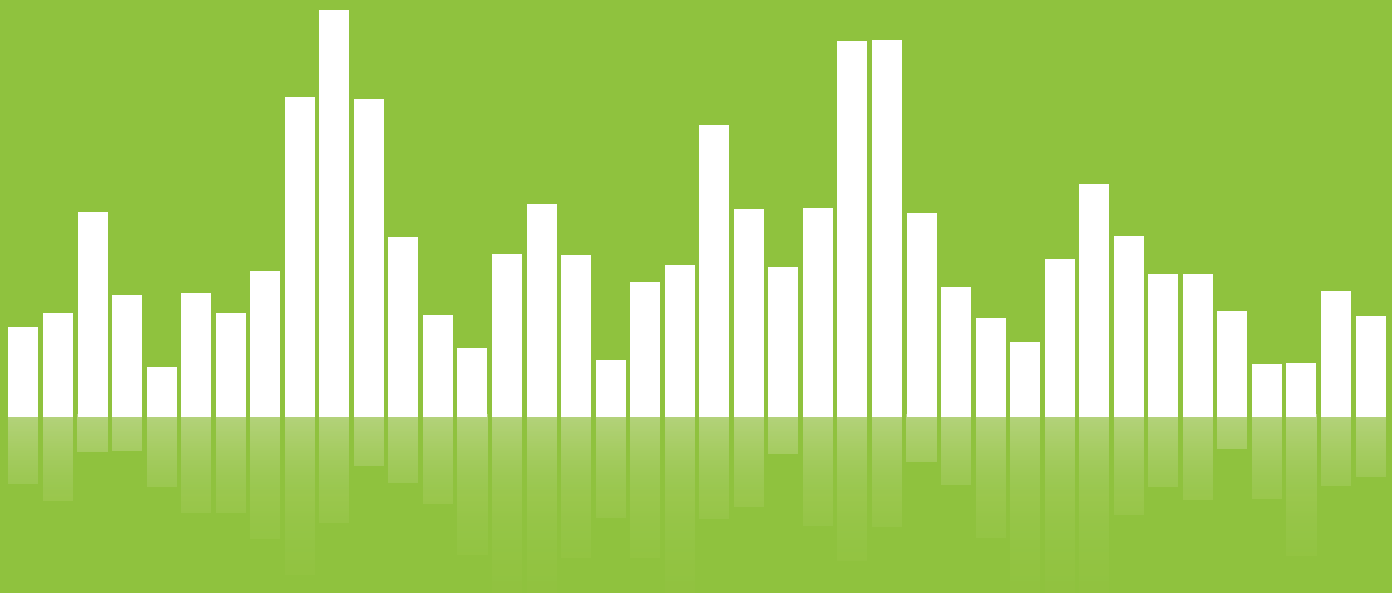
Climate Action in Megacities:

