about 15% of the total investment. The costs of decontaminating the land were particularly high. However, the City is receiving a partial return through land-leasing and selling. Based on interviews with the City,[24] selling the land at the market price – around SEK14,000 (US$2,000)/m2 currently – should result in the project being close to break even on the investment in public finance terms.[24] If realised, the wider economic, environmental and social benefits for the City will have been achieved at relatively low cost.

2.1.3 Policy Actors and Partnerships

Much of the successful implementation of eco-districts in Stockholm has been a result of effective public-private partnerships, particularly between the city, private sector and research institutes such as the Royal Institute of Technology (KTH). The key partner has been the City itself, providing strong leadership, direction and master planning, finance and platforms for partnership – all of which have given the private sector the confidence to invest, innovate and deliver solutions for Stockholm's eco-districts and green buildings. The national government has also played an important role, particularly in providing finance for innovation and R&D, setting national energy efficiency standards and encouraging knowledge-sharing partnerships. Stockholm's eco-districts have been a top-down initiative, and stakeholders such as the local community and NGOs have not been strongly involved. However, research institutes such as KTH have been very important partners, providing R&D expertise and independent evaluation of outcomes.

These partnerships have been formulated at different levels. For example, at a high level, Royal Seaport was originally created as a partnership between the City and six leading companies: Nasdaq OMX (financial services), Tallink Silja (passenger shipping), Fortum Sverige (energy), Vasakronan (property), Länsförsäkringar (insurance) and Envac (waste). Since then, other companies such as Ericsson, ABB and Electrolux have also joined.[28]

At the same time, partnerships at lower levels have been forged to tackle specific technological problems or to foster innovation in particular fields. For example, the City has formed a small partnership of four to five representatives to work on the detail of how to measure the City's new energy target of 55 kWh/m^2.[25] The group includes a City-owned real estate company, a private sector building company, the City department responsible for selling land to developers, the environment department, and the Royal Institute of Technology.

Two key innovation projects at Royal Seaport are the Smart Grid and Smart Communication. ABB and Fortum are responsible for management of the Smart Grid project, whilst KTH is responsible for the project's environmental targets. Associated partners provide strategic solutions. The Smart Communication Innovation is led by Ericsson, who together with VINNOVA are providing SEK10m (around US$1.5m) each to work on the implementation of the project.[22]

Stockholm's eco-districts have also been driven by effective financing partnerships. For example, the funding body for Hammarby Sjöstad comprises the City of Stockholm, Stockholm Transport, the National Road Administration and private investment. In addition, major funding allocations distributed by the City were provided by the Swedish Government's Local Investment Programme (LIP).

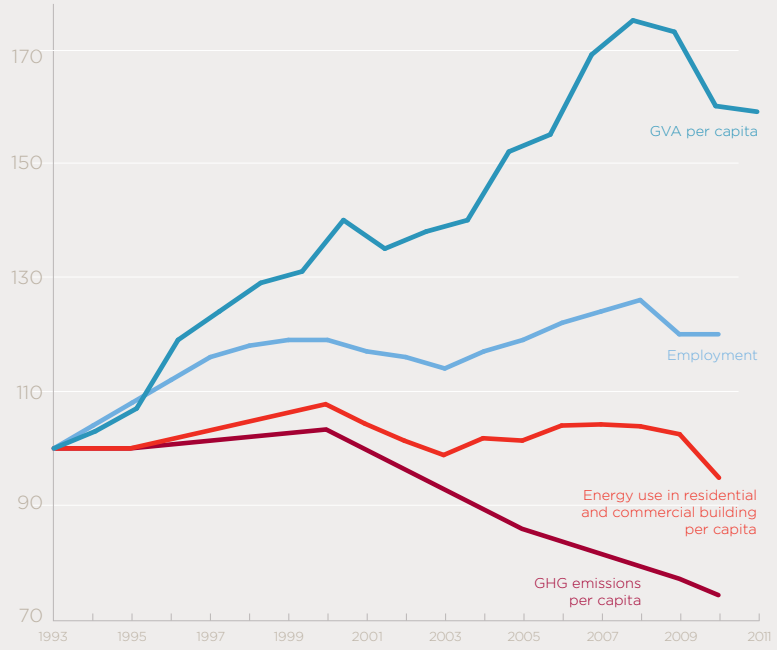
Table 1: Public private partnerships. Eco-districts and buildings in Stockholm

Partner	Supportive actions	Challenges
City Government	**Leadership and strategy.** Driving new green solutions through leadership and master planning of Hammarby. Providing business with the confidence to invest in 5-10 year research programmes through a long-term strategic commitment to eco-districts.[26] **Finance.** Public investment of US$910-1,060m for Hammarby Sjöstad from the City's budget. Major costs included land decontamination and compensating existing on-site companies to clear the site.[24] **Regulation.** Owning the brownfield sites provides strong policy control over environmental and economic outcomes. Setting energy efficiency target of 55 kWh/m^2 for all buildings on land designated by the City[13] and working closely with partners to develop solutions for delivering on the target.[24] **Partnership building.** Creating a platform at the Royal Seaport Innovation Centre where different companies can innovate more effectively.[26]	Basing the competition for Hammarby Sjöstad development tenders on price, rather than on land use, building specifications, energy standards or environmental outcomes.[27] As a result, energy efficiency targets were not met. Lacking detailed economic assessments commissioned by the City or national government on eco-districts and the green buildings sector.
National Government	**Finance.** Contributing national funds for Hammarby Sjöstad and other eco-districts through the Local Investment Programme (LIP).[15, 21] Financing sustainable urban projects through a SEK340m fund managed by the Delegation for Sustainable Cities. E.g. to develop ICT solutions that can support the City in reaching its sustainability goals. Providing 50% of R&D project financing through VINNOVA (Sweden's R&D funding agency) for some private sector green innovation projects at Royal Seaport. Leveraging 50% private sector finance. Providing finance for Royal Seaport's smart grid through the Swedish Government's Energy Department. **Regulation.** Setting national energy efficiency standards of 90 KWh/m^2 for non-electric heating places an obligation to comply.[19] **Partnership building.** Providing a forum through the Delegation for Sustainable Cities where businesses can discuss solutions and innovation for green projects.[26]	Setting different energy efficiency requirements in different geographic areas of Sweden increases production costs to tailor solutions for each area.[25]
Business	**Finance.** Matching 50% public investment from VINNOVA with 50% private investment for various R&D projects at Royal Seaport. **Partnership building.** Actively participating in the city's energy efficiency standards group the Royal Seaport Innovation centre, including the Smart Grid and ICT.[26]	Resisting the City's energy efficiency target for buildings of 55 kWh/m^2, though now accepted by the construction sector.[25] Lacking skills and technology solutions in innovative engineering for green buildings meant that Hammarby targets were not met.[25] However, Hammarby Sjöstad has driven skills and technological development now used at Royal Seaport, across Stockholm and internationally.
Research Institutes	**Partnership building.** Providing R&D expertise for Hammarby Sjöstad and Royal Seaport. E.g. in construction, transport, energy, ICT.[24-27]	

2.2 Portland: A leader of the US green building economy

Portland, Oregon, which sits in Multnomah County in the Pacific Northwest, is considered one of the greenest cities in the United States.[33] Its credentials as a green city began over 50 years ago, when the Oregon health authority introduced a series of clean water regulations to clean up the polluted Willamette river. The city is also known for its urban growth boundary, restricting urban expansion into surrounding farmland and forests.

Fig. 4: Green Growth



Portland in numbers

Population of metropolitan region (2010)[30]/ City of Portland (2010)[31]	2,265,600/ 583,776
GVA per capita - metropolitan region (2010)[10]	US$42,454
Employment - metropolitan region (2010)[10]	1,050,000
GHG emissions per capita - Multnomah County (2010)[32]	10.4 tCO_2e
Number of LEED Certified Buildings (2010)[53]	129

Fig. 4
Portland's metropolitan economy, measured as Gross Value Added (GVA) per capita, grew by 59% from 1993 to 2010 while the metropolitan population grew by 37%, reaching almost 2.3 million in 2010.[10] Over the same period, greenhouse gas emissions per capita in Multnomah County decreased by 26% from 14 tCO_2e to 10.4 tCO_2e.[32] Energy use per capita in residential and commercial buildings remained relatively constant over the period – dipping in 2010 to 15.9 KWh per capita.[39] All variables are indexed: 1993 = 100.

Portland has experienced green economic growth as a result of its combined economic and environmental policies. Between 1993 and 2010, the metropolitan economy grew by 59%, while between 2003 and 2010 the number of jobs in the green sector increased by 32%.[34] Greenhouse gas emissions per capita decreased by 26% from 14 tCO_2e in 1993 to 10.4 tCO_2e in 2010. Over the same period, energy use per capita remained relatively constant (Figure 4).

Residents in the Portland area enjoy shorter travel distances than those in the average U.S. metropolitan area, which not only reduces environmental impacts but also saves the local economy US$2.6bn per year.[35] Evidence also suggests that the skilled workers who help drive the local economy are attracted to Portland's quality of life: the number of college-educated 25 to 34 year olds in the Portland metropolitan area increased by 50% in the 1990s – five times greater than the national rate.[36] Part of the attraction is living in the city centre and using effective public transport – both rates are higher in Portland than in other metropolitan areas in the United States.

In the last three years, the City has attempted to continue decoupling growth from environmental impacts by integrating green growth policies into its overall economic strategy. In 2009, the City Council adopted the Portland Economic Development Strategy, a five year plan for promoting job creation and economic growth.[37] A recent progress report shows that, despite the economic downturn, Multnomah County (in which Portland is located) has added 16,300 new jobs between 2009 and 2012. Unemployment is now lower than the national average and the area has seen a net gain of almost 8,000 new businesses.

Alongside the development strategy is Portland's longer term Climate Action Plan, which aims to reduce greenhouse gas emissions by 40% by 2030.[38] The green buildings sector has been an important component of the City's strategy, backed up by a range of policies at the city, state and federal levels including Portland's Green Building Initiative, promotion of LEED (Leadership in Energy & Environmental Design) building standards and state cash incentives for energy measures in homes. Furthermore, the City is aiming to remain at the forefront of green growth ideas through the creation of five eco-districts in existing Portland neighbourhoods.

Fig. 5: Portland's five eco-districts

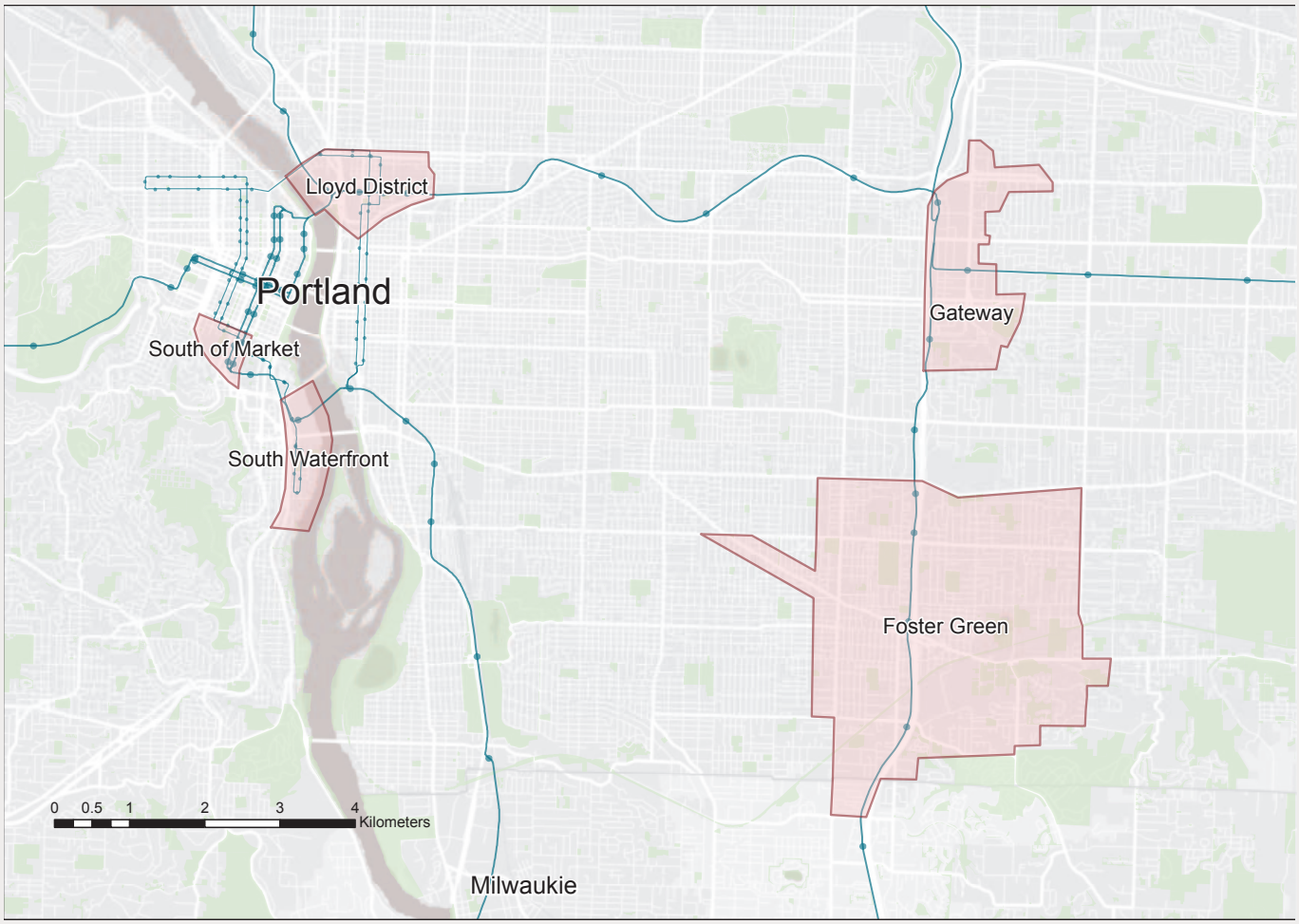


Fig. 5
Portland's five eco-districts, current figures: Gateway (2.7 km²; 6,390 inhabitants; 7,000 total employees),[40] Lloyd District (1.5 km²; 1,369 inhabitants; 16,424 total employees),[41] South of Market (0.4 km²; 2,634 inhabitants; 2,971 total employees),[42] South Waterfront (0.4 km²; 2,634 inhabitants; 2,971 total employees)[43] and Foster Green (18.2 km²; 48,141 inhabitants; 7,825 total employees).[44] LSE Cities graphic based on multiple data sources.[15, 45, 46]

2.2.1 The Policy Programme

The City of Portland has actively promoted the green buildings sector over the last decade. In 1999, Portland's Energy Office established the "Green Building Initiative" to assist home builder associations to develop green building programmes. Since then, the City's Office for Sustainable Development has carried out a progressive green building programme.[47] In 2001, the City Council adopted the City's Green Building Policy,[48] which requires all new city-owned facilities to register and certify at the LEED level and incorporate green building strategies into tenant improvement and operation and maintenance practices. In 2005, the City Council raised the certification level of new City-owned properties to LEED Gold.[49]

The federal government has played an important role in Portland's green buildings sector.[50] High LEED standards for federal-owned and leased buildings have led to pressure and momentum for green certification to be taken up in the private sector.[50] In addition, Clean Energy Works Oregon leveraged US$20m in federal funds to encourage residential energy retrofits through a public-private partnership.[51] This innovative programme provides low-cost improvements to homeowners to become more energy efficient through financing on utility bills.[52]

Alongside these policies, the Energy Trust of Oregon has helped consumers reduce their energy bills through information on how to save energy, and through cash incentives funded by the utility companies to trade in old appliances for more energy efficient models.[53]

Under Portland and Multnomah's Climate Action Plan, the City has four main goals for the building sector to meet by 2030.[38] These are (1) reducing by 25% the total energy use of all buildings built before 2010, (2) achieving zero net greenhouse gas emissions in all new buildings and homes, (3) producing 10% of the total energy used within Multnomah County from on-site renewable sources and clean district energy systems, and (4) ensuring that new buildings and major remodels can adapt to the changing climate.

As well as city-wide policies for green buildings, the City of Portland and the Portland Sustainability Institute are leading the development of five pilot eco-districts in Gateway, Foster Green, Lloyd District, South Waterfront and South of Market. The initiative was launched in 2009. Progress to date includes preparatory assessment, education and capacity-building projects, and feasibility studies for district-scale water and energy infrastructure.[54] The eco-district initiative aims to build on Portland's success in the green building sector and to scale up sustainability benefits from the individual building to the neighbourhood scale.

2.2.2 Impacts

Environmental impacts
Portland has successfully reduced greenhouse gas emissions in the buildings sector over the last decade. Between 2000 and 2010, building emissions decreased by 27%, from 6.6 tCO_2e to 4.8 tCO_2e per person (see Figure 6). This reduction took place in both the residential sector, where emissions fell by 27% to 2.2 tCO_2e per capita and in the commercial sector, where emissions fell by 28% to 2.6 tCO_2e per capita.

In part, this is due to the success of the green building programmes. The Energy Trust of Oregon estimates that, in 2011, their information services and cash incentives, funded through the energy suppliers, saved 46.9 average megawatts of electricity, 5.4m annual therms of natural gas and generated renewable energy sufficient to power 1,144 homes.[55]

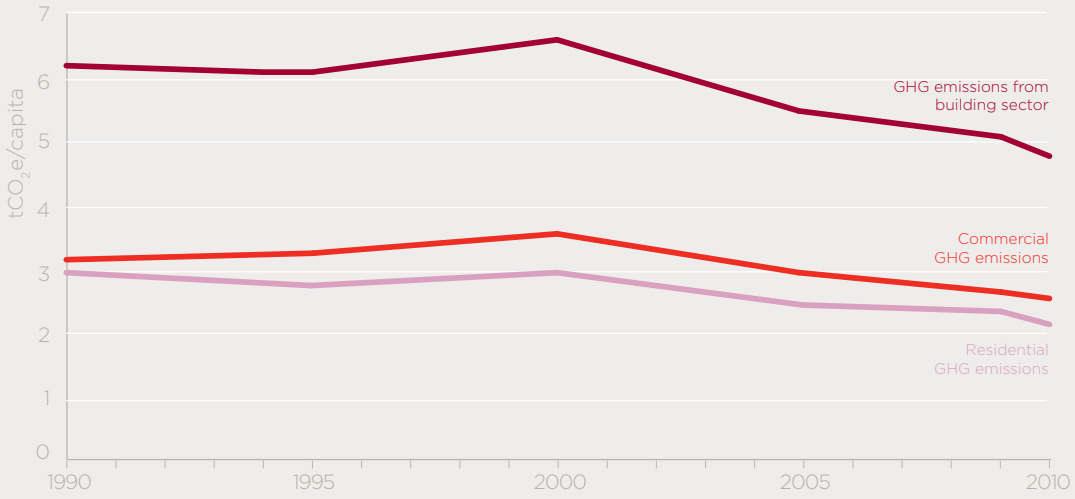
As Portland's eco-districts programme is still largely in the preparatory stages, it is too early to assess its environmental impact.

Economic impacts
Portland's initiatives to increase the energy efficiency of buildings in the City have brought a range of economic gains, even during the recent recession. As one interviewee reported: "The past five years have been hard for the design and construction industry. But we did an analysis of Portland architects, engineers, contractors and so on, and we found that those working on green projects and LEED standards have actually been more resilient in the downturn, and pay higher wages than the broad universe of the development field." Lisa Abuaf, Central City Manager, Portland Development Commission

The Clean Energy Works Oregon programme has completed more than 1,100 retrofits, created almost 30 permanent jobs and supported more than 500 construction jobs.[56] The Energy Trust of Oregon reports that they have helped consumers save over US$1bn, raising disposable income levels during the economic downturn. In 2011 alone, the Energy Trust estimates that it helped consumers and businesses invest in new energy strategies at 143,000 sites. Cost savings included US$94m for residents, US$75m for the commercial sector and US$64m for industrial and agricultural participants.[57]

Fig. 6: GHG emissions in Portland

Commercial, residential and total GHG emissions from the building sector in Portland and Multnomah County.[39]



Portland's reputation as a leader in sustainability has brought inward investment from a range of clean tech companies such as Vestas (wind power) and Solopower (solar), as well as attracting entrepreneurs and highly skilled workers in other sectors through its reputation as an attractive and innovative city.[56] Maintaining its status as one of the greenest cities in the United States will be increasingly difficult as others (e.g. San Francisco) also forge ahead with green economic development. Evidence from interviews suggests that eco-districts are already an important part of Portland's strategy to remain at the cutting edge, promote innovation and attract further inward investment.

2.2.3 Policy Actors and Partnerships

Some of the most successful policy initiatives in the green building sector in Portland have come from public-private partnerships. Portland has implemented a range of different public-private financing mechanisms to encourage lower energy use and higher environmental standards for buildings. For example, Portland Development Commission deals with commercial property, providing small grants of typically US$20,000–50,000 and larger loan programmes from US$200,000 to US$8m. Loans are provided to fill a financing gap between the capital cost and the proportion of finance raised from banks and other private sector investors. A range of "public good" criteria – including green building – is a condition of the loan.[51]

The State of Oregon also contributes, with a range of policy frameworks including financial incentives through the Oregon business energy tax credit, the State Energy Loan Programme and resources supplied by the Energy Trust of Oregon.[51, 53] The Energy Trust of Oregon, funded through an energy supplier obligation in partnership with the utility companies, provides information and cash incentives to replace old electrical appliances, and install renewable energy and insulation.[57] This public-private partnership has been one of the most successful instruments for reducing energy use and producing substantial cost savings.

Other supporting initiatives and organisations in the green buildings sector include the Oregon Built Environment and Sustainable Research Centre (focused on commercialising research on green building technologies), the Earth Advantage Institute (the nation's leading organization for green building), and the Surdna Foundation (awards grants to non-profit organizations in the priority areas of Sustainable Environments, Strong Local Economies, and Thriving Cultures).[51, 53]

The eco-district programme also encompasses a wide range of partners from the public and private sectors, all committed to testing district-scale sustainability best practices and innovation.[59] One key organisation is the Portland Sustainability Institute (PoSI), established by the Mayor of Portland in 2008. PoSI is an independent non-profit organisation that acts to incubate and develop partnerships among policy makers, the private sector and local research institutes in order to drive innovation and solve technological problems and market failures at the City scale. The Portland Development Commission is a key player in the partnership, acting as a financier, broker and communicator, as well as bringing researchers and business together to help bring new technological solutions to market.

Buy-in from local residents and businesses is essential and has been an important part of the approach. However, some eco-districts are more strongly private sector-led, such as Lloyd District, which includes among its partners the Portland Trail Blazers (a sports team and major property owner), Corix (a private utility company) and McKinstry (a construction company). Together with the City government and PoSI, the partnership is developing potentially the largest district energy project in Portland.[59] Other eco-district pilots, such as Foster Green, are more community-led, with social equity objectives and a consensus-driven approach central to the programme. However one interviewee from the City suggested that the consensus approach leads to slower programme implementation, since everyone on the board has to agree to each decision. On the other hand, once a decision is made, the City can be confident that the initiative has complete buy-in.

Another important player in the eco-district pilots is Portland State University. PoSI has helped organise teams of researchers to provide research and innovative solutions for the pilots. Examples include the development of a measuring and evaluation system for district performance based on attitudes of residents before, during and after the process of establishing an eco-district. The partnership also provides opportunities for students to develop their skills directly with business, policy makers and the local community.[59]

Table 2: Public private partnerships. Eco-districts and buildings in Portland

Partner	Supportive actions	Challenges
City Government	**Leadership.** Creating a bold vision of eco-districts in Portland with the Mayor leading from the front.[51, 53, 58] **Finance.** Providing finance and technical advice through the Portland Development Commission to help manage the creation of eco-district organisations.[51] **Partnership building.** Creating the Portland Sustainability Institute as a driver of public-private partnership, working with communities to develop eco-districts. Working with the Regional Workforce Investment Board and WorkSystems Inc. to align resources for skills development to support the city's sustainable economy. Providing support through the Bureau of Planning and Sustainability to build effective community groups to self-manage the eco-districts.	Lacking substantial funds to ensure continued strong management support from the City or to ensure that eco-district community organisations have sufficient resources for self-governance and implementation. Lacking regulatory and non-regulatory incentives and disincentives to drive private sector implementation of new solutions. Lacking metrics for measuring the environmental and economic impacts of eco-districts or for evaluating outcomes.
National/State Government	**Finance.** Providing US$20m of federal funds for residential building energy refits. Providing information and cash incentives through the Energy Trust of Oregon to replace old electrical appliances, and install renewable energy and insulation.[51, 53] **Regulation and contractual obligations.** Setting high LEED standards for federal-owned and leased buildings, creating peer pressure and momentum for LEED to be taken up in the private sector.[50] **Partnership building.** Working with Oregon BEST (Oregon Built Environment & Sustainable Technologies Center) to create a university and industry partnership through the Sustainable Built Environment Research Consortium, commercialising cutting-edge innovations in the built environment.[51]	Lacking federal funding for eco-district initiatives despite funding mass transit systems in cities.[58] Lacking compliance regulation for stringent national energy requirements for all buildings.
Business	**Finance.** Providing private sector finance for green buildings in public-private financing partnership with Portland Development Commission. **Partnership building.** Portland State University working with partners on research and innovation for their own eco-district.	
Research Institutes	**Partnership building.** Portland State University working with partners on research and innovation for their own eco-district.	
Community and NGOs	**Partnership building.** Incubating public-private partnerships to drive innovation and solve problems at the metropolitan scale through the not for profit Portland Sustainability Institute. Connecting private sector stakeholders with funders and the public sector through community groups such as Lloyd TMA.	Currently lacking measurable objectives and associated metrics.

Finally, the "We Build Green Cities" campaign is led by PoSI, developed in partnership with the City of Portland, Portland Development Commission, Business Oregon and Wieden & Kennedy, and is a ground-breaking export strategy designed to drive demand for Portland's expertise in green engineering, design, construction and planning both in the US and globally.[60]

2.3 Lessons

Stockholm and Portland are two cities with a long history of green policy programmes aimed at the buildings sector, particularly in terms of energy efficiency and renewable energy measures. Importantly, in both cases, these programmes have been supported – financially and through parallel policies – by their national/federal government. Building sector greenhouse gas emissions in the cities have fallen, while residents and businesses are already benefiting financially from lower energy consumption.

Furthermore, both cities are at the cutting edge of developing eco-districts, though with very different approaches. Stockholm has used old industrial sites on the waterfront to build completely new eco-districts where new technologies can be tested. Radical innovation is central to this approach. The city has been highly effective at partnership building and harnessing the innovative potential of multi-national companies, private finance, local research institutes and expertise in the city itself. The main challenge that the city now faces is how to roll out solutions created in the new eco-districts to existing neighbourhoods where community engagement will become more important for effective delivery of measures.

Unlike the brownfield test-bed eco-districts of Stockholm, the aim in Portland is to work with existing neighbourhoods; each with different characteristics, different governance structures and different objectives. Furthermore, although the initial push was top-down from the city, the Portland eco-districts are being led more by the community organisations themselves. This more bottom-up approach contrasts with the strong top-down approach of Stockholm. As in Stockholm, Portland's eco-districts involve multiple actors in public-private partnerships.

Key lessons emerging from the experience of Stockholm and Portland can be grouped into four key areas: leadership (including strategy), finance, regulation and partnership building. In each of these areas, set out in the sections below, public and private sector partners have used supportive actions to enable green growth policy programmes to deliver more effectively.

2.3.1 Leadership

A strong vision and long-term commitment from the city raises investor confidence and community buy-in for eco-districts.

Eco-districts require a top down vision. Without a vision, it is impossible to draw together the broad range of objectives, policies and technologies into a focused direction. In addition, master planning and a long-term strategic commitment to eco-districts by the city provides business with the confidence to invest in medium to long-term innovation programmes. "To get the subsidy injection for innovation is important, but more important is that we see the City of Stockholm really has a long-term commitment. For us to engage from a research perspective, we must know this is five to ten years." Matilda Gennvi Gustafsson, Sustainability Director, Ericsson and Rohan Richards, Senior Strategy Consultant, Ericsson

First mover cities can use eco-districts to support their modern, high-tech brand and increase export opportunities.

Both Stockholm and Portland have been early movers in the green buildings sector and cutting-edge eco-districts. As a result, the brand of both cities as modern, green and open for business has been helped. For example, companies such as Ericsson acknowledge that they can leverage Stockholm's image as world-class in sustainability and energy. Lessons from Portland are similar: "We have a national brand around eco-districts that is unparalleled, and our firm and other firms are getting work in other cities and other states, in part because of Portland's programme." Clark Brockman, Principal, Sustainability, SERA Architects In both cities, a dedicated body has been set up to promote technologies and ideas developed in the eco-districts on the export market.

2.3.2 Finance

Pooling city, state and national funding increases the potential for leveraging large-scale private finance.

Partnerships of city government, national government and the private sector are essential for providing the scale of investment needed to kick-start and develop radical and ambitious technological solutions. Cities that pool funding with national funds leverage larger-scale private finance, while specific national schemes for providing upfront capital and R&D matched funding can support the long-term credibility of projects such as eco-districts. "Of course if you want to improve people's quality of life and the environment the costs can be high. But we've learned from Hammarby that with the right financing, and working in partnership, you can get high value at low cost." Martin Skillbäck, Project Manager, Development Department City of Stockholm

2.3.3 Regulation and planning

A mix of national regulation and city land contracts is an effective driver for green buildings.

National and city policy instruments can be used effectively, but need to be coordinated. Alongside financial policy instruments such as funds raised from energy suppliers to provide cash incentives for upgrading appliances, and subsidies for retrofitting existing buildings, building codes and standards for new build are powerful instruments. Building standards can be regulated at the national level, which can be targeted not only at new buildings but also for retrofitting. Alongside these national regulations, contractual obligations can be placed on developers by municipal governments to drive even more ambitious energy and other building standards for specific eco-districts and city-designated new build.

Targets need to be backed up with policy instruments and verification.

Targets for eco-districts and building standards are important for setting the direction, but also need to be matched with regulation (e.g. at the national level) or contractual obligations (through city leasing and sales) to ensure implementation. Stockholm has put these lessons into practice for their new eco-district, Royal Seaport. "Hammarby was a great success in many ways, but we're not satisfied with the energy consumption so far. We've learned a valuable lesson from that – at Royal Seaport we back up the new energy targets with contractual clauses, a technical working group and impact assessments." Martin Skillbäck, Project Manager, Development Department City of Stockholm The city is also ensuring that energy standards are verified not simply on building completion, but also two years later when buildings are in actual use. Similar lessons can be drawn from Portland's experience of eco-districts: "One of the important lessons we've learned in Portland is that it's not enough for the City simply to have a vision for eco-districts, or even to do a feasibility study. It needs planning or zoning requirements. Some form of regulation and financial support. Simply waiting on the side-lines for the private sector to come in and build won't work." Clark Brockman, Principal, Sustainability, SERA Architects

1.3.4 Partnership building

Multiple partnerships are needed for delivering eco-districts, including partnerships for strategy, finance, innovation and communication.

Eco-districts require highly cross-cutting solutions, and as such require broad partnerships. "The mayor recognised that we needed a forum for non-profits, companies, universities and government to come together. Without a partnership it's impossible to push ahead with eco-districts." Lisa Abuaf, Central City and Green Development Manager, Portland Development Commission City leadership in providing forums for different partners to brainstorm and share knowledge is essential for creating the necessary momentum and conditions for radical innovation of new technologies. "As individual companies, it simply wouldn't be worth tackling these challenges in the current market. But by providing clear targets, a firm long-term commitment, and a forum to combine the brains and know-how of our partners, the City of Stockholm has given us the right conditions for all of us to invest – and get a return in the future." Matilda Gennvi Gustafsson, Sustainability Director, Ericsson and Rohan Richards, Senior Strategy Consultant, Ericsson Furthermore, different partnerships are needed for different purposes. City and national government funding leverages private sector finance and technical partnerships can be set up to tackle research or measurement challenges, while a central agency, such as the Portland Sustainability Institute, is an effective means of communicating a common message for eco-districts.

Community engagement is essential for developing and rolling out eco-districts in existing neighbourhoods.

Owning brownfield sites for creating new eco-districts provides strong policy control over environmental and economic outcomes. This is useful for developing and testing new policies, technologies and infrastructure. However, replicating solutions for existing neighbourhoods will require policy instruments that cannot rely on municipal land ownership. "One of the key questions we have from the business perspective is how the City proposes to use the innovative platform at Royal Seaport to roll out solutions in other areas of Stockholm." Matilda Gennvi Gustafsson, Sustainability Director, Ericsson and Rohan Richards, Senior Strategy Consultant, Ericsson Portland has already been tackling this challenge by developing eco-districts in existing neighbourhoods. "What we found in Portland is that eco-districts are more likely to be a success if a neighbourhood asks or wants to have one. It needs grassroots buy-in and involvement." Clark Brockman, Principal, Sustainability, SERA Architects

Eco-roof in Portland

Over the past decade the City of Portland has actively supported the green building sector. In 2001, Portland adopted the City's Green Building Policy, which required all new city facilities to be LEED certified. In 2005 the certification level rose to LEED gold. In addition, eco-roof coverage was made mandatory on new and replacement roofs. Green building policies have produced energy cost-savings and wider reputational benefits for Portland's growing green business sector.

Photo credit: City of Portland, Oregon Local Government

B3 Waste, recycling and energy

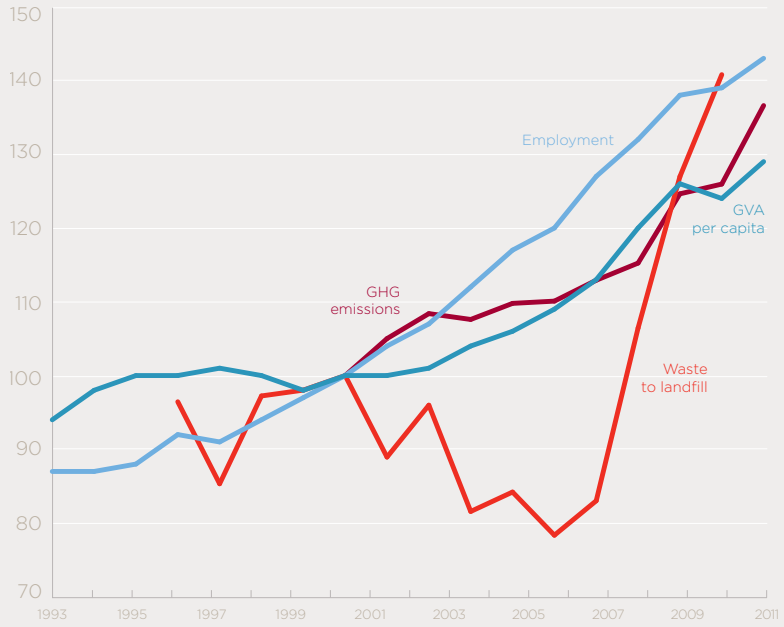
One key component in the transition to a green economy is the improvement in resource efficiency, including improvements in the generation, management and reduction of waste.[1] Around 11.2bn tonnes of solid waste are collected globally every year. This is expected to grow both in volume and complexity as incomes rise and economies continue to grow worldwide, increasing the risk of damage to human health and ecosystems and the sector's contribution to climate change.[2] Greenhouse gas emissions from waste represented 3.6% of the total 44 $GtCO_2e$ emitted globally in 2005. The largest sources of emissions from this sector are from solid waste landfill and wastewater.[3]

New opportunities for greening the waste sector arise from the growth of the waste market, increasing resource scarcity and the availability of new technologies. The two most promising areas are recycling and the production of energy. However reducing or avoiding waste altogether – the ultimate long-term objective – remains a significant challenge. Recycling is likely to grow steadily and be a key component of greener waste management systems while at the same time providing decent employment; it currently employs 12 million people in just three countries, Brazil, China and the United States. The waste to energy market was estimated at US$19.9bn in 2008 and is projected to grow by 30% by 2014.[2]

Nonetheless, in developing countries waste disposal is often beyond the financial capacity of many municipal governments and the impacts on health – particularly for low-income communities – should not be underestimated. As a result, many cities need to focus more on reducing the social and health impacts of waste than the environmental and, increasingly, financial benefits of green waste disposal.

3.1 Belo Horizonte: harnessing collective action to recycle

Fig. 1: Green Challenge



Belo Horizonte in numbers

Population of Metropolitan Region (2009)[4]/ Municipality of Belo Horizonte (2009)[5]	**5,901,622/ 2,452,617**
GVA per capita - metropolitan region (2010)[6]	**US$5,152**
Employment - metropolitan region (2010)[6]	**2,438,250**
Area of metropolitan region[4]/ Municipality of Belo Horizonte[5]	**9,459 km²/ 331 km²**
GHG emissions per capita - city (2010)[7]	**1.6 tCO_2e**
Annual waste generation per capita - city (2011)[5]	**252 kg**

Fig. 1
Belo Horizonte's metropolitan economy, measured as Gross Value Added (GVA) per capita, grew 37% from 1993 to 2010 while the metropolitan population grew 41% reaching almost 6 million in 2010.[6] Over the period 2000 to 2010, greenhouse gas emissions per capita in the City of Belo Horizonte increased by 37% from 1.2 tCO_2e to 1.6 tCO_2e and waste to landfill, while initially declining, rose by 40% during the same period, to 2.1m tonnes a year.[7, 9] All variables are indexed: 2000 = 100.

The City of Belo Horizonte, the centre of Brazil's third largest metropolitan area, is considered a leader of Brazil's economic growth in the last few decades. The metropolitan area's economy – measured as Gross Value Added (GVA) per capita – grew by 37%, its population by 41% and the number of people employed by 65% in the period 1993 to 2010. This growth was accompanied by a 37% increase in greenhouse gas emissions per person in the municipality between 2000 and 2010, though at 1.6 tCO_2e per person (Figure 1) this remains low compared to developed countries, which emit an average of 10.6 tCO_2e.[8]

The city generates an average of 0.7 kg of waste per capita and landfills a total of 3,500 tonnes every day. In the early 2000s, landfill per capita gradually decreased according to the city's records. This is despite the strong growth in the economy. However, this decoupling was reversed between 2006 and 2009, when landfill rates rose sharply (Figure 1).

While recycling rates up until 2009 remained relatively low at around 5-7% of total waste, the city has nevertheless made significant advances in recent years and now has programmes in place to recycle construction waste (around 300 tonnes a day) and is developing a sophisticated composting programme for organic waste (10 tonnes a day), including the redistribution of surplus processed food to registered charities in the city.[5]

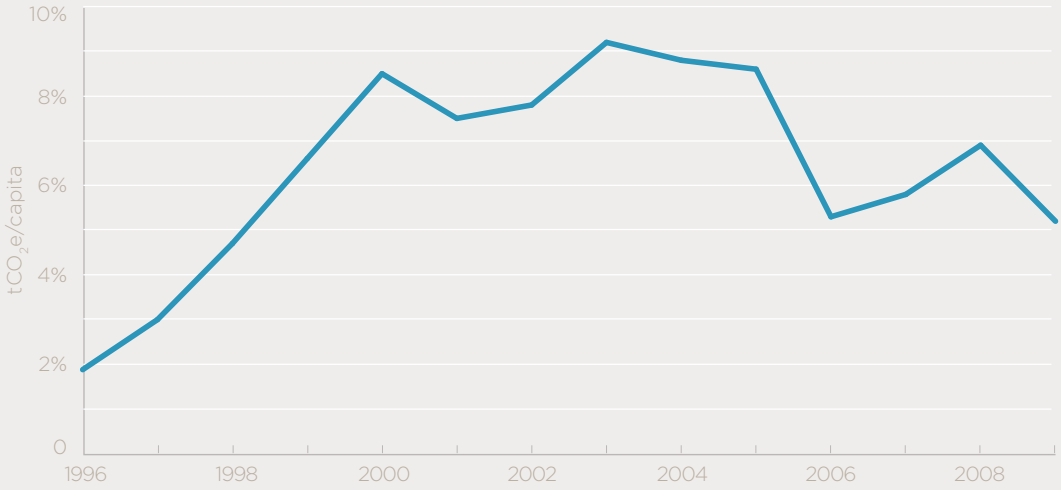
3.1.1 The Policy Programme

Belo Horizonte has been a pioneer in municipal solid waste management in Brazil since the 1990s and instrumental in the move to include the informal sector in municipal recycling strategies. The need to improve existing informal employment structures and raise the standard of living of the urban poor led to the development of an integrated solid waste management (ISWM) strategy. The policy emphasised segregation of waste at source to minimize environmental impacts and maximize social and economic benefits in local communities.[10] "Our solid waste management model is based on a concept of social inclusion and income and job generation." Aurora Pederzoli, Chief of Special Programmes,Superintendência de Limpeza Urbana

In the early 1990s, local legislation was changed to prioritize the collection of recyclables by co-operatives of informal waste-pickers, recognizing that these workers were already contributing significantly to increasing recycling volumes in the city and that a partnership with the city would improve their productivity and help the city meet both environmental and socio-economic goals.[11]

Fig. 2: Percentage of recycled waste

The proportion of waste recycled in Belo Horizonte increased from under 2% in 1996 to over 9% in 2003. As a result of the construction boom, recycling rates fell between 5 and 7% after 2005. Comparative figures for total landfill after 2009 were not available.[9]



Following this regulatory change, the Superintendência de Limpeza Urbana (SLU), responsible for all solid waste management services for the city, used a combination of legislative and financial policy tools to further integrate the informal sector into municipal waste management. The primary focus of this approach has been on developing partnerships between the SLU and local waste-picker's co-operatives in order to achieve the four main objectives of the ISWM: increased recycling rates, social inclusion, job creation and income generation.[10]

Today, around 600 waste-pickers work for the cooperatives, with a total of 80 sorting warehouses run by seven different cooperatives across the city.[12] Selective domestic waste collection is currently restricted to 30 neighbourhoods, serving around 354,000 (14%) of the city's 2.5 million inhabitants.[5] The city has also installed more than 100 voluntary drop-off sites for household waste, which is then delivered to the cooperative warehouses for sorting. Cooperatives additionally collect waste directly using push carts for door-to-door collections from office buildings and businesses. More recently, drop-off sites for composting and construction waste have also been established.[5, 13]

3.1.2 Impacts

Environmental impacts
Since the introduction of the ISWM policy, the city has experienced substantial improvements in the waste sector, including enhanced operations at landfill sites, a significant increase in the composting of organic materials and construction waste and a corresponding increase in environmental awareness among the city's population.[5, 12]

Overall, around 95% of the urban population and 70% of the population in favelas (informal settlements) received a collection service in 2008.[14] As of 2008, 89% of total waste generated was disposed of in environmentally sound landfills or controlled disposal sites, and the city has set a goal of increasing this figure to 100% in the coming years.[15]

Although the precise figure is unknown, SLU and the Cooperative estimate that there are as many as 3,000 informal waste pickers, intermediaries and buyers of recycled goods, recycling up to 10,000 tonnes of waste a year.[12, 16] This is in addition to the domestic waste recycled by the municipality through their collaboration with the cooperatives, which also amounts to around 10,000 a year.[9, 13]

Although important progress has been made in the city, landfill – and its associated environmental impacts – remains the dominant form of waste disposal. According to municipal figures, reported waste to landfill decreased by 28% from 698 kg per capita in 1996 to 504 kg in 2005, despite a growing economy. However, this decoupling trend was followed by a construction boom between 2006 and 2009, when waste to landfill per capita increased sharply by 70%. By the end of the period, landfill rates per person were actually higher than in 1996 (Figure 1).

Following a rapid increase in the late 1990s, the amount of waste recycled per year remained relatively constant between 2000 and 2005. However, a rise in construction waste recycled during the construction boom led to a 65% increase in total waste recycled between 2006 and 2009. Nonetheless, despite 118,000 tonnes being recycled in 2009, this still represented only 7% of total waste produced (Figure 2).

Economic impacts

Around 600 people are currently officially employed in the waste management sector through various cooperatives that have individual agreements with the city.[16] Working conditions for informal workers have improved significantly since their activities were legitimised and their wages are higher. For example, a non-associated waste picker can earn up to US$0.06 per kg based on the resale value. In contrast, an associated picker can earn around US$0.15 per kg. Associated waste pickers also benefit from a minimum wage of US$321 per month.[16]

According to the city, the training provided through the Municipal Waste and Citizenship Forum, as well as through direct sessions in collaboration with the cooperatives, helps to improve the worker's productivity and management skills.[12] From 2008-2010 the Forum received US$150,000 from Caixa Bank and the municipal government to invest in training and equipment for nearly 300 waste pickers.[17]

Belo Horizonte's ISWM strategy has often been cited as a model for Brazil as a whole and has inspired national-level policy on legitimising informal sector work. The approach taken is very much about strengthening the local economy and providing opportunities to the most marginalized members of the community. According to the SLU, working with the cooperatives in the warehouses in many cases is a gateway into more regular employment.[5]

With the increase in construction in the lead-up to the football World Cup in 2014, the city expects that many waste-pickers will access employment opportunities that would not be possible without the training and support they received while working with the city.[12]

Training session for Belo Horizonte waste pickers

Belo Horizonte's integrated waste management strategy places a strong emphasis on job creation and social inclusion by working in partnership with waste pickers' cooperatives. Shown here is a a training course at one of the cooperative warehouses that focussed on improving waste picker's management skills.

Photo credit: Superintendência de Limpeza Urbana

3.1.3 Policy Actors and Partnerships

Belo Horizonte's approach to waste management is characterized by a strong emphasis on local partnerships. Working collaboratively with waste-pickers' co-operatives is a central aspect of the city's ISWM policy and requires a sustained commitment, both politically and financially, to ensure the programme continues to work effectively. The city provides cooperatives with warehouses for sorting and processing the collected materials, while security services, collection carts, water and electricity are subsidised and technical assistance and capacity-building programmes instituted.

The national Government has also played an important role. The Government introduced a new solid waste management policy in 2010 that emphasises the role of partnerships with waste-pickers cooperatives but also recognizes the need to improve overall collection and recycling rates.[18] This national guidance has shaped Belo Horizonte's new Municipal Urban Cleansing Law that came into effect in September 2012 and commits the city to increased efficiency in overall collection services.[19] However, those interviewed in the city reported that recycling rates cannot increase substantially without extra resources, not only for waste-pickers but also for more specialised waste management systems.[16, 12] This remains a substantial barrier.