C40 Cities Baseline and Opportunities

Version 1.0 June 2011



40 cities
297 million residents
4,734 climate actions

ARUP

C40 CITIES
CLIMATE LEADERSHIP GROUP

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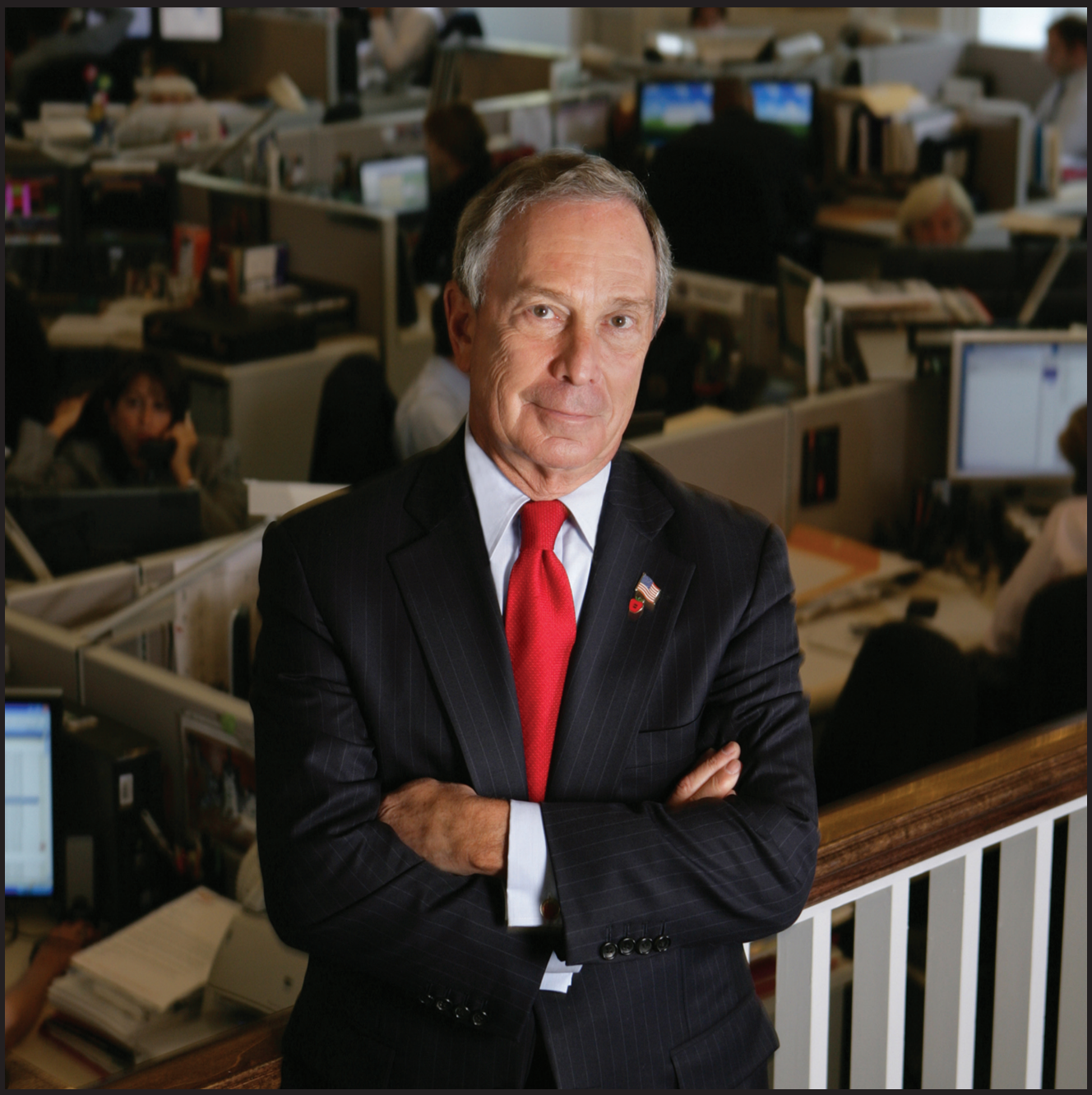


Michael R. Bloomberg, Mayor, City of New York,
Chair, C40 Cities Climate Leadership Group

Cities Act

Five years ago, 40 of the world's leading mayors came together and made a commitment to work collaboratively to address one of the greatest economic, social and environmental challenges of our time. Since then, the urgency to respond to global climate change in urban centers has only increased. And in every respect, our cities continue to be at the forefront of this issue – as innovators and practitioners. Every mayor of every C40 city knows well that we cannot afford to wait for national governments to agree on the right approach to addressing global climate change.

While international negotiations continue to make incremental progress, C40 cities are forging ahead. Acting both locally and collaboratively, cities are making a meaningful global impact by implementing sustainability practices. Each city is unique in its infrastructure, scope of control over municipal services, technical savvy and progress in addressing climate change.

The 58 cities now represented within the C40 account for 8 percent of the global population, 12 percent of global greenhouse gas emissions and 21 percent of global GDP. Our cities control significant economic, environmental and social assets – and have enormous potential to set the framework for a low carbon economy. To date, however, there has been no attempt to measure the true impact of local action, or to capture the value of the C40 network.

The C40 commissioned Arup to co-author this report as the first-ever comprehensive analysis of actions underway in the world's megacities to address climate change. This baseline clearly illustrates the notion that "Cities Act." To date, there are 4,734 actions currently in effect and another 1,465 under consideration.

This study is more than just proof of action, it is also an expression of opportunity. By taking an inventory of mayoral powers, it demonstrates the ability of cities to act today; by supporting knowledge-transfer and collaboration among cities, it enables the C40 to make an even greater impact on climate change going forward.

Clearly, there is no single solution for solving global climate change. However, cities have the ability, capacity and will to lead. This study not only underscores what cities have done to date, but also what they can do now and in the future as local leaders, and as a collective, to have a significant global impact.

EXECUTIVE SUMMARY

Executive Summary

The 40 participating members of the C40 Cities Climate Leadership Group represent 297 million people and generate 18% of global GDP and 10% of global carbon emissions. Collectively they have taken 4,734 actions to tackle climate change. Over three quarters of these actions (74%) have been implemented since the C40 was founded in 2005.

This report is a comprehensive analysis of what the mayors of the C40 participating cities are doing to tackle climate change. Based on a survey of member cities, it analyses the powers, actions and opportunities of the world's 40 premier cities to reduce carbon emissions and adapt to global warming.