Financial partnerships have provided support for the cooperatives, with funds drawn from the budgets of the Cleansing Agency and the Municipal Secretariat for Social Assistance as well as the national Government.[10] The allocation of funds is regularly discussed through the government-sponsored, multi-stakeholder Waste and Citizenship Forum.

In recent years, the city has also started to work more closely with local businesses. In 2008-09, the city launched a tender for a private sector company to operate a biogas thermo-electric plant on the old city landfill site. The winning company, Asja, extracts and flares landfill gas as well as feeding electricity into the Brazilian national grid.[20] Since 2011, the company has also started benefiting from 2.9 million CERs (certified emission reduction credits) for the plant under the UNFCCC's carbon market, the Clean Development Mechanism.[21]

In another partnership, SLU has collaborated with the Belo Horizonte Social Assistance Secretariat that manufactures building blocks made from construction waste recycled by the cooperatives.[5, 13] The city is also implementing a tyre take-back programme with local manufacturers.[5]

In terms of innovation, research and development, the city works very closely with the University of Minas Gerais on optimising solid waste collection – an area that has gained importance since the city committed itself to rapidly increasing recycling rates.[12]

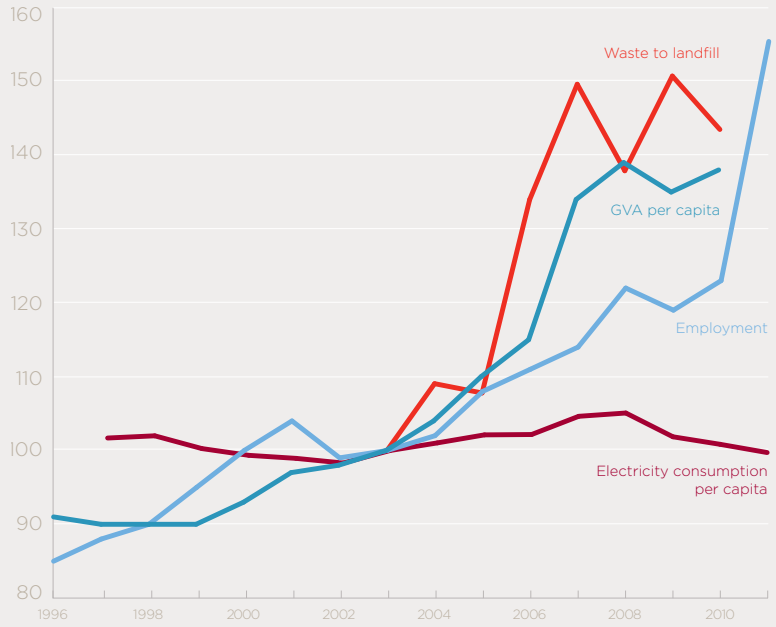
On the ground, the city still faces opposition from some local communities when it comes to the establishment of new warehouses. While NGOs and other advocacy groups are very supportive of these efforts, more environmental education is needed to help local residents understand the importance of the warehouses in helping the city achieve its recycling targets.[12, 14]

Table 1: Public private partnerships. Waste and recycling in Belo Horizonte

Partner	Supportive actions	Challenges
City Government	**Leadership.** Providing the political will to support the formalisation of waste-picking through cooperatives. Pushing for new innovations through private sector partnerships. E.g. recent tender for waste to energy plant on old city landfill site. **Finance.** Providing financial support for waste cooperatives through Superintêndencia de Limpeza Urbana (SLU) and the Municipal Secretariat for Social Assistance, including funding for warehouses, tools and clothing for improved health and safety. **Partnership building.** Educating waste pickers through training programmes. Raising awareness of the importance of recycling and the role of waste–pickers through Social Mobilization Unit of the Municipal Waste Department.	Lacking sufficient financial resources to provide more warehouses to sort waste in the city. Also lacking financial support for waste management that cannot be undertaken by cooperatives due to capabilities required.
National Government	**Leadership.** Introducing solid waste management guidelines in 2010 that put a strong emphasis on partnerships with waste-pickers cooperatives while also pushing for improved collection and recycling rates. **Finance.** Providing financial support for cooperatives and construction of warehouses.	Lacking financial support for waste management that cannot be undertaken by cooperatives due to capabilities required. Also lacking sufficient financial resources to provide more warehouses to sort waste in the city.
Business	**Finance.** Supporting educational programmes for waste-pickers. E.g. US$150,000 from Caixa Bank to provide training to more than 300 waste pickers. **Partnership building.** Extracting biogas from waste. E.g. ASJA's thermo-electric plant on the old municipal landfill site. Partnering on take-back programmes. E.g. tyre manufacturers and distributors.	Lacking private investment in cooperative schemes for waste-pickers due to limited financial return.
Research Institutes	**Partnership building.** Undertaking and sharing research into optimising solid waste collection. E.g. research at the University of Minas Gerais.	
Community and NGOs	**Partnership building.** Forming a partnership with city government through seven cooperatives. Facilitating dialogue between the cooperatives and city government, e.g. through the NGO Pastoral da Rua.	Currently lacking measurable objectives and associated metrics.

3.2 Durban: a leader in waste-to-energy

Fig. 3: Green Challenge



Durban in numbers

Population of Ethekwini metropolitan region (2010)[22]	3,467,302
GVA per capita - metropolitan region (2010)[22]	US$6,032
Employment - metropolitan region (2010)[22]	1,095,087
Area of metropolitan region[23]	2,300 km²
GHG emissions per capita - city (2010)[24]	7.5 tCO_2e
Annual waste generation per capita - city (2011)[25]	519 kg

Fig. 3
Durban's metropolitan economy, measured as Gross Value Added (GVA) per capita, grew by 38% from 1996 to 2010 while the metropolitan population grew by 22%, reaching almost 3.5 million in 2010.[22] Over the period 1995 to 2011, electricity consumption per capita in the City of Durban remained stable at around 3,300 kWh per year per person.[29] The amount of waste sent to landfill grew by 45%, from c. 900,000 tonnes to c. 1,350,000 tonnes between 2003 and 2010.[30] All variables are indexed: 2003 = 100.

The City of Durban, the third largest city in South Africa, is part of the Ethekwini metropolitan municipality, the biggest metropolitan area on the east coast of Africa, with almost 3.5 million people.[25] Durban aims to become "Africa's most caring and liveable city", a goal that is being implemented through the long-term sustainable development initiative known as Imagine Durban.[26] While Imagine Durban has placed a strong emphasis on encouraging sustainable behaviours among Durban's residents, it also aims to enhance the city's brand as one of Africa's most modern and sustainable cities; a brand that was helped when Durban hosted the UN's COP17 international climate summit in 2011.

The metropolitan area's economy, measured as Gross Value Added (GVA) per capita, grew by 38%, its population by 22% and the number of people in employment by 45% in the period 1996 to 2010 (Figure 3). In 2010, 7.5 tCO_2e were emitted per person in the metropolitan area according to the city, largely due to Durban's use of coal for much of its electricity production.[24]

The city's electricity consumption per capita has remained relatively stable over the past 15 years, while the volume of waste sent to landfill has increased by 45% between 2003 and 2010, levelling off at around 1.4m tonnes per year in the last five years (Figure 3).

The majority of this waste is currently disposed of in six landfill sites around the city, but these are reaching capacity and new solutions are needed to curb the negative environmental and public health impacts of these sites, especially on the communities living in informal settlements in the outer regions of the metropolitan area.[27, 28]

3.2.1 Policy Programme

In 2004, the Cleansing and Solid Waste Department of the Durban Metropolitan Area municipal government developed an integrated waste management strategy that covers generation, collection, treatment and disposal of waste.[31]

The city's efforts have been boosted by a new national-level waste strategy that came into force in 2012.[32] The new strategy sets ambitious targets for 2016, including the creation of 69,000 jobs in the waste sector and a separation-at-source programme in all municipalities across the country. The strategy also promotes waste minimisation, ensuring efficient delivery of waste services and growing the contribution of the waste sector to the green economy.[32]

As part of the new integrated waste management policy, the city aims to ramp up its recycling programme and is focusing on educating residents about the importance of waste reduction and recycling. "We realized it can't be business as usual since it is more and more expensive to move waste around the city; if we look at waste as a resource, does that change the way we think about it?" John Parkin, Deputy Head: Plant&Engineering, Cleansing & Solid Waste Department, Ethekwini Municipality

In addition to initiatives concerned with managing waste generation at source, the city is also pioneering gas-to-electricity conversion at two of its landfill sites, making it the first city in South Africa to explore such technologies. Since 2008, the city has been extracting landfill gas (a mixture of methane gas and carbon dioxide produced by the breakdown of organic wastes in the landfill site) for the generation of electricity at the Bisasar Road and Mariannhill landfill sites, both owned and operated by the city.[33] Durban's landfill sites were initially identified as a suitable location for such a project by the World Bank back in 2002.[34] The project finally became financially viable after ratification of the Kyoto Protocol in 2005, which allowed the municipality to apply for funding through the United Nations Framework Convention on Climate Change's (UNFCCC) Clean Development Mechanism (CDM).[28]

3.2.2 Impacts

Environmental impacts
Despite Durban's integrated waste management strategy, between 2003 and 2010 the amount of waste sent to landfill grew by 45%, from around 900,000 tonnes to around 1.3m tonnes. In response, the municipality has set new targets to achieve a 20% recycling rate by 2016, with a zero waste goal to be achieved over the next 20 years. Achieving these ambitious targets will be challenging, and sustained political commitment will be needed. The city is focussing on waste education to improve recycling rates and curb illegal dumping, and has opened a competition for businesses to propose solutions for the disposal of organic waste, which makes up a large proportion of the domestic solid waste produced in the city.[28]

Some progress has already been made on recycling rates. Recycling before waste goes to landfill increased by 60% between 2009 and 2012. However, this represents only around 1% of total waste produced. Further recycling does occur at the landfill site itself, and the city estimates that a total of around 8% of all waste is currently recycled.[28]

As well as a focus on reducing waste generation and improving recycling rates, the two gas-to-electricity plants are helping the city achieve its long-term waste management goals. The plants are preventing about 21 tonnes of methane gas from escaping from the two landfill sites every day, and the plant at Bisasar Road landfill alone is leading to an estimated reduction of 340,000 tCO_2e per year.[35] Over the life-span of both plants, an estimated total of 7.7 million certified emissions reduction credits will be realized.[33] The city plans to install a third gas-to-electricity plant at a new landfill site in the next 18 months, as soon as sufficient levels of waste have been accumulated at the site for the project to become viable.

Overall, Durban's gas-to-electricity programme is one of the largest and most productive in the world today and has become a model for similar projects around the world. The city has also begun to explore the possibility of additional waste-to-energy projects, such as biomass burning, to help improve the environmental footprint of its landfill sites.[28]

Economic impacts
The Bisasar Road and Mariannhill landfill gas projects have already identified Durban as a pioneer in the gas-to-electricity space. City officials involved with the project have travelled extensively to share lessons related to the technological and administrative barriers of CDM-funded gas extraction with other cities around the world, from Kuala Lumpur to Tehran.[28] These visits are about municipal camaraderie and helping other cities learn from Durban's experience rather than about generating direct financial returns for the city. However, the exposure that the city has received as a result has helped drive Durban's reputation as a city of innovation and new technological solutions. In a recent survey, Durban's gas-to-electricity initiative was listed among the world's 100 most innovative infrastructure projects.[36]

The two existing gas-to-electricity plants are feeding up to 7.5 MW of electricity into the municipal electricity grid, enough to supply 5,000 – 6,000 low-income households with electricity every day.[37] This has saved the municipality nearly US$10m in electricity purchases since the project's inception in 2008.[28] In addition, the avoided CO_2 emissions create nearly

Gas-to-electricity production in Durban

Funding through the United Nations-led Clean Development Mechanism has allowed Durban to pioneer gas-to-electricity conversion at two of the city's landfill sites, capturing methane gas to produce enough electricity to supply 5– 6,000 low-income homes. Shown here is the plant at Bisasar Road landfill, with a generation capacity of 6.5 MW.

Photo credit: Durban Solid Waste

300,000 certified emissions reduction (CER) credits a year, for which the municipality receives an additional US$2m through the CDM. This price fluctuates depending on the price of carbon credits on the international market, which has been dropping steadily since the beginning of the project. These price fluctuations mean that the city cannot predict when the project start-up costs will be fully recovered.[28]

The provision of green jobs is an important co-benefit of these projects and in line with efforts by the national government to rapidly develop the country's green economy. Around 150 workers were employed during construction, as well as a dozen highly-skilled permanent jobs created for the operation and maintenance of the plants.[28]

3.2.3 Policy Actors and Partnerships

Durban's gas-to-electricity programme would not have been possible without several years of committed collaboration between the stakeholders involved. The initial impetus for landfill gas extraction came from the World Bank, combined with a strong belief in the benefit of the initiative from the municipal government. The commitment of the Cleansing and Solid Waste Department and the support of the Mayor were crucial to the success of the initiative.

UNFCCC provided a framework for the municipality to justify the project from an environmental and financial perspective.[35] In addition to the revenues generated from carbon emission reduction credits through the UNFCCC's Clean Development Mechanism and the sale of electricity, the municipality also received funding from the national government and the French Development Bank, which helped cover much of the initial start-up costs.[38]

This financing partnership made the project economically viable, since grid-electricity is still considerably cheaper than electricity generated through gas extraction at the landfills.[39] The external funding that the city receives ensures that the project will become a significant source of revenue for the municipality in the coming years, providing a rate of return in excess of 25%.[33]

The willingness of local businesses to partner with the city and a strong commitment by the city's Cleansing and Solid Waste Department to see the project through a range of financial, legal and political hurdles were also essential to the successful implementation of the programme.[28] Applying for CDM funding is a complicated and time-consuming process, requiring the municipality to pay US$75,000 up front simply to cover the registration costs, without any assurance that the project would be approved. Additionally it took until 2011 for the city to start receiving payments through the mechanism, even though the project was registered in 2008.[28]

At the national level, the city received US$120,000 seed funding from the Department of Energy for every MW of generating capacity installed, but otherwise support was limited. Once the Mayor and the City Manager understood the potential benefits of the project, they too were very

Table 2: Public private partnerships. Waste and energy in Durban

Actor	Supportive actions	Challenges
City Government	**Leadership and strategy.** Providing top-level political and departmental support for landfill gas projects despite start-up costs and administrative barriers – including the Mayor, City Manager and the Cleansing and Solid Waste Department. **Partnership building.** Facilitating communication between public and private sector actors.	Lacking sufficient information about CDM and gas-to-electricity to fully support project from outset. Providing limited financial support for project due to budget limitations.
National Government	**Leadership.** Embracing gas-to-electricity as opportunity for local job creation and skills training. Encouraging innovative approaches to waste management through new National Waste Management Strategy **Finance.** Providing seed funding of US$120,000 per MW of electricity from Department of Energy.	Causing delays in project approval due to strict anti-corruption policies and bureaucracy.
International Institutions	**Finance.** Ensuring financial viability of landfill gas projects through Clean Development Mechanism payments as well as seed funding from the French Development Bank.	Maintaining highly complex administrative process that delays approval of projects and deters actors from engaging in CDM process.
Research Institutes	**Partnership building.** Working closely with the city, the University of Kwa Zulu Natal helped optimise the landfill gas technology and used the waste-to-energy projects for teaching and skilling students.	
Community and NGOs		Criticising some aspects of the project based on claims of environmental favouritism.

supportive.[28] At the same time, efforts by the Treasury Department to address corruption and cronyism meant that the project faced a range of legal and administrative hurdles.[28]

Another important partner was the University of KwaZulu-Natal. The University has been at the forefront of research related to the management of landfill gas emissions. Indeed, the University suggested Durban as a suitable site to the World Bank and has been working in close collaboration with the municipality ever since.[33]

Since Durban was the first city in South Africa to implement this technology, there was very limited expertise within local companies as well as the city government. Even without the added complications of having the project recognized through the CDM, the learning curve was very steep for everyone involved.

The scale and complexity of the project meant that the city had to partner with a wide range of local and international companies, from Jenbacher who supplied the engines, to legal advisors, civil engineering firms, and consultants who helped with the environmental impact assessment and ongoing air quality monitoring.

Many of these firms, such as Envitech Solutions and ContraOdour, are local businesses that have benefited from their involvement with the project and are now able to use their skills and expertise in similar projects across South Africa.[40, 41] One of the officials involved in the project through the Cleansing and Solid Waste Department established his own company called GreenEng, which specializes in landfill gas projects and CDM funding. GreenEng was recently acquired by SLR consultants, a large UK-based environmental consultancy that was centrally involved with the project in Durban and has decided to expand its operations in South Africa as a result.[42]

The city has faced some criticism over the project from a small group of NGOs and community groups, who oppose the project from a moral perspective, objecting to the idea of carbon offsets in general. Other local activists would argue that the landfill site should be closed completely, as they are concerned about its continued proximity to surrounding low-income housing and informal settlements.[38, 43] The city has worked to educate the local community about the health benefits of the gas-to-electricity plants, which reduce emissions of dangerous methane gas and improve air quality and odours at the landfill sites.[28]

3.3 Lessons

Belo Horizonte and Durban face a huge waste disposal challenge that is shared by many cities around the world. The rates of waste going to landfill have grown rapidly in both cities over the last 10 years in line with economic growth. Cities with rapidly growing populations and increasing wealth can experience high rates of construction, and unsurprisingly, much of the waste disposed is from the construction sector. Reducing the volume of waste produced will continue to be a major challenge for cities with constrained funds and a range of other pressing policy priorities.

Nonetheless, Belo Horizonte and Durban show that some progress in increasing recycling, reducing greenhouse gas emissions, and attracting finance for waste-to-energy projects can be made with strong leadership and effective partnerships. Both cities have been successful in attracting international finance through the UN's carbon market (Clean Development Mechanism) to fund landfill gas projects: one through commercial tendering of operations on the old Belo Horizonte municipal landfill and the other owned and operated by Durban municipality through collaboration with the local university.

In Belo Horizonte, the creation of cooperatives to support informal waste pickers on a minimum wage has been a successful social policy initiative. While the impact on recycling rates has been marginal, it demonstrates a partnership that delivers its primary goal of better working conditions while also providing environmental and health co-benefits. The wider economic impacts from improved working conditions are difficult to estimate. However, if more workers are to be supported through higher wages, better equipment and training, public funding will be necessary. Support from national governments will be required in many cases given the constraints on city budgets and the scale – and cost – of the waste problem.

Key lessons emerging from the study of waste, recycling and energy programmes in Belo Horizonte and Durban across topics of leadership, finance and partnership building include the following:

3.3.1 Leadership

Committed leadership from the city is needed to drive through innovative projects.

Both the recycling cooperatives in Belo Horizonte and the waste-to-energy projects in Durban needed strong leadership and a sustained commitment from the city government to ensure delivery. In the case of Durban, the support of the Mayor was instrumental. In Belo Horizonte, the Department of City Cleansing has been a powerful supporter of the waste-picker cooperatives. Political and institutional backing of the cooperatives has been particularly important in the face of resistance by some local residents who are unwilling to accept the recognition of waste-pickers in the formal economy.

National waste targets need to recognise constrained municipal budgets.

A major challenge for cities is how to meet national targets on waste disposal when resources to deliver on those targets are constrained. "The cooperatives cannot handle all recyclables and we must find another way to meet national, state and municipal guidelines. Sometimes the national government provides us with guidelines without considering our operational and physical limitations, the capacity of the warehouses and the productivity of the waste-pickers." Patricia Dayrell, Sanitary Civil Engineer, Superintendência de Limpeza Urbana This highlights the need for greater national and state funding for city waste disposal if targets are to be met.

First mover cities can use waste-to-energy projects to support their green brand and attract inward investment.

Durban has built a strong green city brand around Imagine Durban. While the strategy has placed an emphasis on encouraging sustainable behaviours among Durban's residents, it also aims

to project Durban's image as one of Africa's most modern and sustainable cities as a means to attract inward investment. "Any project like this is a benefit to the city and any innovations that come out of the city are seen by the world and could attract businesses from abroad that might relocate here." John Parkin, Deputy Head: Plant & Engineering, Cleansing & Solid Waste Department, eThekwini Municipality

Socio-economic goals can deliver green growth co-benefits.

The provision of jobs and decent employment is central to the waste projects in Belo Horizonte and Durban. The waste-picker cooperatives of Belo Horizonte, and the associated training programmes from the city, are a means of providing a minimum wage and a stepping stone on the way to formal employment. "The training provided by the city helps to improve the workers' productivity and management skills." Aurora Pederzoli, Chief of Special Programmes, Superintendência de Limpeza Urbana

The increased productivity of the workers can lead to higher rates of recycling as a co-benefit. In Durban, developing skills is also a key driver for the waste-to-energy projects: "It will be essential that landfill gas projects not only produce electricity but also become a breeding ground for local skills development in the areas of maintenance and operations." Dibuo Peters, Minister of Energy, South Africa

3.3.2 Finance

Seed funding is key to unlocking international finance through the Clean Development Mechanism.

Carbon credits generated through the UN's Clean Development Mechanism are essential for making waste-to-energy projects financially viable. Electricity generation from the grid is generally lower cost than energy from landfill gas extraction unless the carbon price is included. At the same time, accessing CDM credits is heavily bureaucratic and requires upfront funding for registration and set-up costs, with the whole process taking several years before credits come on stream. Consequently, seed funding is essential and for many developing country cities this needs to be raised externally. In Durban's case, the city received US$120,000 in national seed funding from South Africa's Department of Energy per MW installed and further upfront financing from the French Development Bank.

3.3.3 Partnership building

Public-private partnerships can overcome the barriers facing innovative waste programmes.

In Belo Horizonte, the key partnership for supporting the waste-pickers is public-public: between the city's Municipal Cleansing Agency and the cooperatives. Without the cooperatives, the workers would have no means of organisation. At the same time, public-private partnerships are starting to evolve, such as the tyre take-back schemes with local tyre manufacturers. In Durban, the city would not have been able to develop the landfill gas projects without partnering with local and international companies and consultancies as well as the local research institute, the University of Kwa Zulu Natal. As a result, the city now benefits from lower greenhouse gas emissions, employment for workers at the plants and a finance stream from the Clean Development Mechanism.

Community resistance to innovative waste projects can be a major barrier.

Largely due to their actual and perceived health impacts, overcoming resistance to new projects by local residents is often a major challenge. In Belo Horizonte, siting warehouses for waste-pickers to sort material in local neighbourhoods has been supported by NGOs but met with objections from the community. In Durban, the city has faced opposition to the new commercial landfill gas plant from some local activists who would prefer to see the site closed down due to concerns over its continued proximity to surrounding low-income housing and informal settlements. In order to overcome this barrier, the city has provided information to the local community about the health benefits of the plants in reducing methane emissions.

City to city knowledge sharing can help increase access to international finance and local expertise for waste projects.

While partnerships are central to delivering waste projects within municipalities, cities can also play an important role in knowledge sharing with their peers, both in their own country and abroad. In Durban, the city is using its experience of accessing international finance and delivering waste-to-energy projects to help other cities in South Africa: "We have helped a lot of other cities including Johannesburg and Cape Town who are both in the process of rolling this process out." John Parkin, Deputy Head: Plant & Engineering, Cleansing & Solid Waste Department, eThekwini Municipality The city has also spread their knowledge abroad, including Iran and Malaysia.