It demonstrates that C40 cities have many of the powers necessary to mitigate climate change, and adapt to it. It also demonstrates that the mayors of C40 cities are already using those powers to take action to reduce greenhouse gas emissions – actions that have accelerated rapidly due to the collaboration achieved between cities in the C40. Most importantly, this report demonstrates that the C40 cities have many more opportunities to take action.

1.1 Methodology

The report is based on a survey of the member cities of the C40, conducted between March and April 2011 by Arup on behalf of the C40, with the active support of the staff of the member cities, the C40, and the Clinton Climate Initiative. Quantitative data about the powers, actions and ambitions of C40 cities were collected through interviews with city officials based on a detailed questionnaire. Interviews were supplemented by analysis of official publications and other secondary sources including Arup's own research. Self-reported emissions data was provided by 18 cities through the Carbon Disclosure Project , whose "Measurement for Management" report serves as a companion to this publication.

Data for thirty-six cities was used for analysis in this report.

1.2 C40 cities are important to tackling climate change

The C40 city mayors represent a combined population of 297 million people, are responsible for emitting 2.9 billion tonnes of carbon emissions, and have a combined total GDP of US$10.6 trillion accounting.

When the C40 city mayors choose to take decisive action, particularly if they do it collectively, the potential impact is huge.

1.3 C40 city mayors have the powers to tackle climate change

While many national governments have consistently struggled both at home and on the international stage to take the actions necessary to prevent catastrophic climate change, C40 cities have forged ahead as innovators and leaders in this arena.

Not all problems of global warming can be tackled at a city level. In particular, national governments have to take responsibility for large scale renewable energy generation. But this report demonstrates that C40 city mayors control many of the critical levers needed to dramatically reduce carbon emissions in their cities.

The report analyses the C40 cities' powers, current actions and future plans in nine sectors of activity: transport; existing buildings; waste management; water; energy supply; outdoor lighting; planning and urban land use; and food and agriculture. These sectors are supplemented by three cross-cutting themes: finance and economy, information and communications (ICT) technology, and climate adaptation. Each 'action' taken by cities within these sectors is analysed in relation to the 'scale' of delivery (transformative, significant, or pilot), and the 'levers' utilised to implement them (project / programme, incentive / disincentive or policy / regulation). A high level summary of the key findings for each sector is provided on the following pages.

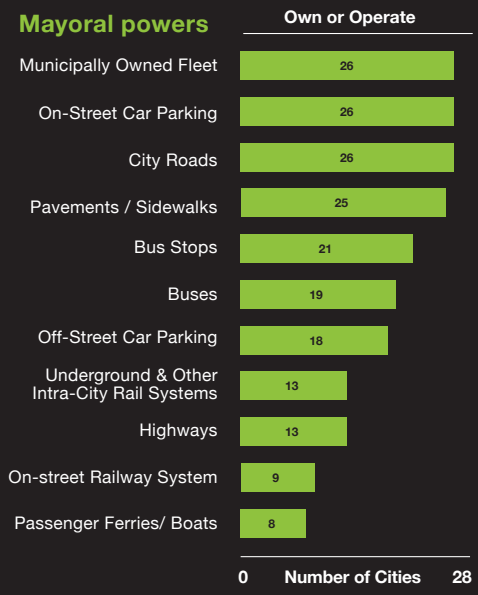
TRANSPORT

C40 cities emit over 300 million metric tonnes of CO_2 per year from the transport sector.

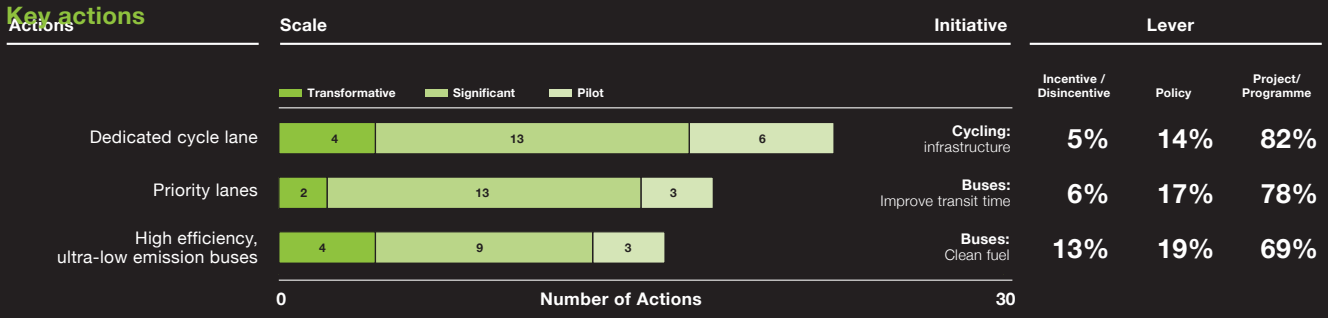
C40 mayors exercise strong powers in the transport sector, in particular through the ownership or operational control of key transport assets and the ability to set and / or enforce regulations.