B4 Electric mobility and renewable energy

The greening of the urban transport sector and the transformation of energy systems with a shift towards renewable energy production are each and by themselves demanding policy objectives. Furthermore, the integration of these two sectors has created a new and highly challenging policy area, and one with substantial economic opportunities. The electric vehicle market alone is estimated to reach 5 million vehicles globally by 2017, with revenues from charging equipment growing rapidly from US$400m in 2011 to US$4.3bn.[1] Cities are leading the electrification of road transport, which is responsible for 16% of energy-related global carbon emissions, by building on their density advantages and on far-reaching synergies with renewable energy generation.[2]

Electric mobility helps to accelerate the transition to renewables through the use of vehicle-to-grid technologies. The batteries of electric vehicles can be used to absorb and store surplus electricity from volatile renewable generation sources, making them a potentially important component of renewable energy systems. From a transport perspective, electrifying road transport can potentially increase multi-modal urban mobility supported by small, efficient and zero-emission vehicles, freeing cities from more traditional car use. Such changes are becoming increasingly urgent. Even within the European Union, a highly urbanised context with ambitious carbon reduction policies in place, transport-related CO_2 emissions increased by a staggering 36%between 1990 and 2006, while other key sectors have achieved at least modest reductions.[3]

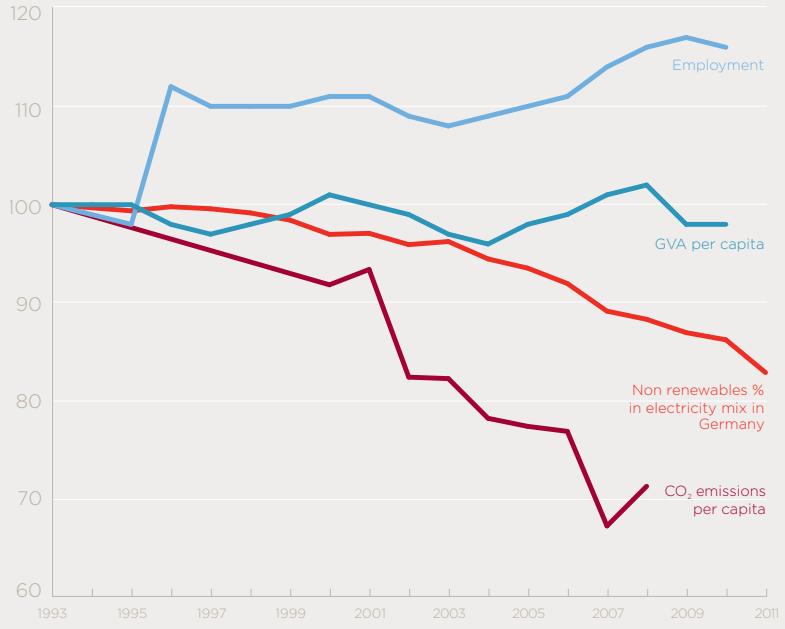
The shift towards renewable energy and electric mobility faces a range of socio-technical uncertainties and challenges from a rapid rate of technology obsolescence. So far, advances are mostly induced by national government investment programmes, tax regimes and market-based policy instruments. At the implementation level in cities, these policy frameworks are complemented by new forms of collaboration between a diverse range of public, private and third party actors. Both Berlin and London represent two particularly informative cases.

4.1 Berlin: urban mobility for the next industrial revolution

Following reunification in the early 1990's, Berlin's metropolitan economy initially contracted, with slow growth occurring during the last 10 years. Overall, GVA per capita has remained relatively flat since 1993, ending 2% lower in 2010 (Figure 1). Overall, however, the economy proved more resilient during the recent recession compared to most European cities.[4] Berlin's comparatively weak economy has required the region to embrace new industrial opportunities, including a strong commitment to becoming a green technology hub. This is in line with the city's wider ambition to improve its environmental credentials and cut greenhouse gas emissions, with per capita CO_2 emissions decreasing by 29% between 1990 and 2008 (Figure 1).

Over the last decade, the Berlin-Brandenburg metropolitan region has embarked on one of the most ambitious renewable energy and electric mobility agendas of any city region of similar size and status. On the one hand, this agenda builds on the decade-long policy leadership by the German Federal Government of triggering a sweeping energy transformation (Energiewende). On the other hand, it is Berlin's tradition of successfully implementing integrated transport strategies that has created the conditions that allow for the piloting of innovative electric mobility programmes.

Fig. 1: Green Economy



Berlin in numbers

Population of metropolitan region (2004)[5]/ City of Berlin (2011)[6]	**4,971,331/ 3,501,900**
GVA per capita - metropolitan region (2010)[4]	**US$26,909**
Employment - metropolitan region (2010)[4]	**1,743,358**
Area of metropolitan region[5]/ City of Berlin[6]	**17,382 km²/ 891,7 km²**
Carbon emissions per capita - city (2009)[7]	**5.3 tCO_2**

Fig. 1
While GVA per capita in the Berlin metropolitan region contracted slightly by 2% between 1993 and 2010, employment has been rising steadily since 2003.[4] Per capita carbon emissions in the Berlin metropolitan region declined by 29% from 7.9 tCO_2 in 1990 to 5.4 in 2008, compared to 23% across the whole of Germany.[7] The share of renewable energy in Germany's electricity mix increased from 3.9 in 1993 to 20.3 in 2011.[21] All variables are indexed 1993=100.

4.1.1 The Policy Programme

The Berlin-Brandenburg electric mobility programme is part of the German Federal Government's National Development Plan for Electric Mobility.[11] At the federal level, this programme is primarily based on an agenda to build a globally competitive electric mobility industry and to introduce 1 million electric vehicles to German streets by 2020, coupled with a €680m (US$880m) investment programme over four years. More broadly, this policy is part of Germany's Energy Transformation, which itself is facilitated by six new federal laws including the much publicised feed-in tariff for renewable energy.[12] By 2030, renewable energy is expected to supply 100% of Berlin and Brandenburg's electricity needs.[13] The Electric Mobility Plan itself focuses on funding new battery technology, new e-mobility systems and related infrastructure development, as well as provisions for regulatory incentives.

The electric mobility programme for the Berlin metropolitan region (Land Berlin jointly with Land Brandenburg) received €47m (US$60m) as part of a competitive bid from this federal programme which is matched with local funding through a public-private partnership arrangement, with €75m (US$96m) from the private sector and €25m (US$32m) from Land Berlin. The so-called International Electromobility Showcase Berlin focusses on new urban mobility, charging and parking, and electricity storage systems.[14] With this pilot project the city

Fig. 2: Location of electric vehicle charging points across Berlin.

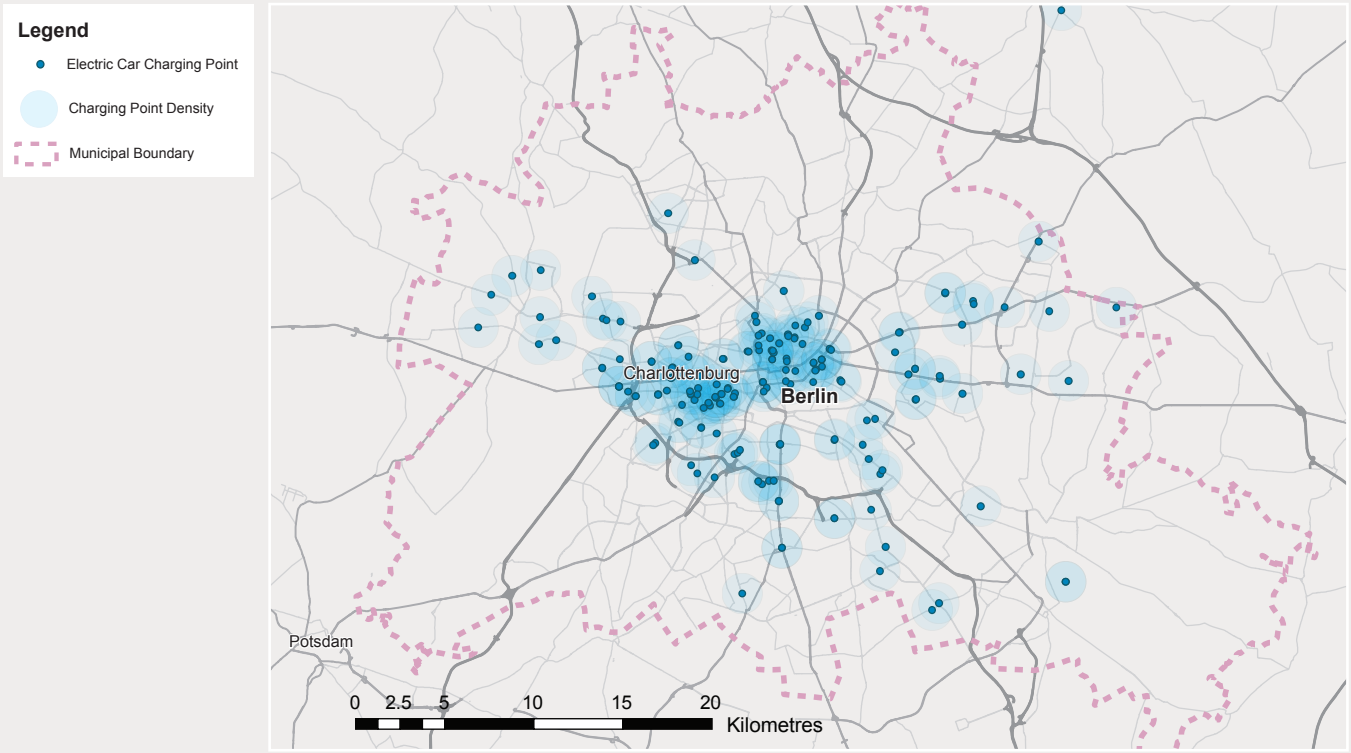


Fig. 2
Location of electric vehicle charging points across Berlin. As of September 2012, there are more than 220 public charging points across the capital, and the city plans to have 1,400 installed by 2015. The majority of charging points are operated by the utility companies RWE, Vattenfall, and DB Energie, the energy provider owned by Deutsche Bahn. LSE Cities graphic based on multiple data sources.[8-10]

aims to introduce 15,000 electric vehicles by 2015 and install 1,400 public and 2,300 private charging points.[15]

The programme builds on Berlin's outstanding reputation for integrated transport policy, facilitated by the Urban Development Plan for Transport and the city's experience with car sharing programmes over several decades.[16, 17] In line with these existing mobility programmes, electric mobility is not an isolated policy solely focussed on the introduction of electric vehicles. Instead, it is a central component of a wider strategy for shifting the mobility system away from an ownership model to a sharing model. Considerable emphasis is also placed on integrating electric mobility and emerging smart grid technology, by exploring the possibilities of vehicle-to-grid systems for storing renewable energy.[18]

The BeMobility pilot initiative is indicative of this approach. It integrates electric mobility with public transport by offering electric vehicle fleets through e-Flinkster, Deutsche Bahn's car sharing scheme.[17] A new Mobility Card allows users to transition between electric cars, bicycles and public transport through an entirely integrated payment system.[19, 20]

4.1.2 Impacts

Environmental impacts
Significant progress has been made in advancing renewable energy generation in Germany. At the national level, the share of electricity from renewable sources rose from less than 3% in 1990 to over 20% in 2011.[21] The Berlin-Brandenburg metropolitan region has been even more successful and today produces 45% of its electricity through renewable sources.[18] Partly as a result of this, carbon emissions of the Land Berlin have declined by more than 30% per capita over the last two decades. Despite this progress, electrifying urban road transport based on renewables is still at a pilot stage. Across Germany, only about 3,000 new vehicles were electric, compared to 6.5 million newly registered vehicles between 2010 and 2011.[22] In Berlin/Brandenburg, about 500 electric vehicles are registered today and 220 public charging stations have been installed, supplying 100% certified renewable energy (Figure 2).[23]

A more pronounced shift towards a broader concept of 'new urban mobility' (combining walking, cycling and shared transport) has helped Berlin maintain the lowest motorization rate of any German city, with only 324 cars per 1000 inhabitants,[24] compared to for example 611 cars per

1000 inhabitants in Hamburg.[25] Besides cycling, car sharing has flourished with more than 3000 shared vehicles in the city, including an increasing number of electric cars.[26] In September 2011, the car manufacturer Citroën launched Multicity in Berlin, Germany's first fully electric car sharing programme. In partnership with Deutsche Bahn, Multicity has introduced 100 new electric cars, with plans for 500 cars by 2013.[27] Other manufacturers such as Daimler and Peugeot have also announced that they will be adding several hundred electric cars to their existing car sharing fleets by 2013.[28]

Economic impacts
In recent years, Germany has positioned itself at the forefront of the emerging green technology market, which has experienced double digit growth rates since 2007 and globally is now worth more than €2 trillion (US$2.5 trillion) in annual revenues, with German green tech firms accounting for 15% of this figure.[29] Employment in this sector across Germany is expected to grow by more than 70% between now and 2025, rising to 2.4 million jobs, with total revenues predicted to increase to 20% of national GDP over the same time period.[29]

Germany's efforts to position itself as a pioneer in renewable energy and electric mobility technologies is relatively unique in combining both environmental and industrial policy at this scale. It also provides a unique economic opportunity for the Berlin metropolitan region, which has weak industry compared to other metropolitan regions in Germany. The city has begun to capitalise on its appeal to entrepreneurs, its socio-technical research expertise, willingness to experiment and progressive transport policies, which have attracted foreign investment, enhanced the export potential of local technologies and ideas and developed the city's brand as a global green technology leader.[16, 30, 31]

Today, Berlin has established itself as a "pilot market"[28] and an international innovation centre for electric mobility, which cuts across universities, research centres and a large group of private sector players, including car manufacturers such as Daimler and Citroën, utility companies such as RWE and Vattenfall and technology providers such as Siemens and Bosch.[30]

Deutsche Bahn is establishing a centre of excellence for integrating electric mobility with public transport in Berlin, which it plans to export to other cities in Germany and Europe.[32] German car manufacturers and providers of auxiliary infrastructure are also using Berlin as a testing-ground for new technologies. This has created a highly competitive market, with hundreds of companies involved in various aspects of electric mobility, with investment interests also extending beyond Europe: "SK Innovation, a South Korean company, has entered a joint venture with Continental on battery development and they decided to invest in Berlin because they need the research from Berlin universities and research institutions." Jürgen Varnhorn, Head of Technology and Innovation Policy, Berlin Government

A dedicated research campus for electric mobility and smart renewable energy, the EUREF campus, was established in 2009 and plans for the re-use of the site of Tegel Airport are focusing on the manufacturing of energy and transport components.[33] However, these developments are currently in their infancy and none of the interviewed investment partners has yet started to generate related profits.[19, 27, 28]

4.1.3 Policy Actors and Partnerships

The Berlin-Brandenburg electric mobility programme is an extremely complex form of public-private partnership, formed and maintained through the International Electromobility Showcase, dedicated intermediaries, regular events and meetings as well as extensive information sharing. On the public side, it includes the German Federal Government as the most central policy actor, as well as the two Länder Berlin and Brandenburg. Borough level administrations play only a marginal role. The private sector brings together a uniquely diverse group of large corporations and SMEs, cutting across markets such as energy, automotive, electronics, ICT, mobility services and consulting. Participation from the third sector includes universities and several public and private research organizations. Furthermore, residents are identified not only as passive recipients of future mobility options but as active agents of the piloting process.[17, 30]

Federal Government is represented by two ministries, the Ministry of Economic Cooperation and Development and the Ministry of Transport, Building and Urban Development. Together, they oversee the national investment programmes and focus on agenda setting. It is the latter that has been particularly important: "Setting this ambitious goal was helpful in our electric strategies

because everybody now knew that this was a key goal of the German Government and we needed to do something about it." Steffen Sauerbrei, Head of Strategic Planning, Mu by Peugeot

The Land Berlin's role is mainly in the facilitation of the overall public private partnerships, creating a favorable investment climate while also contributing to the pilot programmes through targeted funding: "Berlin is a very poor city, highly indebted, so there was a decision not to go into tax reductions, so we are looking more into public private partnerships." Jürgen Varnhorn, Head of Technology and Innovation Policy, Berlin Government A central part of this facilitation role involved setting up the Berlin Agency for Electromobility (eMO). This is the main organizing body that pools expertise from business, science, politics and public administration. eMO is responsible for coordinating the activities of all actors, acquiring new partners, and promoting the electric mobility activities of the city.[34] Companies rely on eMO to facilitate communication and act as an intermediary between the many organizations involved. "They are very helpful. They initiate contacts and make networking easy by getting the right people around the table." Steffen Sauerbrei, Head of Strategic Planning, Mu by Peugeot

Overall, Berlin's approach to electric mobility is one of close collaboration, recognizing that no company or government body can bring about a mobility revolution on its own, and at the same time nurturing healthy competition to accelerate innovation. Important private sector support came in particular from the energy utilities with, for example, RWE establishing nearly 100 charging stations since 2010 (Figure 2).[35] Numerous partnerships and innovative intermediaries such as the Innovation Centre for Mobility and Societal Change (InnoZ), which acts as a leading research and innovation hub for universities, research organisations and large corporations, are testament to this widespread collaboration. A particularly relevant partner in Berlin is Deutsche Bahn, connecting shared electric mobility to broader mobility services and using its expertise in the field to forge innovative partnerships such as its work with Citroën on the Multicity project. "Deutsche Bahn is very well connected and they provided the whole negotiation bridge between us and the government." Mauricio Sabater, Project Manager, Citroën Multicity

Electric car sharing in Berlin

Deutsche Bahn has led the integration of electric mobility with public transport in Berlin. Currently there are 50 electric vehicles in the Deutsche Bahn's own Flinkster fleet as well as 100 electric vehicles as part of the company's e-car sharing collaboration with Citroën Multicity, which will be expanded to 500 vehicles in 2013. At present, Berlin has around 220 public charge points, and the goal is to increase this to 1,400 by 2015.

Photo credit: Deutsche Bahn

Table 1: Public private partnerships. Electric mobility in Berlin

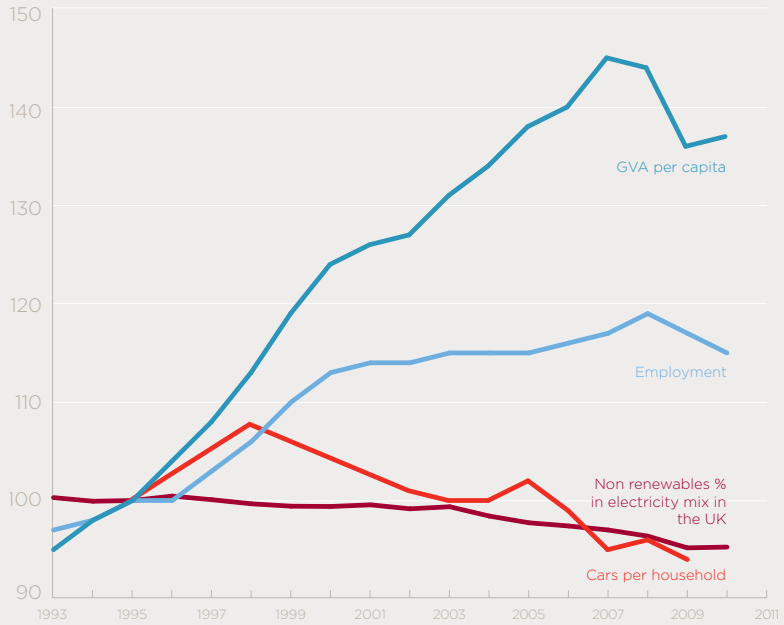
Actor	Supportive actions	Challenges
City Government (Land Berlin)	**Leadership and strategy.** Steering and implementing the Berlin-Brandenburg Electric Mobility Pilot jointly with Land Brandenburg. Committing to integrated and multimodal transport strategies as part of Urban Development Plan for Transport. **Finance.** Investing €25m (US$32m) in Berlin-Brandenburg Electric Mobility Pilot. **Partnership building.** Coordinating activities of key actors as part of complex public private partnership arrangements and setting-up Berlin Agency for ElectricMobility.	Enforcing parking spaces reserved for electric cars is not at the required level. Giving little priority of on-street parking to car sharing and electric mobility. Insufficient information and education related to electric mobility.
Federal Government	**Leadership and strategy.** Initiating a National Development Plan for Electric Mobility linked to broader agenda for an energy transition towards renewables with support of European Union. **Finance.** Funding pilot programmes, research and development through a €680m (US$880m) electric mobility programme. **Regulation.** Triggering Germany's radical Energy Transformation (Energiewende) by implementing a substantial policy programme which includes regulatory, market- and investment-based policy instruments.	Focussing on technology development rather than broader changes which include a shift towards mobility services as part of electric mobility. Supporting status-quo motorisation and car use through a range of policies including direct subsidies and downgrading of tougher regulation on heavier vehicles (including lobbying against EU regulation).
Business	**Finance.** Investing €75m (US$96m) in new infrastructure and technology, including charging points and other auxiliary infrastructure. **Partnership building.** Collaborating closely with the city, other businesses and research community to accelerate uptake of electric mobility.	Struggling to make the business case for electric mobility and demonstrate that there is a long-term pay off. Fragmenting approaches, systems and technologies related to electric mobility.
Research Institution	**Leadership and strategy.** Leading research into new technologies: charging infrastructure, vehicle-to-grid systems and integrated mobility solutions. Integrating technical solutions with knowledge of behaviour of end users and helping companies understand customer needs. **Partnership building.** Facilitating information exchange, collaboration and project management through EUREF campus and InnoZ.	
General public, NGOs and community organisations	**Leadership.** Promoting advantages of electric cars through advocacy groups. **Partnership building.** Supporting Berlin electric mobility pilots by active engagement and interest in using electric vehicles and car sharing programmes.	General interest in electric mobility too rarely translated into actual behaviour change. Sharing some scepticism about implementing electric mobility.

4.2 London: the electric vehicle pioneer

London has experienced substantial economic growth over the past twenty years, with per capita GVA of the metropolitan area increasing by 45% between 1993 and 2011 (Figure 3). During the same period the metropolitan region experienced significant inward migration, leading to a population increase of 12% and a rise of 19% in numbers employed. While this strong economic performance has been remarkable, growth has slowed during the current global downturn (Figure 3). The current period of economic uncertainty coincides with new demands for renewing London's role as a leading global city and pro-actively embracing emerging opportunities in the transformation to a low carbon economy.[39]

The city's green economy can build on London's relatively new role as a green policy innovator. Over the last decade, London has become a prominent leader in progressive transport policies and is globally recognized for introducing congestion charging, the upgrading of public transport and more recently the promotion of cycling. These policies have contributed to a steady drop in car ownership across London, from an average of 0.81 cars per household in 1995 to 0.76 in 2011 (Figure 3). The city has also seen the introduction of about 2,300 electric vehicles, the largest number in any city to date, and has been leading on the development of charging infrastructure for over five years.[40] More broadly, the UK Government's aim to increase renewable energy production to 15% by 2020[41] has seen a gradual de-carbonisation of the country's electricity generation (Figure 3).