C40 cities have implemented over 919 actions in the transport sector.

Mayoral powers



Key actions

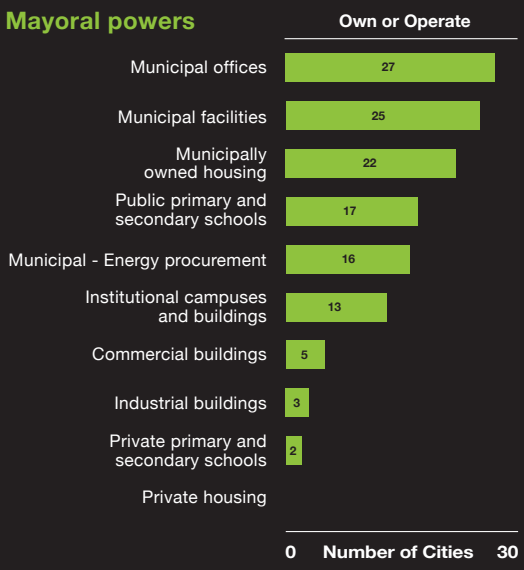


EXISTING BUILDINGS

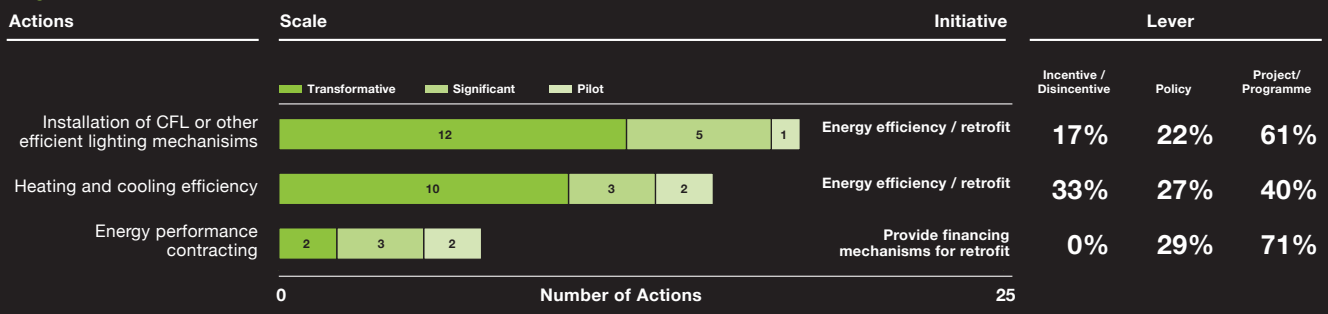
On average, energy used in buildings accounts for 45% of C40 cities' carbon emissions.

Mayoral powers in the building sector are strong among the C40 cities. Twenty-seven city governments own and operate (either in full or partially) municipal office and other buildings and 22 own and operate municipal housing. Seventeen cities reported powers to set policies and enforce regulation over private sector residential and the same number hold regulatory powers commercial buildings. C40 cities have implemented 1,343 actions to reduce carbon emissions from existing buildings.

Mayoral powers



Key actions



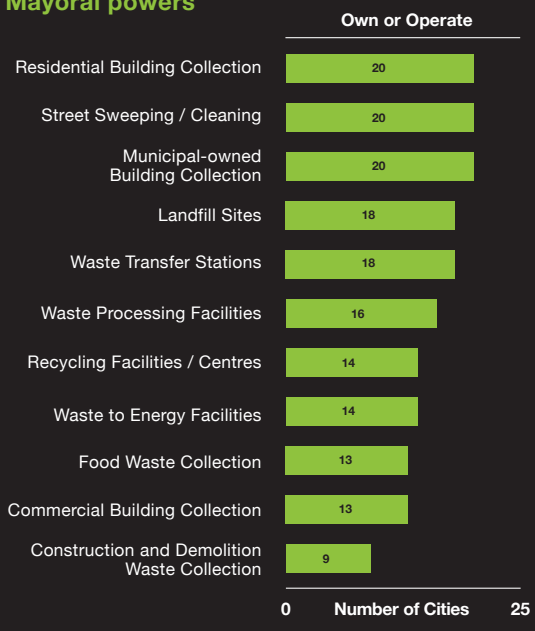
WASTE MANAGEMENT

Globally, waste accounts for around 3% of greenhouse gas emissions.

On average, C40 mayors exercise strong powers over the waste sector, especially over residential and municipal building waste collection, and street cleaning where 20 cities own and operate these functions.

C40 cities have implemented 783 actions to reduce carbon emissions from waste.

Mayoral powers



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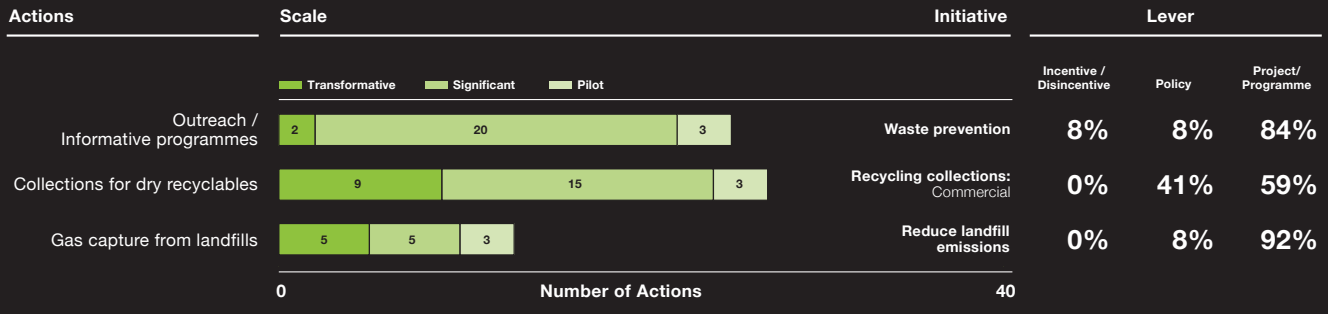
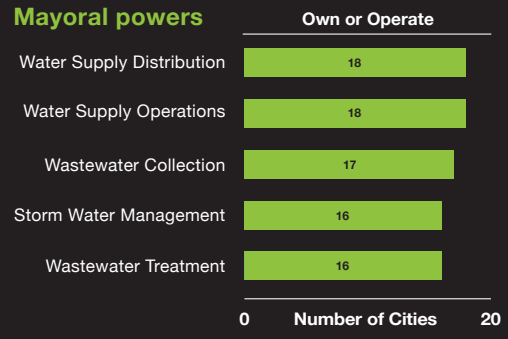


WATER

Average water use per capita per day varies from about 450 litres in USA and Canadian C40 cities to just over 100 litres in African C40 cities.

On average, C40 mayors exercise relatively strong powers over the water sector. The strongest average powers relate to water supply, with 18 cities owning or operating this infrastructure. 16 cities also own or operate wastewater and storm-water infrastructure respectively. C40 cities have implemented 192 actions to reduce carbon emissions in the water sector.

Mayoral powers



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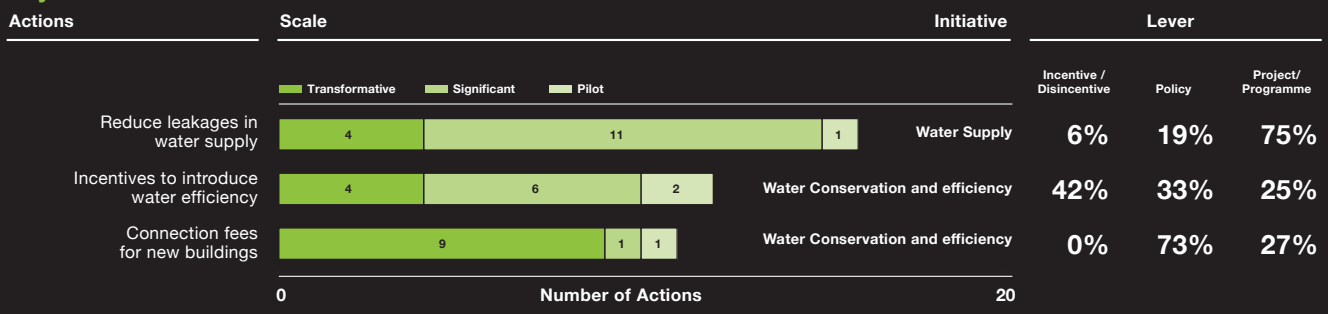


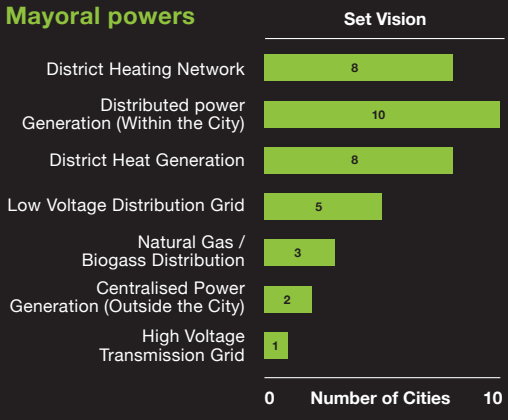
ENERGY SUPPLY

The main sources of greenhouse gas emissions from urban areas are generated by the consumption of fossil fuels.