Fig. 3: Green Growth



London in numbers

Population of metropolitan region (2011)[36]/ Greater London Area (2011)[36]	**14,598,900/ 8,174,100**
GVA per capita - metropolitan region (2010)[4]	**US$47,313**
Employment - metropolitan region (2010)[4]	**8,072,219**
Area of metropolitan region[37]/ Area of Greater London[37]	**12,168 km²/ 1,595 km²**
Carbon emissions per capita - city (2010)[38]	**5.7 tCO_2**

Fig. 3
London's metropolitan economy has grown strongly over the past 20 years. Even considering the impact of the global downturn on London's economy since 2007, GVA per capita has still grown by 45% between 1993 and 2011.[4] During this period of rapid growth, car ownership in London dropped by 6% from an average of 0.81 cars per household in 1995 to 0.76 in 2011.[62] At the same time, the percentage of non-renewables in the total electricity mix of the UK fell by 5%.[41] All variables are indexed 1995=100.

4.2.1 The Policy Programme

The London electric mobility programme is part of the city's wider effort to de-carbonize transport and address air quality issues in the city. While not directly linked to a renewable energy strategy, it builds on the broader ambition of the UK Government to increase renewable energy production.[41] The relatively early adoption of electric vehicles in London was initially stimulated by a 100% discount on the congestion charge introduced in 2003, with savings for electric vehicle owners of up to £2,000 (US$3,200) a year.[44] While this created an important financial incentive, the marketing effect of this approach was arguably even more important.[45] More recently, a range of regulatory, incentive-driven and investment-based policy instruments have been established at national, city and borough level to encourage a shift towards electric vehicles.

Nationally, policies to support electric mobility focus on two main elements, for which £300m has been set aside. First, electric vehicle uptake is supported through the Plug-in Car Grant, which provides a subsidy of 25% up to the value of £5,000 (US$8,000) for each electric vehicle

Fig. 4: Location of electric car charging points in the Greater London Area.

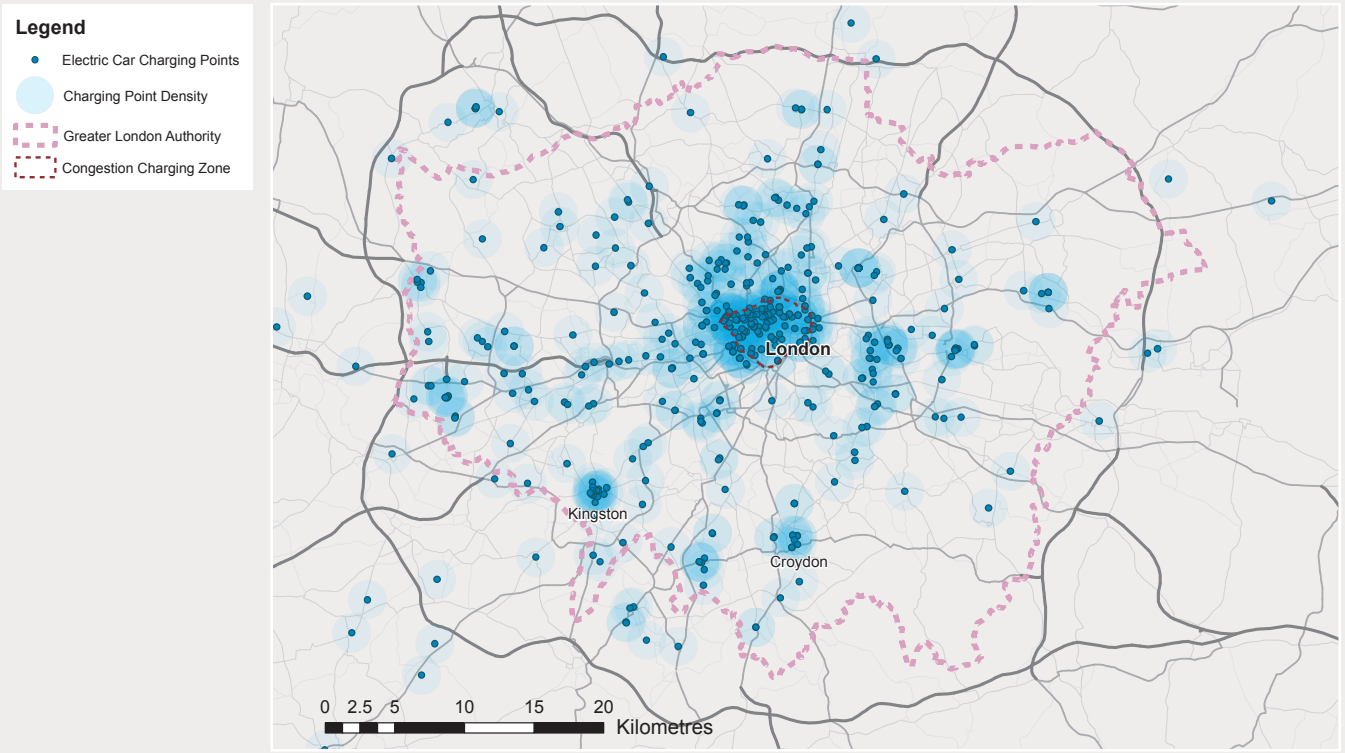


Fig. 4
Location of electric car charging points in the Greater London Area. In September 2012, there were more than 700 charge points in the city, with the majority of these concentrated in Inner London. LSE Cities graphic based on multiple data sources.[9, 42, 43]

purchased.[46] Second, £30m (US$48m) was awarded through the Plugged-In Places programme to fund eight electric vehicle pilot projects, including in London.[46] In addition, tax incentives are provided, including an exemption of electric vehicles from the Vehicle Excise Duty and the company car tax.[47]

For London, more recent electric mobility policy is based on the Mayor's Electric Vehicle Delivery Plan. This plan establishes a comprehensive set of targets, including the installation of 25,000 public charge points and the introduction of 1,000 electric vehicles into the Greater London Authority vehicle fleet by 2015, with the longer-term goal of having 100,000 electric vehicles on London roads 'as soon as possible'.[48] Supported by national funding together with sponsorship from Siemens, the city established a public charging network, Source London, in early 2011.[49] Additional funding for a charging infrastructure has recently been secured by Transport for London (TfL) and a consortium of public and private actors. To increase uptake of commercial electric vehicles, the city also founded the Mayor's Electric 20, a consortium of organisations that already use electric vehicles in their fleets and facilitates the sharing of information about their experiences. At the borough level, financial benefits for electric vehicles are provided by offering free parking and the use of charging facilities.[50]

4.2.2 Impact

Environmental impacts
London's electric mobility strategy is deeply embedded within the city's overall transport strategy, which has led to significant reductions in transport-related environmental impacts over the last decade. Congestion charging has reduced car use in central London by 16% and CO_2 emissions from vehicles by 19.5%.[51] Car ownership has fallen 6% since 1995, while cycling has doubled and bus use has increased by more than 60% since 2001.[52]

While substantial progress has been made in reducing car use, road vehicles still account for around 80% of transport-related CO_2 emissions, and meeting the city's target of reducing total CO_2 emissions by 60% by 2025 is only likely if the city continues its commitment to electric vehicles.[53] More direct links will also be needed between the electric vehicle strategy and renewable electricity.

Fig. 5: CO_2 emissions per capita in Greater London and UK.

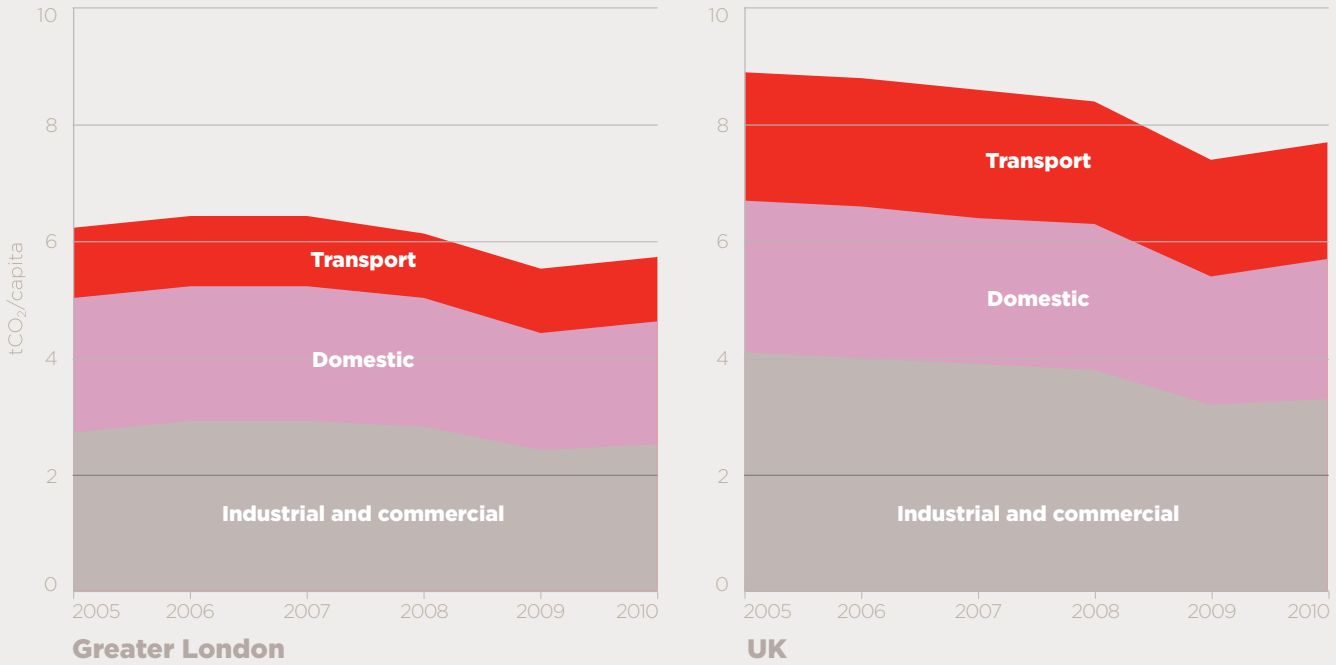


Fig. 5
CO_2 emissions per capita have been decreasing across the UK and London for several years, with significantly lower average emissions per capita in London. Overall, CO_2 emissions from road transport in the UK and London have remained relatively stable, with the exception of a brief recession-induced dip in 2009.[38]

With regard to electrifying road transport, London has been relatively successful compared to other cities, with around 2,300 electric vehicles currently registered in Greater London.[15] There are currently 745 charging points in the city, with a goal of installing 1,300 charging points by 2013 (Figure 4). However, with only 0.08 % of all vehicles in London currently being electric, the goal of 100,000 electric vehicles 'as soon as possible' remains ambitious.[40] Furthermore, the limited integration of London's electric mobility policy with renewable energy strategies risks compromising the role of electric vehicles in reducing carbon emissions.

Economic
London's comparatively long experience with electric vehicles has enhanced the city's reputation as a green technology leader and has positioned it as an attractive test bed for electric mobility. This has attracted businesses to the city and created a variety of economic opportunities: "One of the main advantages of being a first mover is that you gain the attention of industry and manufacturers that may target trials and R&D in your city and you may also feature in some of their longer term investment plans. If these companies didn't think there was potential in London they wouldn't have come here". Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority Daimler started testing its electric Smart on London's streets as early as 2007, and more recently BMW used the Olympics to showcase its range of electric vehicles and launch the world's first fully electric vehicle dealership in the city.[54]

Siemens has chosen London as the site of its new Urban Sustainability Centre, which opened this summer in East London's Green Enterprise Zone and showcases the company's electric charging technology.[55] "We want to be in a position to offer a complete urban transport management system that will, we believe, include electric vehicles." Mark Bonnor-Moris, Head of Electromobility, Siemens UK However, directly related manufacturing of vehicles or charging infrastructure has not taken place in London so far and "most of the job creation at this stage is at a very small scale and has been around the knowledge economy of the trials and charge point installation and maintenance". Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

Capitalising on this existing knowledge infrastructure has helped to reinforce London's position as a leading clean technology hub. In East London's rapidly growing 'Tech City' – a business cluster of more than 3,000 digital economy firms[56] – this trend is starting to take shape, with an increasing number of firms involved in the green tech and intelligent city space. Building on existing skills in computer programming and taking advantage of the entrepreneurial spirit in the area, these firms are ideally positioned to innovate at the intersection of new urban mobility and digital technology.

4.2.3 Policy Actors and Partnerships

The London electric mobility programme brings together all three tiers of government, the UK national government, the Greater London Authority (GLA) and London's boroughs. Additional private sector partnerships are primarily linked to the city level, where a large number of companies are contributing to this policy agenda. In addition, advocacy groups such as The Low Carbon Vehicle Partnership have been important in bringing together a wide range of organisations, currently counting more than 200 members from industry and the public sector.[57]

At the national level, the UK Department for Transport and its Office for Low Emission Vehicles (OLEV) have been instrumental in providing financial support for London and individual electric vehicle users. They have also fostered city-level partnerships by using competitive bidding to assign funding across the UK. Furthermore, the Department for Transport is also playing a critical role in encouraging standardization of charging infrastructure. The working relationship between London and national government on electric mobility is good and "there was a common view that this was a policy that we could work together on". Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

At the city level, the GLA and TfL are leading London's electric mobility programme, working together with the boroughs and the private sector. Currently, Source London is among the more significant partnerships and involves direct sponsorship through Siemens, which also supplies the back office infrastructure, IT systems, customer service centre and the registration processing.[49] In addition to installing new charge points, Source London is also helping boroughs retrofit existing charging infrastructure to ensure it is compatible with the Source London technology.[58]

TfL is leading the London consortium of public and private partners involved in the Government's Plugged-In Places (PIP) initiative, which provides match funding from the Department for Transport (up to 50%) for the installation of publicly-accessible electric vehicle charge points for partners in the consortium. At the same time, TfL also provides secretariat services for the London Electric Vehicle Partnership (LEVP), which brings together key stakeholders and decision makers from within the vehicle manufacturing industry, London boroughs, the GLA Group, energy and infrastructure suppliers, and electric vehicle users.[50] More recently, TfL has agreed a new partnership with Chargemaster, a UK based company that is currently rolling-out its POLAR charging network to help the city meets its electric vehicles target by 2013.[59] The city-led Mayor's Electric 20 partnership is also supported by national government and includes UPS, Marks & Spencer, Hertz, Tesco and Veolia among many others.[60]

The city has played an important role in bringing a wide variety of stakeholders together, not just through the Mayor's Electric 20 but also through its direct involvement with a wide range of industries. "We were in a position to talk to the charge point manufacturers and the energy companies. I think the project was fairly unique in that we were dealing with such a wide cross-sectorial group of stakeholders." Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority At the same time, closer collaboration with energy utilities, which are essential for connecting electric mobility with renewable energy strategies, remains more challenging as the UK's utility market is severely fragmented.[45]

Source London charge points

London's Electric Vehicle Delivery plan aims to install 25,000 public charge points across the city by 2015, with an interim goal of 1,300 charge points by 2013. 745 charge points are already in place, the majority of which are part of the Siemens-sponsored Source London network. London's leadership on electric vehicles may help the city in positioning itself as a clean technology hub.

Photo credit: Transport for London

Table 2: Public private partnerships. Electric mobility in London

	Supportive actions	Challenges
City Government (Greater London Authority)	**Leadership and strategy.** Setting specific targets for London's electric vehicle policy and positioning the city as an attractive R&D test bed. Promoting innovation and attracting foreign businesses through public-private partnerships. **Stakeholder engagement.** Facilitating the Source London partnership and coordinating activities of key actors through Mayor's Electric 20.	Preventing long-term investments by private sector due to uncertainty of future policy direction. Providing insufficient information and education on electric mobility to the general public. Neglecting the importance of private and workplace charging in favour of a focus on public charging.
National Government	**Leadership and strategy.** Setting the broader policy context for a move to low-carbon vehicles through the Climate Change Act and related CO_2 reduction targets. Establishing binding targets for renewable energy generation. **Finance.** Providing financial support of £300m (US$480m) through the Plugged-In Places programme and the Plug-In Car grant, as well as funding for R&D into new technologies.	Focussing on conventional resource intense strategies for economic recovery rather than green growth, including electric mobility and carbon reduction measures. Focussing on supporting infrastructure and vehicle purchases without integrating transport strategy with broader renewable energy targets.
Business	**Finance.** Investing in R&D and trials independent from public funding. Sponsoring various aspects of electric mobility infrastructure. **Partnership building.** Collaborating closely with the city, other businesses and research community to accelerate uptake of electric mobility.	Hesitating to embrace electric mobility as part of strategies by energy utilities. Providing only limited support to help the city integrate renewable energy sources with electric mobility.
Research Institution	**Leadership and strategy.** Leading research into new technologies: charging infrastructure, vehicle-to-grid systems and integrated mobility solutions. **Partnership building.** Partnering with private sector on trials and helping to position the city as an attractive R&D centre.	
General public, NGOs and community organisations	**Leadership.** Promoting the uptake of electric vehicles through public information campaigns and lobbying. **Partnership building.** Facilitating communication between city and other networks of stakeholders.	Hesitating to invest in electric vehicles due to high up-front investment and lack of knowledge about incentive programmes. Displaying range anxiety and limited awareness of technological capabilities of electric vehicles.

4.3 Lessons

Electric mobility policy in Berlin and London is still in its infancy and the overview above only covers a few years of experience in establishing several pilot programmes. But this experience already provides some preliminary perspectives and has highlighted some related challenges. There are two major differences in Berlin's and London's approaches to electric mobility. They relate to the integration of electric mobility with renewable energy and the extent to which electric mobility is part of overall urban mobility services.

Renewable energy integration is a central component of Berlin's electric mobility strategy, which also positions the entire policy programme closer to an industrial development strategy. This strategy aims to establish Berlin as a centre for the development and production of smart grid components, renewable energy systems, vehicle-to-grid technology and mobility services. Such a strategy does not exist in London and the integration of renewable energy with electric mobility is a much lower priority: "There was a policy aspiration from the beginning to link renewable energy over time to electric vehicle use. In the short term it's not been possible but it's sort of a medium to longer term aspiration." Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

Commentators also identify a lack of strategic leadership. London needs to ensure that it has a long-term strategy in place that guarantees that its electric mobility infrastructure meets the requirements of its users and remains at the forefront of technological innovation.

Berlin has also focused more on promoting systemic change of urban transport rather than providing subsidies to individual car owners. Through a comprehensive and integrated approach to electric mobility, local partnerships have implemented a mobility card that is transferable between public transport, car sharing and cycle hire. This approach is also acknowledged in London but implementation is lagging behind: "The Oyster Card, Barclay's Bikes and the Source Network have been extremely successful – the next step is to integrate these schemes. Particularly if you are looking at more of a multi-modal strategy, you need to start thinking about transitioning people across different forms of mobility." Mark Bonnor-Moris, Head of Electromobility, Siemens UK In the short term, London will therefore have to focus more on private rather than public charging to facilitate consumer acceptance of privately owned electric vehicles.[61] London's narrower and more pragmatic approach to electric mobility also allowed the city to advance more rapidly with the roll-out of charging infrastructure and electric vehicles.

Regardless of these differences, there are a number of consistent messages that have emerged from implementing both the electric mobility programmes in Berlin and the electric vehicle policy in London.

4.3.1 Leadership

National level policy frameworks are essential.

Germany's federal policy programmes have been the backbone of Berlin's integrated renewable energy and electric mobility agenda, and national level competitive bidding processes have helped foster local partnerships. "Without these programmes, I suppose nothing would have happened and if the German Energy Transformation is no longer supported by the German Federal Government then the electric car sharing topic is dead." Anke Borcherding, Senior Project Manager, E-mobility Projects, Deutsche Bahn Fuhrpark In the UK, the national government has been instrumental in providing financial support for London's electric vehicle strategy and for individual electric vehicle users.

Policy targets send important signals but need to be realistic.

The broader agenda setting by governments at federal and city levels is important, including communicating clear targets such as the 1 million electric vehicles by 2020 for Germany. However, these targets have also been questioned as overly ambitious and any underperformance will be seen as potential failure. One interviewee emphasised that "we started too early saying that our goal is to have 100,000 electric cars in Berlin by 2020." In London, the target of 100,000 electric vehicles 'as soon as possible' is more flexible but is now also regarded as too ambitious.

Electric mobility first mover benefits outweigh disadvantages.

While it can be a challenge, the potential reputational benefits of being a first-mover on electric mobility cannot be underestimated. "Of course there are costs as a first mover because you invest in a business model or technology that is in pilot development and there are a limited number of potential customers." Steffen Sauerbrei, Head of Strategic Planning, Mu by Peugeot But potential reputational benefits are clearly acknowledged: "This programme gives Deutsche Bahn a big chance to reposition itself as a green mobility provider." Anke Borcherding, Senior Project Manager, E-mobility Projects, Deutsche Bahn Fuhrpark There is also a significant trust in large cities as lead markets: "Everything that happens in Berlin will eventually happen somewhere else" Mauricio Sabater, Project Manager, Citroën Multicity And direct benefits related to increasing local investment in the long run are also recognised: "One of the main advantages of being a first mover is that you gain the attention of industry and manufactures that may target trials and R&D in your city and you may also feature in some of their longer term investment plans." Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

Broader implications of electric mobility need to be better understood while acknowledging technological constraints.

In terms of building green economies in cities, one important criticism of electric mobility initiatives is that the electrification of cars is a distraction from the more pressing need to move away from car use in cities altogether. In addition, there are concerns that electric car-sharing schemes would tend to attract public-transport users more than current private car owners, thereby increasing rather than decreasing overall car use. Significant technical barriers, above all battery technology and charging, will also need to be addressed before the full scaling of electric

mobility becomes possible and it can make a significant contribution to a more sustainable urban transport system.

4.3.2 Finance

Major public investments need to be combined with public private partnerships to facilitate the roll-out of electric mobility in cities.

The national governments in Germany and the UK are spending €680m (US$880) and £300m (US$485m) respectively on electric mobility strategies. At the city level, funding has been matched with significant contributions by the private sector. In Berlin, businesses have invested €75m (US$96m) in new infrastructure and technology, including charging points and other auxiliary infrastructure. Partnerships in London with companies such as Siemens and Chargemaster are reducing the financial burden for the city and accelerating the development of the charging network while creating local jobs. "Their investment is critical; we know that as a city we cannot provide all the funding that is needed." Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

4.3.3 Partnership building

Competitive bidding at national level is important for fostering local partnerships.

In Germany, the national bidding process for establishing Electric Mobility Showcases in cities and regions has established effective collaboration between public, private and third party stakeholders even at the bidding stage. Similarly, the UK's national government programmes, such as the Plugged-In Places initiative, have brought together city-level actors to respond to competitive bidding. This was regarded as an important first step in fostering more permanent project partnerships.

City governments play a central role in establishing and supporting electric mobility partnerships.

Having brought together key partners for the competitive bidding process for nationally supported electric mobility strategies, local government in both Berlin and London play an important role in facilitating partnerships. This role does not depend on significant funding, instead working closely with the private sector to drive innovation forward. Creating a space where stakeholders can exchange experiences and learn from each other can be very helpful, as the case of the Mayor's Electric 20 demonstrates. "Once you overcome the initial issue that they were competitors, the fleet managers opened up and it became a useful information exchange for them … our own fleet managers find it useful because it gives them confidence that we are not investing in a technology which is going to become a white elephant." Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority

Consumer acceptance of electric mobility is essential.