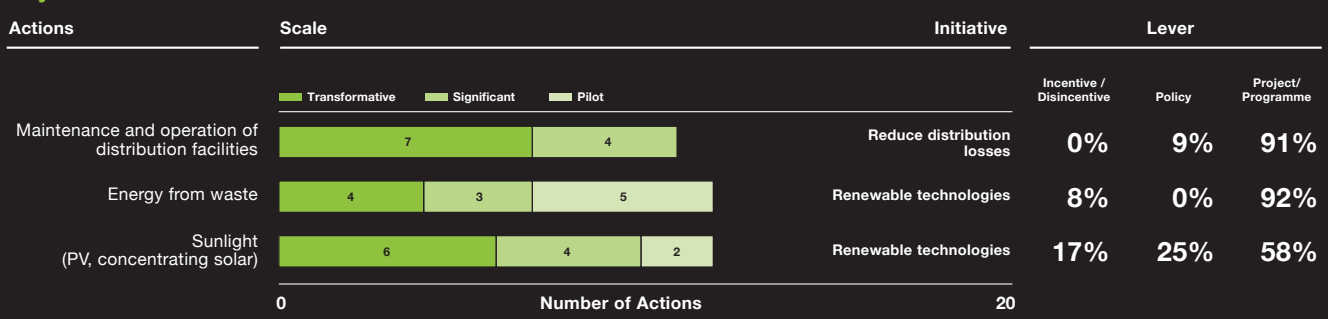
In general, C40 cities did not register strong powers in the energy supply sector, reflecting the fact that most energy supply infrastructure is controlled by state, regional, or central governments. The strongest powers cities reported in this sector are related to the ability to set vision, which can be used to unofficially influence higher levels of government who hold most of these powers.

Nevertheless, C40 cities have implemented 268 actions to create low carbon energy supply.

Mayoral powers



Key actions



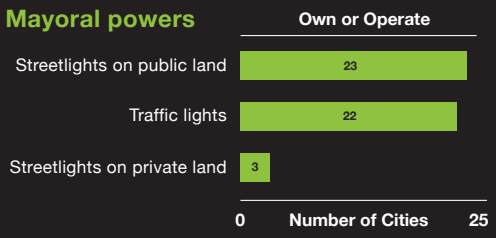
OUTDOOR LIGHTING

Although outdoor lighting (street and traffic lights) is responsible for a relatively low percentage of C40 cities' carbon emissions (less than 1%), it is an area with considerable potential for energy and carbon savings as most existing lighting is inefficient compared with newly available technologies such as LED (Light Emitting Diode) and CFL (Compact Fluorescent Lighting) technology.

C40 mayors have strong powers in the outdoor lighting sector, with 23 and 22 mayors respectively owning or operating public streetlights and traffic lights.

C40 cities have implemented 121 actions relating to outdoor lighting.

Mayoral powers



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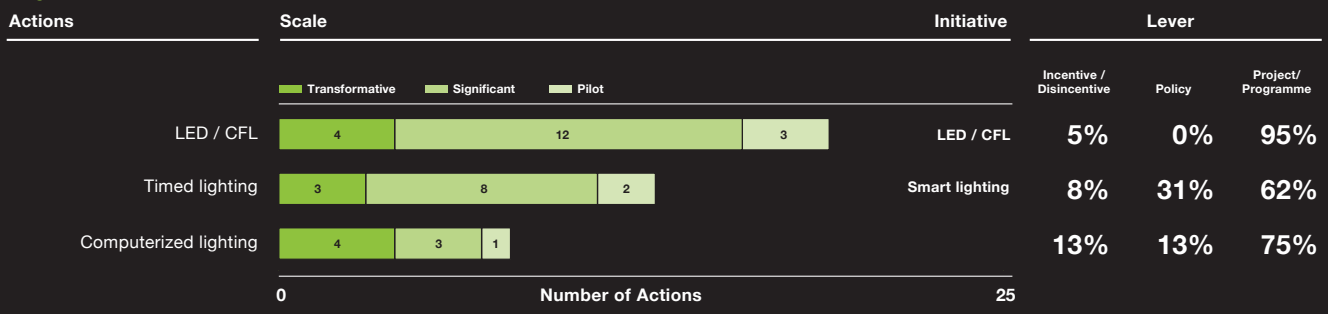