While companies are fairly confident that the policy environment will continue to support electric mobility, "the higher business risk is to find enough customers to use the service since it is something that hasn't been offered before." Steffen Sauerbrei, Head of Strategic Planning, Mu by Peugeot "If our customers do not rent electric cars, everything comes to a stand-still." Anke Borcherding, Senior Project Manager, E-mobility Projects, Deutsche Bahn Fuhrpark In London, commentators emphasised that the approach to charging infrastructure has been successful: "The whole Source network is a good idea, it's the most successful scheme in the UK and probably even in Europe in terms of numbers" Mark Bonnor-Moris, Head of Electromobility, Siemens UK But infrastructure alone is not sufficient. There are still many financial and behavioural barriers that prevent the uptake of electric vehicles by the general public. Infrastructure development needs to be complemented by a comprehensive communications effort to increase public awareness and acceptance of electric vehicles.

Barclay's Cycle Hire in London

London is globally recognised as a leader in progressive transport policies, including the introduction of congestion charging, the upgrading of public transport and more recently the promotion of cycling and electric vehicles. Cycling rates in the city have doubled since 2001, a trend that has been accelerated by the introduction of the Barclay's Cycle Hire scheme in 2010. London's position as a 'first mover' in the transport sector is helping to attract businesses trialling new technologies and innovations.

Photo credit: Garry Knight

Endnotes

Introduction

1 UN General Assembly, 2010.
2 UN, 1992
3 ICLEI, 2012.
4 Stern, 2006.
5 Sedgely, Elmslie 2004.
6 Kamal-Chaoui, Robert, 2009.
7 Price Waterhouse Coopers, 2009.
8 UNEP, Bloomberg, 2011.
9 UNEP, 2011.

Land-use and Transport

1 Knoflacher, Rode and Tiwari, 2008.
2 Rydin, 2011.
3 Dimitriou and Gakenheimer, 2009.
4 Newman and Kenworthy, 1989a.
5 Newman and Kenworthy, 1996.
6 ECOTEC, 1993.
7 Houghton, 1995.
8 World Bank, 2002.
9 OECD, 2001.
10 European Commission, 1999a.
11 European Union, 2007.
12 UNEP, 2011.
13 UN Habitat, 2009.
14 European Commission, 1990.
15 World Bank and Gwilliam, 2002.
16 Confederation of British Industry, 2004.
17 Fallah, Partridge and Olfert, 2011.
18 Prud'homme and Lee, 1999.
19 Cervero, 2001.
20 Jenks, Burton and Williams, 1996.
21 Gertz, 1997.
22 Urban Task Force, 1999.
23 Williams, Jenks and Burton, 2000.
24 Cervero, 2003.
25 OECD, 2012.
26 UN Habitat, 2012.
27 City of Copenhagen, 2011a.
28 City of Copenhagen, 2012a.
29 City of Copenhagen, 2012b.
30 Damvad, 2011.
31 City of Copenhagen, 2012c.
32 Economist Intelligence Unit, 2009.
33 OECD, 2009.
34 Urban Audit, 2012.
35 Brookings Institution, LSE Cities and Deutsche Bank Research, 2010.
36 LSE Cities, 2012a.
37 LSE Cities, 2012b.
38 City of Copenhagen, 2012d.
39 Danish Ministry of the Environment, 2007.
40 Interview Tue Rex, 2012.
41 Statistics Denmark, 2009.
42 City of Copenhagen, 2012e.
43 Knowles, 2012.
44 Majoor, 2008.
45 City of Copenhagen, 2011b.
46 City of Copenhagen, 2011c.
47 EuroStat, 2007.
48 Urban Audit, 2012.
49 Newman and Kenworthy, 1989b.
50 Office for National Statistics, 2001.
51 United States Census Bureau, 2010.
52 Ordnance Survey, 2011.
53 Openstreetmap, 2012.
54 Copenhagen Traffic Department, 2010.
55 Naess, Naess, et al., 2009.
56 UITP, 2006.
57 Laconte, 2005.
58 Green Growth Leaders, 2011.
59 Interview Claus Skytte, 2012.
60 Gehl Architects, 2012.
61 Danish Ministry of Transport, 2011.
62 Copenhagen City and Port Development Corporation, 2012.
63 Metroselskabet, 2012.
64 Hong Kong Government, 2007.
65 Economist Intelligence Unit, 2008.
66 Hong Kong Census and Statistics Department, 2011.
67 LSE Cities, 2012c.
68 World Bank, 2012a.
69 Cullinane and Cullinane, 2003.
70 Kam Ng, 1999.
71 Interview Raymond Wong, 2012.
72 Hong Kong Planning Department, 2011.
73 Hong Kong Census and Statistics Department, 2006.
74 Hong Kong Planning Department, 2012a.
75 Hong Kong Information Services Department, 2012.
76 Interview David Tang and Steve Yiu, 2012.
77 Cevero and Murakami, 2008.
78 Tang, Chiang, et al., 2004.
79 Hong Kong Planning Department, 2012b.
80 World Bank, 2012b.
81 Burdett, Taylor and Kaasa, 2011.
82 UITP, 2009.
83 Storper and Venables, 2004.
84 Loh and Kilburn, 2011.
85 MTR Corporation Ltd, 2012.

Buildings and eco-districts

1 UNEP, 2007.
2 UNEP, 2009.
3 McGraw Hill Construction, 2009.
4 IPCC, 2007.
5 UNEP, 2011.
6 Selzter, Smith, Cortright, Bassett, Shandas, 2010.
7 Sustainable Business Oregon, 2011.
8 City of Stockholm, 2012a.
9 City of Stockholm, 2012b.
10 Brookings Institution, LSE Cities, Deutsche Bank Research, 2010.
11 City of Stockholm, 2012c.
12 City of Stockholm, 2012d.
13 City of Stockholm, 2012e.
14 City of Stockholm Executive Office, 2010.
15 Openstreetmap, 2012.
16 City of Stockholm Development Administration, No date.
17 City of Stockholm, 2012f.
18 International Energy Agency, 2008.
19 Boverket, 2011.
20 Svane, Wangel, Engberg, Palm, 2011.
21 Iverot, Brandt, 2011.
22 City of Stockholm, No date.
23 Eurostat, 2012.
24 Interview Martin Skillbäck, 2012.
25 Interview Jan-Ulric Sjögren, 2012.
26 Interview Matilda Gennvi Gustafsson and Rohan Richards, 2012.
27 Interview Marcus Svensson, 2012.
28 Stockholm Royal Seaport, 2012.
29 SymbioCity, 2012.
30 United States Census Bureau, 2012.
31 Oregon Metro, 2011.
32 City of Portland, Multnomah County, 2012.
33 Business Courier, 2011.
34 Metropolitan Policy Program at Brookings, 2011.
35 Cortright, 2007.
36 Cortright, Coletta, 2004.
37 City of Portland, Portland Development Commission, 2009.
38 City of Portland, Multnomah County, 2009.
39 City of Portland, 2012.
40 Portland Sustainability Institute, 2011a.
41 Portland Sustainability Institute, 2011b.
42 Portland Sustainability Institute, 2011c.
43 Portland Sustainability Institute, 2011d.
44 Portland Sustainability Institute, 2011e.
45 Portland Sustainability Institute, 2012a.
46 Museum of the City, 2012.
47 Allen, Potiowsky, 2008
48 City of Portland, 2001.
49 City of Portland, 2005.
50 Interview Dennis Wilde, 2012.
51 Interview Lisa Abuaf, 2012.
52 Community Action Partnership, No date.

53 Interview Alisa Kane, 2012.
54 Portland Sustainability Institute, 2012b.
55 Energy Trust of Oregon, 2011.
56 City of Portland, Portland Development Commission, 2012.
57 Energy Trust of Oregon, 2012.
58 Interview Rick Williams, 2012.
59 Portland Sustainability Institute, 2011f.
60 Portland We Build Green Cities, 2011.
61 Stockholm Vatten, 2012.
62 City of Stockholm, 2012g.

Waste, recycling and energy

1 UNEP, 2012.
2 UNEP, 2011.
3 Baumert, et al., 2005.
4 Brazilian Institute for Geography and Statistics, 2012.
5 Pederzoli, 2012.
6 Brookings Institution, LSE Cities and Deutsche Bank Research, 2010.
7 Mendes, 2012a.
8 Marchal, et al., 2011.
9 Superintendência de Limpeza Urbana, 2011.
10 Dias, 2011.
11 Municipal Government of Belo Horizonte, 1990.
12 Interview Patricia Dayrell, 2012.
13 Interview Aurora Pederzoli, 2012.
14 Dias, et al., 2010.
15 Superintendência de Limpeza Urbana, 2008.
16 Interview Neli de Souza Silva Medeiros, 2012.
17 Caixa Price – Best Practices in Local Governance, 2011.
18 Government of Brazil, 2010.
19 Municipal Government of Belo Horizonte, 2012.
20 Mendes, 2012b.
21 Asja Brazil, 2012.
22 Ethekwini Municipality, 2011a.
23 Municipal Institute of Learning, 2010.
24 Ethekwini Municipality, 2011b.
25 Economist Intelligence Unit, 2011.
26 Imagine Durban Website, 2012.
27 Ethekwini Municipality, 2009.
28 Interview John Parkin, 2012.
29 Ethekwini Municipality, 2011c.
30 Ethekwini Municipality, 2011d.
31 Ethekwini Municipality, 2004.
32 Government of South Africa, 2012.
33 Ethekwini Municipality, 2011e.
34 World Bank, 2006.
35 Clean Development Mechanism Projects, 2009.
36 KPMG International, 2012.
37 Sustainable Cities, 2011.
38 Bond, 2012.
39 Impumelelo Platinum Sustainability Awards, 2010.
40 Contra Odour, 2012.
41 Envitech Solutions, 2012.
42 SLR Consulting, 2011.
43 Global Anti-Incinerator Alliance, 2011.

Electric mobility and renewable energy

1 Pike Research, 2011.
2 Herzog, 2009.
3 European Commission, 2007.
4 Brookings Institution, LSE Cities and Deutsche Bank Research, 2010.
5 Eurostat Urban Audit, 2004.
6 Amt für Statistik Berlin-Brandenburg, 2011.
7 Amt für Statistik Berlin-Brandenburg, 2012.
8 Open Street Map, 2012.
9 Open Charge Map, 2012.
10 Vattenfall, 2012.
11 German Government, 2009.
12 German Government, 2012.
13 Brandenburg Government, 2012.
14 Berlin Government, 2012.
15 IEA, 2012.
16 Interview Friedemann Kunst, 2012.
17 Interview Gernod Lobenberg, 2012.
18 Weiss, et al., 2011.
19 Interview Anke Borcherding, 2012.
20 Knie, et al., 2012.
21 German Government, 2012.
22 German Government, 2012.
23 Berlin Agency for Electromobility, 2012.
24 Berlin Government, 2011.
25 Kolodziej, 2009.
26 Menzel, et al., 2012.
27 Interview Mauricio Sabater, 2012.
28 Interview Steffen Sauerbrei, 2012.
29 German Federal Ministry for the Environment, 2012.
30 Interview Jürgen Varnhorn, 2012.
31 Westervelt, 2012.
32 InnoZ, 2012.
33 Berlin Agency for Electromobility, 2011.
34 Berlin Agency for Electromobility, 2012.
35 RWE, 2012.
36 UK Office for National Statistics, 2011.
37 Greater London Authority, 2009.
38 AEA, 2012.
39 Mayor of London, 2010.
40 Greater London Authority, 2012a.
41 UK Department for Energy and Climate Change, 2011.
42 Source London, 2012a.
43 Ordnance Survey, 2011.
44 Mayor of London, 2009a.
45 Interview Richard McGreevy, 2012.
46 UK Office for Low Emission Vehicles, 2012.
47 UK Automotive Council, 2012.
48 Mayor of London, 2009b.
49 Siemens UK, 2011.
50 Source London, 2012b.
51 Beevers, et al., 2005.
52 Transport for London, 2011.
53 Greater London Authority, 2012b.
54 Masson, 2012.
55 Siemens UK, 2012.
56 Nathan, et al., 2012.
57 Low Carbon Vehicle Partnership, 2012.
58 Source London, 2012.
59 Polar Network, 2012.
60 Source London, 2012c.
61 Interview Mark Bonnor-Moris, 2012.
62 UK Department for Transport, 2011.

List of Interviewees

Lisa Abuaf, Central City and Green Development Manager, Portland Development Commission (17 September 2012)

Mark Bonnor-Moris, Head of Electromobility UK and Ireland, Siemens (21 September 2012)

Anke Borcherding, Senior Project Manager, E-Mobility Projects, Deutsche Bahn FuhrparkService GmbH (18 September 2012)

Clark Brockman, Principal, Sustainability, SERA Architects (17 September 2012)

Patrícia Dayrell, Sanitary Civil Engineer, Superintendência de Limpeza Urbana, Belo Horizonte Municipal Government (13 September 2012)

Matilda Gennvi Gustafsson, Sustainability Director, Ericsson (16 March 2012)

Rita Justesen, Head of City Planning, Copenhagen City & Port Development Corporation (19 September 2012)

Alisa Kane, Green Building Program Manager, City of Portland Bureau of Planning and Sustainability (17 September 2012)

Dr. Friedemann Kunst, Head of Transport Division, Senate Department for Urban Development and the Environment, Berlin Government (27 April 2012)

Gernod Lobenberg, Director, Berlin Agency for Electromobility (2 May 2012)

Richard McGreevy, Transport Policy & Projects Manager, Greater London Authority (24 September 2012)

John Parkin, Deputy Head, Plant & Engineering, Cleansing & Solid Waste Department, eThekwini Municipality (14 September 2012)

Aurora Pederzoli, Chief of Special Programmes, Planning Department, Superintendência de Limpeza Urbana, Belo Horizonte Municipal Government (13 September 2012)

Tue Rex, Planning Consultant, City of Copenhagen (18 July 2012)

Rohan Richards, Senior Strategy Consultant, Ericsson (16 March 2012)

Mauricio Sabater, Project Manager, Citroën Multicity (24 September 2012)

Steffen Sauerbrei, Head of Strategic Planning, Mu by Peugeot (19 September 2012)

Jan-Ulric Sjögren, Project Leader, Energicentrum, Environment and Health Administration, City of Stockholm (18 September 2012)

Martin Skillbäck, Project Manager, Development Department, City of Stockholm (11 September 2012)

Claus Skytte, Head of Project Development, NCC Property Development (12 September 2012)

Neli de Souza Silva Medeiros, President of the REDESOL Cooperative Network and President of COOPERSOLI Barreiro, Belo Horizonte City (21 September 2012)

Marcus Svensson, Business Development Manager, ByggVesta (13 September 2012)

David Tang, Property Director, MTR Corporation (12 September 2012)

Dr. Jürgen Varnhorn, Head of Unit, Technology and Innovation Policy, Senate Department for Economics, Technology and Research, Berlin Government (18 September 2012)

Dennis Wilde, Principal, Gerding Edlen Development (12 September 2012)

Rick Williams, Executive Director, Lloyd Transportation Management Association (LTMA) (13 September 2012)

Raymond Wong, Director of Planning/ Territorial, Hong Kong Planning Department (11 September 2012)

Steve Yiu, Head of Town Planning, MTR Corporation (12 September 2012)

Special thanks to:

Sam Adams, Michael Armstrong, Richard Boon, Elisabet Bremberg, Margaret Chan, Joe Cortright, Radcliffe Dacanay, Isabel Dedring, Signe Gaarde, João Marcelo Horta Mendes, Sônia Knauer, Jacob Korreborg Andersen, Gustaf Landahl, Neil Larat, Florian Lennert, Jimmy Leung, Lars Lindblom, Thøger Lund-Sørensen, Stephan Lützenkirchen, Torsten Malmberg, Mable Mei Bo Lok, Derek Morgan, Neeri Moodley, Leshan Moodliar, Tom Osdoba, Malin Parmander, Martin Powell, Peter Preston, Debra Roberts, Claus Schøsler, Helen Slättman, Gunnar Soderhölm, Louise Tang Pedersen,Denny Thaver, Jonas Tolf, Chris Whyte.

Participating Cities

The following cities have responded and are included in the samples of the main survey or sectoral surveys (Section A).

Aberdeen, United Kingdom
Ahmedabad, India
Ajax, Canada
Amsterdam, Netherlands
Auckland, New Zealand
Austin, USA
Baguio, Philippines
Balikpapan, Indonesia
Barcelona (diputacio), Spain
Barrington, USA
Batangas, Philippines
Belo Horizonte, Brazil
Berkeley, USA
Berlin, Germany
Birmingham, United Kingdom
Bogor, Indonesia
Bogota, Colombia
Bologna, Italy
Boston, USA
Bremen, Germany
Brussels, Belgium
Buenos Aires, Argentina
Cali, Colombia
Cape Town, South Africa
Cleveland, USA
Copenhagen, Denmark
Curitiba, Brazil
Dallas, USA
Dezhou, China
Dublin, Ireland
Durban, South Africa
Edinburgh, United Kingdom
Edmonton, Canada
Ekurhuleni, South Africa
El Paso, USA
Guntur, India
Hamburg, Germany
Hamilton CA, Canada
Hamilton, New Zealand
Helsinki, Finland
Hong Kong, Hong Kong SAR, China
Iloilo, Philippines
Isoko, Nigeria
Jeju, Republic of Korea
Johannesburg, South Africa
Kampala, Uganda
Karachi, Pakistan
Katowice, Poland
Kitchener, Canada
Las Vegas, USA
Lincoln, USA
Liverpool, United Kingdom
London, United Kingdom
Makati, Philippines
Manaus, Brazil
Medellin, Colombia
Melbourne, Australia
Mexico City, Mexico
Montevideo, Uruguay
Montreal, Canada
Muntinlupa, Philippines
Naga, Philippines
New Taipei, Chinese Taipei
New York, USA
Norfolk, USA
Oak Park, USA
Oeiras, Portugal
Oslo, Norway
Paris, France
Philadelphia, USA
Plymouth, United Kingdom
Portland, USA
Quezon, Philippines
Rajkot, India
Raleigh, USA
Reykjavik, Iceland
Riga, Latvia
Rome, Italy
Salt Lake City, USA
San Diego, USA
San Fernando, Philippines
San Francisco, USA
Sao Paulo, Brazil
Seattle, USA
Semarang, Indonesia
Seoul, Republic of Korea
Singapore, Singapore
Sorocaba, Brazil
Stockholm, Sweden
Surat, India
Suwon, Republic of Korea
Tainan, Chinese Taipei
Tokyo, Japan
Toronto, Canada
Vadodara, India
Vancouver, Canada
Washington, USA
Winston-Salem, USA
Zurich, Switzerland

The following cities have been featured in the study of policy programmes (Section B).

Belo Horizonte, Brazil
Berlin, Germany
Copenhagen, Denmark
Durban, South Africa
Hong Kong, Hong Kong SAR, China
London, United Kingdom
Portland, USA
Stockholm, Sweden

Bibliography

AEA for Department of Energy and Climate Change (2012) 'Local and Regional CO_2 Emissions Estimates for 2005-2010'. http://www.decc.gov.uk/en/content/cms/statistics/climate_stats/gg_emissions/laco2/laco2.aspx

Allen, J. H., & Potiowsky, T. (2008) 'Portland's Green Building Cluster. Economic Trends and Impacts' in Economic Development Quaterly, 22(4), 305-315.

Amt für Statistik Berlin-Brandenburg (2011) 'Bevölkerungsstatistiken' Accessed: 8 September 2012. http://www.statistik-berlin-brandenburg.de/Statistiken/inhalt-statistiken.asp

Amt für Statistik Berlin-Brandenburg (2012) Energie und CO_2 Bilanz in Berlin 2009 Statistischer Bericht. Potsdam. http://www.statistik-berlin-brandenburg.de/Publikationen/Stat_Berichte/2012/SB_E04-04-00_2009j01_BE.xls

Andersen, H. T., & Jørgensen, J. (1995) 'Copenhagen' in Cities, 12(1), 13-22. http://www.sciencedirect.com/science/article/pii/026427519591862A

Asja Brazil (2012) 'Clean Development Mechanism: Belo Horizonte Landfill Gas Recovery Project CTRS/BR040' Accessed: 28 September 2012. http://www.asja.biz/subcategoria.php?id=24

Baumert, K., Herzog, T., & Jonathan Pershing (2005) Navigating the numbers: greenhouse gas data and international climate policy. Washington, D.C.: World Resources Institute. http://pdf.wri.org/navigating_numbers.pdf

Beevers, S., & Carslaw, D. (2005) 'The impact of congestion charging on vehicle emissions in London' in Atmospheric Environment, 39, 1-5. http://www.sciencedirect.com/science/article/pii/S1352231004009513

Berlin Agency for Electromobility (2011) Berlin is Going Electric – Action Plan for Electromobility Berlin 2020. www.berlin-partner.de/.../eMO_Aktionsprogramm_en.pdf

Berlin Agency for Electromobility (2012a) 'Zahlen, Daten und Fakten zur Elektromobilität in Berlin-Brandenburg '. Berlin: Obtained through personal communication.

Berlin Agency for Electromobility (2012b) 'Sustainable Mobility of Tomorrow' Accessed: 4 September 2012. http://www.emo-berlin.de/

Berlin Government (2011) Mobility in the City – Berlin Traffic in Figures, 2010 Edition. Berlin: Ministry of Urban Development of the State of Berlin. http://www.stadtentwicklung.berlin.de/verkehr/politik_planung/zahlen_fakten/entwicklung/index_en.shtml

Berlin Government (2012) Bewerbung fuer ein internationales Schaufenster der Elektromobilitaet Berlin-Brandenburg. http://www.emo-berlin.de/index.php?id=87&type=0&jumpurl=uploads%2Fmedia%2FeMO_Schaufenster_Zusammenfassung.pdf&juSecure=1&locationData=87%3Att_content%3A362&juHash=c5f2a9b72746664fcdda30d4689e107202d2e515.

Bond, P. (2012) 'Africa's Biggest Landfill Site: The Case of Bisasar Road'. Le Monde Diplomatique Online. http://mondediplo.com/blogs/africa-s-biggest-landfill-site-the-case

Boverket Swedish National Board of Housing Building and Planning (2011) Energy Management.

Brandenburg Government (2012) 'Renewable Energies' Accessed: 24 September 2012. http://www.mugv.brandenburg.de/cms/detail.php/5lbm1.c.170959.de

Brazilian Institute for Geography and Statistics (2012) 'Belo Horizonte Statistics'. http://www.ibge.gov.br/cidadesat/topwindow.htm?1

Brookings Institution, LSE Cities, & Deutsche Bank Research (2010) Global Metro Monitor: the path to economic recovery Washington D.C./London: Brookings Institution/LSE Cities – London School of Economics and Political Science/Deutsche Bank Research (underlying data supplied by subscription). http://www.brookings.edu/~/media/research/files/reports/2010/11/30-global-metro-monitor/1130_global_metro_monitor

Burdett, R., Taylor, M., & Kaasa, A. (2011) Cities Health and Wellbeing: Hong Kong Urban Age Conference London: LSE Cities, London School of Economics and Political Science. http://downloads0.cloud.lsecities.net/downloads/2011/11/2011_chw_hong-kong-newspaper.pdf

Business Courier (2011) 'Green City Index 2011' Accessed: 28 September 2012. http://www.bizjournals.com/cincinnati/feature/green-city-index-2011.html

Caixa Price – Best Practices in Local Governance (2011) 'Projecto capacitacao de trabalhadores vinculados a associacoes e cooperativas integranted do forum municipal lixo e cidadania de Belo Horizonte' Accessed: 12 September 2012. http://www1.caixa.gov.br/imprensa/imprensa_release.asp?codigo=6611120&tipo_noticia=47

Caspersen, O. H., Konijnendijk, C. C., & Olafsson, A. S. (2006) 'Green space planning and land use: An assessment of urban regional and green structure planning in Greater Copenhagen' in Geografisk Tidsskrift Danish Journal of Geography 106(2), 7-20.