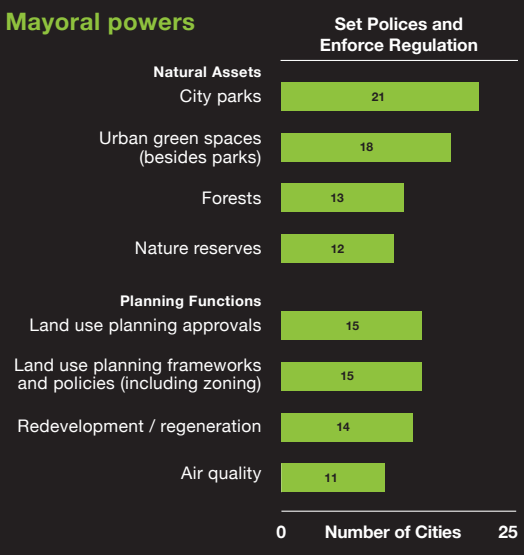
PLANNING AND URBAN LAND USE

Decisions taken today about urban land use can have an impact over many decades. Urban land use and planning powers are also critical tools for mayors to use to adapt their cities to the inevitable and potential impacts of climate change.

Overall, powers in the Planning and Urban Land Use sector are strong among the C40 cities, both over assets related to city greening and biodiversity and over the function of urban planning.

C40 cities have implemented 388 actions related to planning and urban land use.

Mayoral powers



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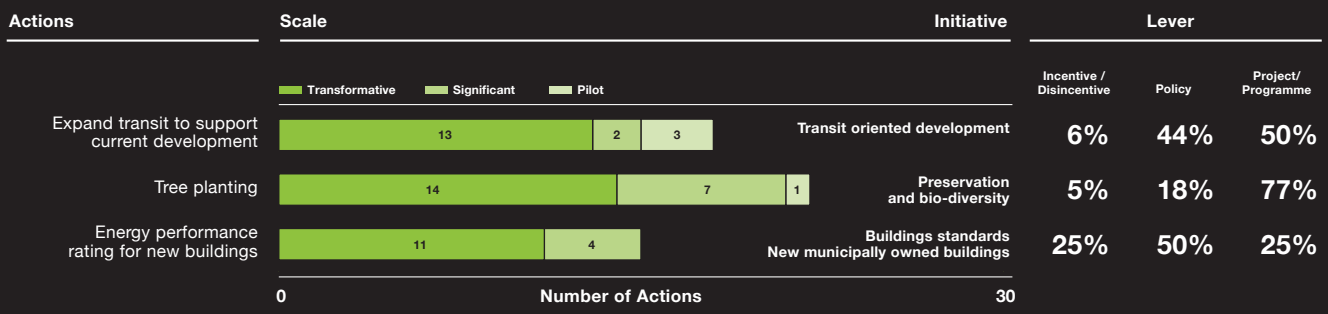


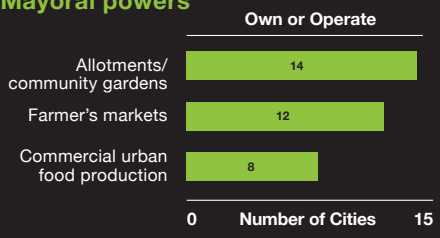
FOOD AND URBAN AGRICULTURE

Globally, agricultural production accounts for 14% of greenhouse gas emissions, with the largest contributor being deforestation, fossil fuel consumption and methane from livestock.

C40 mayors generally have limited powers in this sector, although 14 cities own or operate allotments / community gardens.

97 actions have been implemented by C40 mayors relating to food and urban agriculture, but there is also a relatively high number of actions being expanded or planned for the future, reflecting the increasing interest of C40 cities in this sector.

Mayoral powers



Key actions

Actions	Scale	Initiave	Lever		
	Transformative / Significant / Pilot		Incentive / Disincentive	Policy	Project/ Programme
Community gardens or allotments	7 / 6 / 4	Agriculture	12%	12%	76%
Encourage farmer's markets	10 / 5 / 1	Food distribution	13%	0%	88%

0 Number of Actions 25

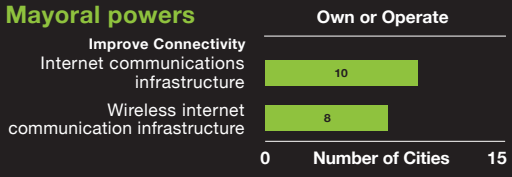
ICT

Information and Communications Technology (ICT) has the potential to transform energy-hungry urban centres into low-carbon 'smart cities' of the future.

Only 10 C40 cities have direct powers over communications infrastructure, reflecting the reality that most ICT infrastructure is owned and operated by the private sector and governed by national and international standards.

C40 cities have implemented 105 actions relating to Information and Communications Technology to date.