Cervero, R. (2001) 'Efficient Urbanisation: Economic Performance and the Shape of the Metropolis' in Urban Studies, 38(10), 1651-1671. http://usj.sagepub.com/content/38/10/1651.abstract

Cervero, R. (2003) 'Growing Smart by Linking Transportation and Land Use: Perspectives from California' in Built Environment, 29(1), 66-78. http://www.ingentaconnect.com/content/alex/benv/2003/00000029/00000001/art00008

Cevero, R., & Murakami, J. (2008) Rail + Property Development: A model of sustainable transit finance and urbanism. Berkeley: UC Berkeley Center for Future Urban Transport. http://www.its.berkeley.edu/publications/UCB/2008/VWP/UCB-ITS-VWP-2008-5.pdf

City of Copenhagen (2009) Copenhagen Climate Plan: the short version. Copenhagen: City of Copenhagen. http://kk.sites.itera.dk/apps/kk_publikationer/pdf/836_BrgoHzXMK7.pdf

City of Copenhagen (2011a) City of Copenhagen Municipal Plan. Copenhagen: City of Copenhagen, Finance Administration, Center for Urban Development. http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/Greengrowth/Strategy/-/media/2BBC312EB83546408B009C81864D1831.ashx

City of Copenhagen (2011b) Copenhagen: Solutions for Sustainable Cities. Copenhagen: City of Copenhagen, City Hall. http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/-/media/9933EE8E38A547C7B3A3C52BC4CAD89D.ashx

City of Copenhagen (2011c) Good, Better, Best: The City of Copenhagen's Bicycle Strategy 2011-2025. Copenhagen: City of Copenhagen. http://www.kk.dk/FaktaOmKommunen/PublikationerOgRapporter/Publikationer/tmf_publikationer.aspx?mode=detalje&id=823

City of Copenhagen (2011d) Copenhagen City of Cyclists: Bicyle Account 2010. Copenhagen: City of Copenhagen, Technical and Environmental Administration. http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/LivingInCopenhagen/CityAndTraffic/-/media/439FAEB2B21F40D3A0C4B174941E72D3.ashx

City of Copenhagen (2012a) CPH 2025 Climate Plan: short version draft. Copenhagen: City of Copenhagen, Technical and Environmental Administration. http://kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/LivingInCopenhagen/-/media/C0E2947732784C8CBB79BD665354F613.ashx

City of Copenhagen (2012b) 'Population by age and density'. Copenhagen: City of Copenhagen. http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Press/FactsOnCopenhagen/Statistics/Population/PopulationAgeDensity.aspx

City of Copenhagen (2012c) Copenhagen's Green Accounts 2011. Copenhagen: City of Copenhagen, Technical and Environmental Administration. http://kk.sites.itera.dk/apps/kk_publikationer/pdf/873_kR3Q91i6pn.pdf

City of Copenhagen (2012d) 'CO_2-emissions from transport and heat and power consumption in Copenhagen' City of Copenhagen: supplied through personal communication.

City of Copenhagen (2012e) 'Land-use and transport network spatial data' Copenhagen Planning Department/ TetraPlan: supplied through personal communication.

City of Copenhagen (2012f) CPH Carbon Neutral 2025 – Mobility. Copenhagen: City of Copenhagen. http://kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/LivingInCopenhagen/~/media/9003038D2A6F4F6F8E47FD808CEF440F.ashx

City of Copenhagen (2012g) 'Public transport network data' City of Copenhagen Planning DepartmentL: supplied through personal communication.

City of Portland (2001) Green Building Resolution. Portland, Oregon. http://www.portlandoregon.gov/bps/article/211352.

City of Portland (2005) Green Building Resolution. Portland, Oregon. http://www.portlandoregon.gov/bps/article/112681.

City of Portland (2009) Green Building Resolution. Portland, Oregon. http://www.portlandoregon.gov/bps/article/243213.

City of Portland (2012) 'Energy Use in Residential and Commercial Buildings'. Portland, Oregon: Dataset obtained through personal communication.

City of Portland, & Multnomah County (2009) Climate Action Plan 2009. Portland, Oregon: City of Portland Bureau of Planning and Sustainability and Multnomah County Sustainability Program. http://www.portlandoregon.gov/bps/article/268612

City of Portland, & Multnomah County (2012) Climate Action Plan 2009. Year Two Progress Report. Portland, Oregon: City of Portland Bureau of Planning and Sustainability and Multnomah County Sustainability Program.

City of Portland, & Portland Development Commission (2009) Economic Development Strategy. A Five-Year Pland for Promoting Job Creation and Economic Growth. Portland, Oregon. http://pdxeconomicdevelopment.com/docs/Portland-Ec-Dev-Strategy.pdf

City of Portland, & Portland Development Commission (2012) Economic Development Strategy. Three Year Status Report. Portland, Oregon. http://pdxeconomicdevelopment.com/docs/Portland-EcDev-Strategy-3-Year-Status-Report.pdf

City of Stockholm (2012a) 'Statistik om Stockholm. Folkmängd. Översikt. [In Swedish] Statistics in Stockholm. Population. Overview'. Stockholm. http://www.statistikomstockholm.se/index.php/historisk-statistik/befolkning-historisk

City of Stockholm (2012b) 'Population of Stockholm City and County'. Stockholm: Dataset obtained through personal communication.

City of Stockholm (2012c) 'Employment in Stockholm City and County': Dataset obtained through personal communication.

City of Stockholm (2012d) 'Utsläpp av växthusgaser (In Swedish: Greenhouse Gas Emissions)' Accessed: 24th April 2012. http://miljobarometern.stockholm.se/key.asp?mo=1&dm=1&nt=2

City of Stockholm (2012e) 'The Stockholm Environment Programme 2012-2015'. Stockholm. http://international.stockholm.se/PageFiles/135805/The%20Stockholm%20Environment%20Programme%202012-2015.pdf

City of Stockholm (2012f) 'District heating and Cooling' Accessed: 1st October 2012. http://international.stockholm.se/Stockholm-by-theme/Professional-study-visits/6-District-heating-and-cooling/

City of Stockholm (2012g) 'Energianvändning per sektor (In Swedish: Energy consumption by sector)' Accessed: 24th April 2012. http://miljobarometern.stockholm.se/key.asp?mo=8&dm=1&nt=1

City of Stockholm (No date) Vision Stockholm Royal Seaport 2030. Stockholm: Stockholm Executive Office.

City of Stockholm Development Administration (No date) Stockholm Royal Seaport. Powerpoint presentation. Stockholm. www.stockholmroyalseaport.com

City of Stockholm Executive Office (2010) Vision 2030. A guide to the Future. Stockholm. http://international.stockholm.se/Global/Om%20Stockholms%20stad/Utveckling/Framtidsguiden_ENG.pdf

City of Stockholm Executive Office (2011) Stockholm – The First European Green Capital. Stockholm.

Clean Development Mechanism Projects (2009) Project 1921: Durban Landfill-Gas Bisasar Road. United Nations Framework Convention on Climate Change.

Community Action Partnership (No date) Clean Energy Works Portland: Broadening Home Energy Retrofit Efforts. http://resources.communityactionpartnership.com/storage/documents/cewp%20case%20study.pdf

Confederation of British Industry (2004) The UK as a place to do business: Is transport holding the UK back? CBI Report. London: Confederation of British Industry.

Contra Odour (2012) 'Our Projects' Accessed: 21 September 2012. http://www.contraodour.co.za/index.htm

Copenhagen City and Port Development Corporation (2012) Copenhagen Growing: The Story of Ørestad. Copenhagen: Copenhagen City and Port Development Corporation. http://www.orestad.dk/Fakta/~/media/Orestad/pdf/Copenhagen-Growing_web.ashx

Copenhagen Planning Department (2012) 'Public transport network spatial data' City of Copenhagen: supplied through personal communication.

Copenhagen Traffic Department (2010) Traffic in Copenhagen 2009. Copenhagen: City of Copenhagen. http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/LivingInCopenhagen/~/media/BF3A66B079AB4ACAA6CA167ECF151EB3.ashx

Cortright, J. (2007) Portland's Green Dividend. Chigago: CEOs for Cities. http://blog.oregonlive.com/commuting/2009/09/pdxgreendividend.pdf

Cortright, J., & Coletta, C. (2004) The Young and the Restless. How Portland Competes for Talent. Impresa Inc. Portland, Oregon: Portland Development Commission.

Cullinane, S., & Cullinane, K. (2003) 'Hong Kong city profile' in Cities, 20(4), 279-288.

Damvad (2011) Green Growth in Copenhagen. Copenhagen: Damvad. http://www.damvad.com/media/41107/green_growth_in_copenhagen.pdf

Danish Ministry of the Environment (2007a) The Copenhagen Finger Plan after the Administrative Reform 2007. Copenhagen: Danish Ministry of the Environment,. http://www.mim.dk/NR/rdonlyres/AD037041-1F8A-4EBE-AAD7-3076CF431087/0/COP15_EP_Thefingerplanafterthereform.pdf

Danish Ministry of the Environment (2007b) Spatial Planning in Denmark. Copenhagen: Ministry of the Environment, Denmark. http://commin.org/upload/Denmark/Spatial_Planning_in_Denmark_2007.pdf

Danish Ministry of Transport (2011) The Ministry of Transport: A brief organisational overview. Copenhagen: Danish Ministry of Transport. http://www.trm.dk/~/media/Files/Publication/English/EUprecidency%202012/Organisational%20overview-netversion.pdf

Department for Energy and Climate Change (2011) Digest of UK Energy Statistics http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx.

Dias, S. (2009) Trajectories and Memories of the Waste and Citizenship Forums – Unique Experiments of Social Justice and Participatory Governance. PhD Thesis, State University of Minas Gerais, Belo Horizonte

Dias, S. (2011) 'Recycling in Belo Horizonte, Brazil – An Overview of Inclusive Programming.' in WIEGO Policy Brief (Urban Policies), 3.

Dias, S., Ijgosse, J., & R.Barros (2010) 'Belo Horizonte City Profile' UN Habitat Solid Waste Management in the World's Cities : Water and Sanitation in the World's Cities 2010. London: Earthscan.

Dimitriou, H. T., & Gakenheimer, R. (2009) Urban transport in the developing world: perspectives from the first decade of the new millenium: Edward Elgar Pub.

Economist Intelligence Unit (2008) Country Profile 2008: Hong Kong London: Economist Intelligence Unit.

Economist Intelligence Unit (2009) European Green City Index: Assessing the environmental impact of Europe's major cities. Munich: Siemens AG Corporate Communications and Government Affairs. http://www.siemens.com/entry/cc/en/greencityindex.htm

Economist Intelligence Unit (2011) 'Durban -South Africa' African Green City Index: Assessing the environmental performance of Africa's major cities Munich: Siemens. http://www.siemens.com/press/en/presspicture/?press=/en/presspicture/2011/corporate_communication/2011-11-african.php

ECOTEC (1993) Reducing transport emissions through planning. London: HMSO.

Energy Trust of Oregon (2011) Annual Report. http://energytrust.org/library/reports/2011_AnnualReport.pdf

Energy Trust of Oregon (2012) 'Public purpose, public results. Delivering cost-effective, lon-term benefits for ratepayers' Accessed: 1 October 2012. http://energytrust.org/about/annual-report/stakeholder.aspx

Envitech Solutions (2012) 'Landfill Gas Management' Accessed: 21 September 2012. http://www.envitech.co.za/index.php?pageID=5

Ethekwini Municipality (2004) Integrated Waste Management Plan for Ethekwini Municipality. . Durban. http://www.durban.gov.za/Documents/CityServices/Cleansing%20and%20Solid%20Waste/Integrated_Waste_Management_Plan.pdf.

Ethekwini Municipality (2009) Sustainable Waste Management Guideline. Durban. http://www.imaginedurban.org/docs/Waste%20web.pdf.

Ethekwini Municipality (2011a) 'Population and Economic Data for Ethekwini Municipality 1990-2011'. Durban: Dataset obtained through personal communication.

Ethekwini Municipality (2011b) Ethekwini Greenhouse Gas Emissions Inventory 2010 Summary Report Durban. http://www.kznenergy.org.za/Common/DownloadFile.aspx?guid=8e4fe8c1-5881-4533-81e9-4f66ce55dd6c

Ethekwini Municipality (2011c) 'Electricity Purchase Data 1990 – 2011'. Durban: Dataset obtained through personal communication.

Ethekwini Municipality (2011d) 'Waste to Landfill Data 2003-2011'. Durban: Dataset obtained through personal communication.

Ethekwini Municipality (2011e) Project Summary Document: Durban Landfill-Gas to Electricity. Durban. http://www.kznenergy.org.za/Common/DownloadFile.aspx?GUID=08a2ed6b-0d05-4a68-b207-701f32639e5a.

Ethekwini Municipality (2012) Draft Integrated Development Plan 2012/2013. Durban. http://www.durban.gov.za/Resource_Centre/IDP/Pages/default.aspx.

European Commission (1990) Green Paper on the Urban Environment. Brussels. http://ec.europa.eu/environment/urban/pdf/com90218final_en.pdf.

European Commission (1999a) European Spatial Development Perspective. Brussels.

European Commission (1999b) The EU Compendium of Spatial Planning – Germany. Luxembourg.

European Commission (2007) 'EU 27 CO_2 emissions by sector'. http://ec.europa.eu/dgs/energy_transport/figures/pocketbook/doc/2007/2007_environment_en.xls

Eurostat (2007) 'Transport in Urban Audit cities – core city, Share of journeys to work by car in Urban Audit cities '. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00089&plugin=1

Eurostat (2012) 'European Statistics' Accesses: 25 September 2012. http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

Eurostat Urban Audit (2004a) 'City Profiles: Berlin' Accessed: 28 September 2012. http://www.urbanaudit.org/CityProfiles.aspx

Eurostat Urban Audit (2004b) 'City Profiles: London' Accessed: 24 September 2012. http://www.urbanaudit.org/CityProfiles.aspx

Eurostat Urban Audit (2012a) 'City Profiles: Copenhagen, Total Resident Population, Larger Urban Zone 2004'. http://www.urbanaudit.org/CityProfiles.aspx

Eurostat Urban Audit (2012b) 'Proportion of Journeys to Work by Bicycle, 2004'. http://www.urbanaudit.org/DataAccessed.aspx

Fallah, B. N., Partridge, M. D., & Olfert, M. R. (2011) 'Urban sprawl and productivity: Evidence from US metropolitan areas' in Papers in Regional Science, 90(3), 451-472. http://dx.doi.org/10.1111/j.1435-5957.2010.00330.x

Federal Ministry for the Environment Conservation and Nuclear Safety (February 2012) Green-Tech Atlas 3.0. Berlin: German Government. http://www.bmu.de/wirtschaft_und_umwelt/downloads/publ/49125.php

First Magazine (2011) 'The Backbone of Hong Kong: Interview with Sir C K Chow, Chief Executive Officer, MTR Corporation'. http://www.firstmagazine.com/DownloadSpecialReportDetail.1176.ashx

Gehl Architects (2012) 'Profile'. Copenhagen: Gehl Architects. http://www.gehlarchitects.com/#/159108/

German Government (2009) Nationaler Entwicklungsplan Elektromobilitaet der Bundesregierung. http://www.bmbf.de/pubRD/nationaler_entwicklungsplan_elektromobilitaet.pdf.

German Government (2012a) 'Energiewende – die Gesetze' Accessed: 22 August 2012. http://www.bundesregierung.de/Content/DE/Artikel/2011/08/2011-08-05-gesetze-energiewende.html

German Government (2012b) Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland. http://www.erneuerbare-energien.de/erneuerbare_energien/datenservice/zeitreihen/doc/45919.php.

German Government (2012c) Fortschrittsbericht der Nationalen Plattform Elektromobilitaet (Dritter Bericht). http://www.bmu.de/files/pdfs/allgemein/application/pdf/bericht_emob_3_bf.pdf.

Gertz, C. (1997) Umsetzungsprozesse in der Stadt- und Verkehrsplanung: Die Strategie der kurzen Wege.

Global Anti-Incinerator Alliance (2011) 'Carbon Trading Prolongs Environmental Racism at Africa's Largest Municipal Dump'. www.no-burn.org/downloads/bisasar.pdf

Government of Brazil (2010) National Solid Waste Policy (7404 – 10). Brasilia. http://www.jusbrasil.com.br/legislacao/1026318/decreto-7404-10.

Government of South Africa (2012) National Waste Management Strategy: South Africa. http://www.pmg.org.za/files/doc/2012/120530strategy.pdf.

Greater London Authority (2009) London Office Policy Review (pp. 213). London. http://www.london.gov.uk/archive/mayor/planning/docs/lopr-2009.pdf

Greater London Authority (2010) 'London secures £17 million funding for UK's largest electric vehicle charge point network'. http://www.london.gov.uk/media/press_releases_mayoral/london-secures-%C2%A317-million-funding-uk%E2%80%99s-largest-electric-vehicle-charge

Greater London Authority (2012a) Charging ahead? An overview of progress in implementing the Mayor's Electric Vehicle Delivery Plan. http://www.london.gov.uk/moderngov/documents/s8512/Appendix%201%20-%20Charging%20Ahead.pdf.

Greater London Authority (2012b) 'Reducing London's carbon footprint' Accessed: 4 September 2012. http://www.london.gov.uk/priorities/transport/vision/strategy/reduce-emissions

Green Growth Leaders (2011) Copenhagen – Beyond Green: The socio-economic benefits of being a green city. http://greengrowthleaders.org/wp-content/uploads/2011/11/CPH-Beyond-Green.pdf

Herzog, T. (2009) World Greenhouse Gas Emissions in 2005 WRI Working Paper. Washington DC: World Resources Institute.

Hong Kong Census and Statistics Department (2006) 'Demographic spatial data from the 2006 Hong Kong Census'. Hong Kong: Hong Kong Census and Statistics Department.

Hong Kong Census and Statistics Department (2011) 'Population and Average Annual Growth Rate, 1981 – 2011,'. Hong Kong: Hong Kong Census and Statistics Department,. http://www.census2011.gov.hk/en/main-table.html

Hong Kong Government (2007) Hong Kong 2030: Planning vision and strategy – final report. Hong Kong: Hong Kong Government, Development Bureau, Planning Department. http://www.pland.gov.hk/pland_en/p_study/comp_s/hk2030/eng/finalreport/pdf/E_FR.pdf

Hong Kong Information Services Department (2012) Hong Kong: the facts – Transport Hong Kong: Hong Kong Information Services Department,. http://www.gov.hk/en/about/abouthk/factsheets/docs/transport.pdf

Hong Kong Planning Department (2011) 'Hong Kong Planning Standards and Guidelines' Accessed: 24 September 2012. http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/index.htm

Hong Kong Planning Department (2012a) 'Land-use and transport network spatial data'. Hong Kong: Dataset obtained through personal communication.

Hong Kong Planning Department (2012b) 'Public transport network spatial data'. Hong Kong: Dataset obtained through personal communication.

Hong Kong Transport Department (2012) 'Coordination of different transport modes' Accessed: 14 September 2012. http://www.td.gov.hk/en/publications_and_press_releases/publications/free_publications/the_third_comprehensive_transport_study/5_coordination_of_different_transport_modes/index.html

Houghton, J. (1995) 18th Report of the Royal Commission on Environmental Pollution: Transport and the Environment. London: Oxford University Press. http://webarchive.nationalarchives.gov.uk/20110322143804/http://www.rcep.org.uk/reports/18-transport/1994-18transport.pdf.

Hui, E. C.-m., & Ho, V. S.-m. (2003) 'Does the planning system affect housing prices? Theory and with evidence from Hong Kong' in Habitat International, 27(3), 339-359.

ICLEI (2012) Local Sustainability 2012: Taking stock and moving forward. Bonn, Germany,: ICLEI Local Governments for Sustainability. http://local2012.iclei.org/fileadmin/files/LS2012_GLOBAL_REVIEW_www.pdf

IEA (2012) 'EV City Case Book – A look at the global electric vehicle movement' www.iea.org/evi/EVCityCasebook.pdf

Imagine Durban Website (2012) 'Vision: Imagining Tomorrow Today' Accessed: 28 September 2012. http://www.imaginedurban.org/Pages/Vision.aspx

Impumelelo Platinum Sustainability Awards (2010) 'Durban Landfill Gas to Electricity Project'. http://impumelelo.org.za/what-we-do/impumelelo-innovations-awards/2010/platinum/durban-landfill-gas-to-electricity-project

Infrastructure Ne.Ws. (2012) 'Durban's waste to energy project receives top honours'. http://www.infrastructurene.ws/2012/08/29/durbans-waste-to-energy-project-receives-top-honours/

InnoZ (2012) 'Electric Mobility Platform – The Idea'. http://www.innoz.de/idee.html?&L=1

International Energy Agency (2008) Energy Policies of IEA Countries. Sweden, 2008 Review. http://www.iea.org/textbase/nppdf/free/2008/sweden2008.pdf

IPCC (2007) Residential and Commercial Buildings. Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Intergovernmental Panel on Climate Change.

Iverot, S. P., & Brandt, N. (2011) 'The development of a sustainable urban district in Hammarby Sjöstad, Stockholm, Sweden?' in Environment, Development and Sustainability, 13(6), 1043-1064.

Jenks, M., & Burgess, R. (2000) Compact cities : sustainable urban forms for developing countries: E. & F.N. Spon.

Jenks, M., Burton, E., & Williams, K. (1996) The Compact City: A Sustainable Urban Form? : E & FN Spon.

Kam Ng, M. (1999) 'Political economy and urban planning: a comparative study of Hong Kong, Singapore and Taiwan' in Progress in Planning, 51(1), 1-90. http://www.sciencedirect.com/science/article/pii/S0305900698000270

Kamal-Chaoui, L., & Roberts, A. (2009) Competitive Cities and Climate Change OECD Regional Development Working Papers (Vol. 2). Paris: OECD.

Knie, A., Kramer, S., Scherf, C., & Wolter, F. (2012) 'E-Carsharing als Bestandteil multimodaler Angebote' in Internationales Verkehrswesen, 64(1/2012), 42-45. http://www.innoz.de/fileadmin/INNOZ/pdf/extern/Knie_etal_IV_01_2012_kpl.pdf

Knoflacher, H., Rode, P., & Tiwari, G. (2008) 'How roads kill cities' in Richard Burdett & Deyan Sudjic (Eds.), The Endless City. London: Phaidon.

Knowles, R. D. (2012) 'Transit Oriented Development in Copenhagen, Denmark: from the Finger Plan to Ørestad' in Journal of Transport Geography, 22, 251-261.