Mayoral powers



Key actions

Actions	Scale	Initiative	Lever		
	Transformative / Significant / Pilot		Incentive / Disincentive	Policy	Project/ Programme
Smart card ticketing	5 / 11 / 4	Improve public transport	20%	50%	30%
Real-time transport displays	4 / 6 / 4	Improve public transport	11%	22%	67%
Increase population's access to computers/internet	2 / 8 / 4	Improve connectivity	0%	20%	80%

0 Number of Actions 25

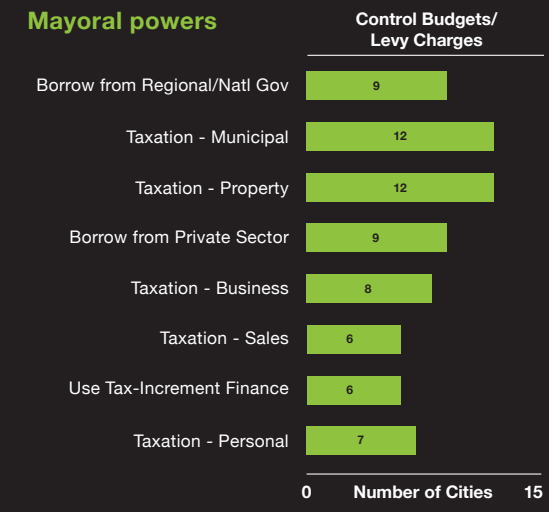
FINANCE AND ECONOMY

Addressing the challenges of climate change - both mitigation and adaption - places a huge financial burden on city governments, many of whom are already responding to the global economic crisis and struggling to provide basic services like health care and education to their residents.

About a quarter of cities have strong powers over municipal and property taxes, with about a third able to borrow funds from central/regional government or from the private sector.

C40 cities have implemented 66 actions to use finance and economic levers to tackle climate change.

Mayoral powers



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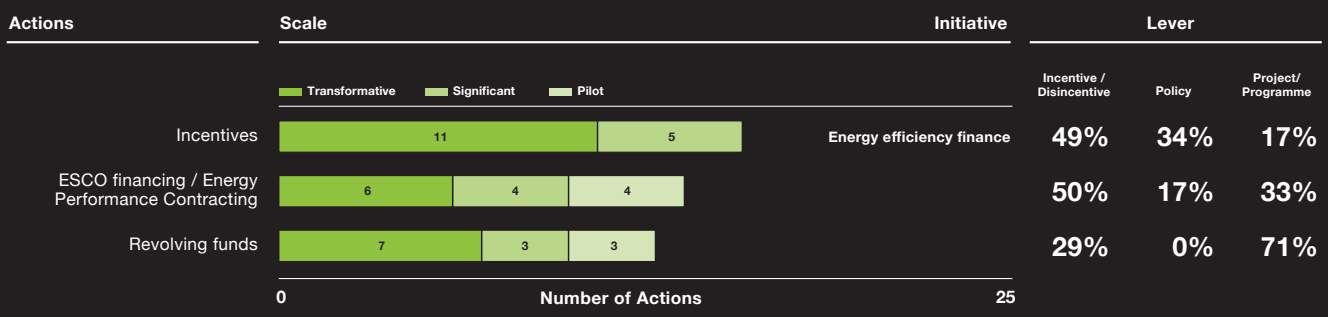


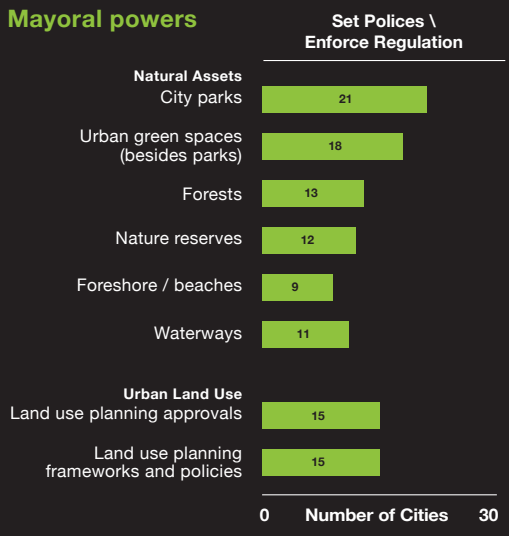
CLIMATE ADAPTATION

The challenges facing cities include: risk of flooding from sea level rise; tropical cyclones; heavy rainfall events; drought; flooding; landslides; extreme heat events and urban heat island.

19 C40 cities have allocated funding for adaptation measures, but only 12 out of 21 responding cities have developed a climate change adaptation plan. Cities have focused strongly on assessing flood risk, which is not surprising given that 90% of C40 cities are located by rivers and lakes or border the coast.

C40 city mayors have implemented 452 actions relating to adapting their cities to climate change.

Mayoral powers



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