KPMG International (2012) Infrastructure 100: World Cities Edition. Laura Jablonski & Peter Schram. http://www.kpmg.com/Global/en/WhatWeDo/Special-Interests/infra100-world-cities/Pages/infrastructure-world-cities.aspx

Laconte, P. (2005). Urban and Transport Management – International Trends and Practices Paper presented at the International Symposium "Sustainable Urban Transport and City, Shanghai. http://www.ffue.org/PDF/Laconte_Urban_and_transpMgt_Shanghai_2005.pdf

Lau, S. S. Y., Giridharan, R., & Ganesan, S. (2005) 'Multiple and intensive land use: case studies in Hong Kong' in Habitat International, 29(3), 527-546.

Loh, C. K. W., & Kilburn, M. (2011) 'The Costs and Benefits of High Density Urban Living' in Ricky Burdett, Myfanwy Taylor & Adam Kaasa (Eds.), Cities, Health and Wellbeing: HK Urban Age Conference. London: LSE Cities, London School of Economics and Political Science. http://downloads0.cloud.lsecities.net/downloads/2011/11/2011_chw_hong-kong-newspaper.pdf

London Government (2007) ' Press Release: Mayor unveils London Climate Change Action Plan'. http://www.london.gov.uk/media/press_releases_mayoral/mayor-unveils-london-climate-change-action-plan

Low Carbon Vehicle Partnership (2012) 'LowCVP Members' Accessed: 24 September 2012. http://www.lowcvp.org.uk/about-lowcvp/index.asp

LSE Cities (2012a) 'Analysis based on data from Landsat 7 (2009), United States Geological Survey Earth Resources Observation and Science Centre'. London: LSE Cities. http://glovis.usgs.gov/

LSE Cities (2012b) 'Analysis based on spatial demographic data from Danish Census 2009'. London: LSE Cities.

LSE Cities (2012c) 'Analysis based on data supplied by Hong Kong Planning Department'. London: LSE Cities.

Majoor, S. (2008) 'Progressive Planning Ideals in a Neo-liberal Context, the Case of Ørestad Copenhagen' in International Planning Studies, 13(2), 101-117. http://dx.doi.org/10.1080/13563470802291978

Masson, L. (2012) 'London Olympics Shine Light on Electric Cars'. Plug In Cars. http://www.plugincars.com/olympic-games-are-electric-123525.html

Mayor of London (2009a) London's Electric Vehicle Infrastructure Strategy. https://www.sourcelondon.net/sites/default/files/draft%20Electric%20Vehicle%20Infrastructure%20Strategy.pdf.

Mayor of London (2009b) An Electric Vehicle Delivery Plan for London. http://www.london.gov.uk/archive/mayor/publications/2009/docs/electric-vehicles-plan.pdf.

Mayor of London (2010) The Mayor's Economic Development Strategy for London 2010. London. http://www.london.gov.uk/sites/default/files/Economic-Development-Strategy.pdf

McGraw Hill Construction (2009) Water use in buildings: Achieving business performance benefits through efficiency.

Mendes, J. M. H. (2012a) 'Results of the Municipal GHG Emissions Inventory Update 2000 – 2010' Way Carbon. Belo Horizonte.

Mendes, J. M. H. (2012b) 'E-mail Exchange (28 September 2012)'.

Menzel, M., & Constantin Bergander (2012) 'Car Sharing in Berlin im Vergleich'. Motor Talk. http://www.motor-talk.de/news/drivenow-car2go-oder-flinkster-carsharing-im-vergleich-t3982492.html

Metropolitan Policy Program at Brookings (2011) Sizing The Clean Economy. A national and Regional Green Jobs Assessment: The Brookings Institution.

Metroselskabet (2012) Metroselskabet 2011 Annual Report Copenhagen: Metroselskabet I/S. http://intl.m.dk/~/media/Metro/PDF/PDF%202012/Metro-annual-report-2011.ashx

Ministry of Transport (2012) A Greener Transport System in Denmark. Copenhagen: Ministry of Transport, Denmark. http://www.trm.dk/~/media/Files/Publication/English/EUprecidency%202012/A%20greener%20transport%20system-netversion.pdf

MTR Corporation Ltd (2012a) Announcement of audited results for the year ended 31 December 2011. Hong Kong: MTR Corporation. http://www.mtr.com.hk/eng/corporate/file_rep/PR-12-013-E.pdf

MTR Corporation Ltd (2012b) Sustainability Report 2011. Hong Kong: MTR Corporation Ltd,. www.mtr.com.hk/eng/sustainability/2011rpt/sustainabilityreport2011.pdf

Municipal Government of Belo Horizonte (1990) 'Organic Law of the Municipality of Belo Horizonte.' (1990). http://bhz5.pbh.gov.br/legislacao.nsf/42d34f6e3014477e0325679f0041f8fa/1abf7fae53aeb5fd032567a100633dea?OpenDocument

Municipal Government of Belo Horizonte (2012) 'Municipal Urban Cleansing Law (10.534)' (2012). http://portal6.pbh.gov.br/dom/view/jsp/artigo_impressao.jsp

Museum of the City (2012) 'Portland EcoDisctricts' Accessed: 1 October 2012. http://www.museumofthecity.org/topics/city?page=9

Naess, P., Naess, T., Nicolaisen, M. S., & Clemens, E. (2009) The challenge of sustainable mobility in urban planning and development in Copenhagen Metropolitan Area – Second Edition. Aalborg: Department of Development and Planning, Aalborg University. http://vbn.aau.dk/files/19642767/download.pdfPT.pdf

Nathan, M. (2012) East London: From tech city to electric city? LSE Cities/Urban Age. London.

Nathan, M., Vandore, E., & Whitehead, R. (2012) 'A Tale of Tech City: The Future of Inner East London's Digital Economy'. London: Demos. http://www.demos.co.uk/publications/ataleoftechcity

Newman, P., & Kenworthy, J. R. (1989a) Cities and automobile dependence : a sourcebook. Aldershot: Gower.

Newman, P. W. G., & Kenworthy, J. R. (1989b) 'Gasoline Consumption and Cities' in Journal of the American Planning Association, 55(1), 24-37.

Newman, P. W. G., & Kenworthy, J. R. (1996) 'The land use—transport connection: An overview' in Land Use Policy, 13(1), 1-22. http://www.sciencedirect.com/science/article/pii/0264837795000275

OECD (2001) Towards a New Role for Spatial Planning: OECD Publishing. http://dx.doi.org/10.1787/9789264189928-en

OECD (2009) OECD Territorial Reviews: Copenhagen, Denmark. Paris: OECD.

OECD (2012) Compact City Policies: A Comparative Assessment OECD Green Growth Studies: OECD Publishing. http://dx.doi.org/10.1787/9789264167865-en

Openstreetmap (2012) 'Public transport network data' Openstreetmap contributors. www.openstreetmap.org

Ordnance Survey (2011) 'Meridian 2 transport network data'. Edinburgh: Digimap. http://edina.ac.uk/digimap

Oregon metro (2011) 'Metro Region and County Population: 1850 to present'. Portland, Oregon. http://www.oregonmetro.gov/index.cfm/go/by.web/id=24905

Pederzoli, A. (2012). Selective Collection with Inclusivity: Belo Horizonte's Project Paper presented at the ICLEI World Congress, Belo Horizonte. http://worldcongress2012.iclei.org/fileadmin/templates/WC2012/Documents/Presentations/C3-Pederzoli.pdf

Peters, D. (2010) 'Speech by Minster of Energy during the official launch of the Durban Landfill Gas to Electricity Clean Development Mechanism (CDM) project, Bisasar Road landfill site, Durban. '. http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=6754&tid=6899

Phang, S.-Y. (2007) 'Urban rail transit PPPs: Survey and risk assessment of recent strategies' in Transport Policy, 14(3), 214-231.

Pike Research (2011) 'Electric Vehicle Charging Equipment Sales to Reach $4.3 Billion Worldwide by 2017'. http://www.pikeresearch.com/newsroom/electric-vehicle-charging-equipment-sales-to-reach-4-3-billion-worldwide-by-2017

Polar Network (2012) 'Chargemaster extends POLAR Network with TfL partnership'. http://www.polarnetwork.com/article/news-polar-news/chargemaster-extends-polar-network-tfl-partnership

Portland Sustainability Institute (2011a) Pilot Report: Gateway EcoDistrict Development. Fiscal year 2010-2011. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/Pilot_Reports/gateway_pilot_report.pdf

Portland sustainability Institute (2011b) Pilot Report: Lloyd EcoDistrict Development. Fiscal year 2010-2011. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/Pilot_Reports/lloyd_pilot_report.pdf

Portland Sustainability Institute (2011c) Pilot Report: South of Market (SoMa) EcoDistrict Development. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/Pilot_Reports/southofmarket_pilot_report.pdf

Portland Sustainability Institute (2011d) Pilot Report: South Waterfront EcoDistrict Development. Fiscal year 2010-2011. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/Pilot_Reports/southwaterfront_pilot_report.pdf

Portland Sustainability Institute (2011e) Pilot Report: Foster Green EcoDistrict Development. Fiscal year 2010-2011. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/Pilot_Reports/fostergreen_pilot_report.pdf

Portland Sustainability Institute (2011f) Annual Report. The Future: Green Cities. Portland, Oregon. http://www.pdxinstitute.org/images/posi_publications/PoSI_AnnualReport.pdf

Portland Sustainability Institute (2012a) 'Eco-district Maps' 1 October 2012. http://www.pdxinstitute.org/index.php/ecodistricts

Portland Sustainability Institute (2012b) 'EcoDistricts, Building Blocks of Sustainable Cities' Accessed: 12 September 2012. http://www.pdxinstitute.org/index.php/ecodistricts

Portland We Build Green Cities (2011) ' 1 October 2012. http://www.webuildgreencities.com/

Price Waterhouse Coopers (2009) Carbon Taxes vs Carbon Trading: pros, cons and the case for a hybrid approach: Price Waterhouse Coopers,. http://www.ukmediacentre.pwc.com/content/detail.aspx?releaseid=3133

Prud'homme, R., & Lee, C.-W. (1999) 'Size, Sprawl, Speed and the Efficiency of Cities' in Urban Studies, 36(11), 1849-1858. http://usj.sagepub.com/content/36/11/1849.abstract

Rabinovitch, J. (1992) 'Curitiba: towards sustainable urban development' in Environment and Urbanization, 4(2), 62-73.

RWE (2012) 'Map of RWE charging stations across Germany' Accessed: 4 September 2012. https://www.rwe-mobility.com/web/cms/de/1195202/emobility/rwe-ladesaeulenfinder/

Rydin, Y. (2011) The Purpose of Planning: Creating Sustainable Towns and Cities: Policy Press. http://books.google.co.uk/books?id=FFP3NKh9jO4C

Sedgley, N., & Elmslie, B. (2004) 'The Geographic Concentration of Knowledge: Scale, Agglomeration, and Congestion in Innovation Across U.S. States' in International Regional Science Review, 27(2), 111-137. http://irx.sagepub.com/content/27/2/111.abstract

Selzter, E., Smith, T., Cortright, J., Bassett, E. M., & Shandas, V. (2010) Making Eco-districts: concepts and Methods for Advancing Sustainability in Neighborhoods. Portland, Oregon. http://www.pdx.edu/sites/www.pdx.edu.usp/files/Bullitt%20Foundation%20Paper.pdf

SERA Architects (2011) Gateway Ecodistrict Assessment. Portland, Oregon: SERA Architects, Puttman Infrastructure, Brightworks. http://www.sera-architects.com/blog/wp-content/uploads/2011/11/101411_Gateway-EcoDistrict-Assessment-FINAL-Report-SM.pdf

SERA Architects (2012) Foster Green EcoDistrict Assessment. Portland, Oregon: SERA Architects, Puttman Infrastructure, Brightworks.

Siemens UK (2011) 'Siemens helps to put London at the forefront of the electric vehicle revolution'. http://www.siemens.co.uk/en/news_press/index/news_archive/forefront-of-electric-vehicle-revolution-source-london.htm

Siemens UK (2012) 'The Chrystal Website' Accessed: 24 September 2012. http://www.thecrystal.org/_html/index.html

SLR Consulting (2011) 'SLR acquires fourth international company in 18 months'. http://www.slrconsulting.com/news_stories/slr-acquires-fourth-international-company-in-18-months

Source London (2012a) 'Source London Charge Point Map' Accessed: 28 September 2012. https://www.sourcelondon.net/map.php

Source London (2012b) 'Greater London Authority Group' Accessed: 14 September 2012. https://www.sourcelondon.net/greater-london-authority-group

Source London (2012c) 'London Local Authorites' Accessed: 24 September 2012. https://www.sourcelondon.net/london-local-authorities

Source London (2012d) 'Mayor's Electric 20' Accessed: 14 September 2012. https://www.sourcelondon.net/mayors-electric-20

Statistics Denmark (2009) 'Demographic and spatial data from the 2009 Danish Census'. Copenhagen: Statistics Denmark.

Stead, D. (2007) 'Transport energy efficiency in Europe: Temporal and geographical trends and prospects' in Journal of Transport Geography, 15(5), 343-353.

Stern, N. (2006) Stern Review on the Economics of Climate Change. London: HM Treasury. http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/stern_review_report.htm

Stockholm Royal Seaport (2012) 'Stockholm Royal Seaport' Accessed: 13 February 2012. www.stockholmroyalseaport.com

Stockholm Vatten (2012) 'Water Rates and Consumption, Stockholm Water'. Stockholm: Dataset obtained through personal communication.

Storper, M., & Venables, A. J. (2004) 'Buzz: face-to-face contact and the urban economy' in Journal of Economic Geography, 4(4), 351-370. http://joeg.oxfordjournals.org/content/4/4/351.abstract

Strumsky, D., Lobo, J., & Fleming, L. (2004) Metropolitan Patenting, Inventor Agglomeration and Social Networks: a tale of two effects. Los Alamos, NM,: Los Alamos National Laboratory,.

Superintendência de Limpeza Urbana (2008) Annual Report 2008 of the SLU. Belo Horizonte, Brazil.

Superintendência de Limpeza Urbana (2011) 'Timeseries waste data 1975-2011' Statistics Section. Belo Horizonte.

Sustainable Business Oregon (2011a) 'Anderson: EcoDistricts tap into neighborhood energy' 24 September 2012. http://www.sustainablebusinessoregon.com/articles/2011/10/anderson-ecodistricts-tap-into.html?page=all

Sustainable Business Oregon (2011b) 'Cole: Leverage scale for EcoDistricts ' 24 September 2012. http://www.sustainablebusinessoregon.com/articles/2011/10/cole-leverage-scale-for-ecodistricts.html?page=3

Sustainable Cities (2011) 'Durban: Powered by Waste'. http://sustainablecities.dk/en/city-projects/cases/durban-powered-by-waste

Svane, Ö., Wangel, J., Engberg, L. A., & Palm, J. (2011) 'Compromise and learning when negotiating sustainabilities: the brownfield development of Hammarby Sjöstad, Stockholm' in International Journal of Urban Sustainable Development, 3(2), 141-155. http://www.tandfonline.com/doi/abs/10.1080/19463138.2011.620959#tabModule

SymbioCity (2012) 'SymbioCity, Sustainability by Sweden' Accessed: 2 September 2012. http://www.symbiocity.org/

Tang, B., Chiang, Y., Baldwin, A., & Yeung, C. (2004) Study of the Integrated Rail-Property Development Model in Hong Kong: Hong Kong Polytechnic University.

Tang, S., & Lo, H. K. (2008) 'The impact of public transport policy on the viability and sustainability of mass railway transit – The Hong Kong experience' in Transportation Research Part A: Policy and Practice, 42(4), 563-576.

Transport for London (2011) 'Bus Travel in London highest in 50 Years'. http://www.tfl.gov.uk/corporate/media/newscentre/archive/20391.aspx

UITP (2006) Mobility in Cities Database. Brussels: International Association of Public Transport.

UITP (2009) 'Media Backgrounder: Public Transport and CO_2 Emissions' Accessed: 12 September 2012. http://www.uitp.org/news/pics/pdf/MB_CO23.pdf

UK Automotive Council (2012) 'Low Carbon Techonology – Grants and Incentives' Accessed: 14 September 2012. http://www.automotivecouncil.co.uk/low-carbon-technology/grants-and-incentives/

UK Department for Energy and Climate Change (2011) UK Renewable Energy Roadmap. London. http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/re_roadmap/re_roadmap.aspx.

UK Department for Transport (2011a) 'Household car ownership by region and area type: Great Britain'. London. http://www.dft.gov.uk/statistics/tables/NTS9902

UK Department for Transport (2011b) 'UK Plug In Car Grant ' Accessed: 14 September 2012. http://www.dft.gov.uk/topics/sustainable/olev/plug-in-car-grant/

UK Office for Low Emission Vehicles (2011) Making The Connection –The Plug-In Vehicle Infrastructure Strategy London: Department for Transport. http://assets.dft.gov.uk/publications/making-the-connection-the-plug-in-vehicle-infrastructure-strategy/plug-in-vehicle-infrastructure-strategy.pdf.

UK Office for National Statistics (2001) 'Demographic spatial data'. London: Office for National Statistics. www.census.ac.uk

UK Office for National Statistics (2012a) '2011 Census: Population and household estimates for England and Wales'. http://www.ons.gov.uk/ons/rel/mro/news-release/census-result-shows-increase-in-population-of-london-as-it-tops-8-million/censuslondonnr0712.html

UK Office for National Statistics (2012b) 'Regional Profiles – Key Statistics – London, August 2012' Accessed: 30 August 2012. http://www.ons.gov.uk/ons/rel/regional-trends/region-and-country-profiles/key-statistics-and-profiles---august-2012/key-statistics---london--august-2012.html

UN Habitat (2009) Planning Sustainable Cities – Global Report on Human Settlements 2009. http://www.unhabitat.org/content.asp?typeid=19&catid=555&cid=5607

UNEP (2007) Buildings and Climate Change. Status, Challenges and Opportunities. Geneva: United Nations Environment Programme. http://www.unep.fr/shared/publications/pdf/DTIx0916xPA-BuildingsClimate.pdf

UNEP (2009) Buildings and Climate Change. Summary for Decision-Makers. Geneva: United Nations Environment Programme. http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf

UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. Geneva: United Nations Environment Programme. http://www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx

UNEP (2012) Green Economy Briefing Paper: Metrics and Indicators. Geneva: United Nations Environment Programme. http://www.unep.org/greeneconomy/ResearchProducts/GEBriefingPapers/tabid/79434/language/en-US/Default.aspx

United Nations (1992) 'Chapter 28: Local Authorities' Initiatives in Support of Agenda 21' Earth Summit Agenda 21: The United Nations Programme of Action from Rio: United Nations. http://www.un.org/esa/dsd/agenda21/res_agenda21_28.shtml

United Nations Environment Programme, & Bloomberg New Energy Finance (2011) Global Trends in Renewable Energy Investment 2011. http://fs-unep-centre.org/publications/global-trends-renewable-energy-investment-2011

United Nations General Assembly (2010) Objective and themes of the United Nations Conference on Sustainable Development: Report of the Secretary-General (pp. 3-4). New York: United Nations. http://www.uncsd2012.org/rio20/content/documents/N1070657.pdf

United States Census Bureau (2010) 'Demographic spatial data '. Washington D.C.: US Census Bureau. http://www.census.gov/main/www/access.html

United States Census Bureau (2012) 'Population, 2010 (April 1) estimates base'. Portland, Oregon. http://quickfacts.census.gov/qfd/states/41/4159000.html

Urban Task Force (1999) Towards an Urban Renaissance. London: E and F N Spon.

Vejre, H., Primdahl, J., & Brandt, J. (2007) 'The Copenhagen Finger Plan: keeping a green space structure by a simple planning metaphor' in B Pedroli, A Van Doorn, B De Blust, ML Paracchini, D Wascher & F Bunce (Eds.), Europe's living landscapes. Essays on exploring our identity in the countryside: Landscape Europe, KNNV. www.landscape-europe.net/files/311-328%2520correctie.pdf

Vuk, G. (2005) 'Transport impacts of the Copenhagen Metro' in Journal of Transport Geography, 13(3), 223-233.

Weiss, J., Neumann, A., Kramer, S., Bost, M., & Tobias Cutler (2011) Renewable Energy in Transport in Berlin and Brandenburg. http://www.catch-mr.eu/public/DB_Data/files/Downloads/Kurzfassung_Gutachten_Regionale_Energiepartnerschaften_final_en-1-2.pdf.

Westervelt, E. (2012) 'The Next Silicon Valley? Berlin startups catching up with the hype'. http://www.npr.org/blogs/alltechconsidered/2012/07/09/156486272/the-next-silicon-valley-berlin-startups-catching-up-with-the-hype

World Bank (2006) Africa Region – South Africa Durban Landfill Gas-to-Electricity Project. Washington D.C: World Bank. http://documents.worldbank.org/curated/en/2006/06/6858555/africa-region-south-africa-durban-landfill-gas-to-electricity-project-africa-region-south-africa-durban-landfill-gas-to-electricity-project

World Bank (2012a) 'World Development Indicators: CO_2 emissions (metric tons per capita) – Hong Kong'. Washington D.C.: World Bank. http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

World Bank (2012b) 'World Development Indicators, Road sector gasoline fuel consumption per capita (kg of oil equivalent) – Hong Kong'. Washington D.C.: World Bank. http://data.worldbank.org/indicator/IS.ROD.SGAS.PC

World Bank, & Gwilliam, K. (2002) Cities on the move: a World Bank urban transport strategy review. Washington D.C.: World Bank.

Zhang, M. (2004) 'The Role of Land Use in Travel Mode Choice: Evidence from Boston and Hong Kong' in Journal of the American Planning Association, 70(3), 344-360.

LSE Cities

LSE Cities is an international centre at the London School of Economics and Political Science that carries out research, education and outreach activities in London and abroad. Its mission is to study how people and cities interact in a rapidly urbanising world, focussing on how the design of cities impacts on society, culture and the environment. Through research, conferences, teaching and projects, the centre aims to shape new thinking and practice on how to make cities fairer and more sustainable for the next generation of urban dwellers, who will make up some 70 per cent of the global population by 2050.

LSE Cities is one of a small number of research centres that contribute to LSE's reputation as one of the foremost social science universities in the world. With the support of Deutsche Bank's Alfred Herrhausen Society, the centre builds on the interdisciplinary work of the Urban Age Programme, an international investigation of cities around the world that since 2005 has studied the social and spatial dynamics of metropolitan areas such as Istanbul, São Paulo, Mumbai, Johannesburg, New York City and London.

www.lsecities.net

ICLEI – Local Governments for Sustainability

ICLEI is the world's leading association of cities and local governments dedicated to sustainable development. ICLEI is a powerful movement of 12 mega-cities, 100 super-cities and urban regions, 450 large cities as well as 450 small and medium-sized cities and towns in 84 countries. ICLEI promotes local action for global sustainability and supports cities to become sustainable, resilient, resource-efficient, biodiverse, low-carbon; to build a smart infrastructure; and to develop an inclusive, green urban economy with the ultimate aim to achieve healthy and happy communities.

www.iclei.org

Global Green Growth Institute

GGGI was founded as a non-profit organisation under Korean law in June 2010. It is in a process of converting to an intergovernmental organisation later in 2012. The organization is dedicated to helping government and industry pioneer and diffuse a new model of economic growth, known as "green growth", that simultaneously targets key aspects of economic and environmental performance. These include poverty reduction, job creation and social inclusion as well as mitigation and adaptation to climate change, biodiversity loss and energy and water security.

www.gggi.org

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE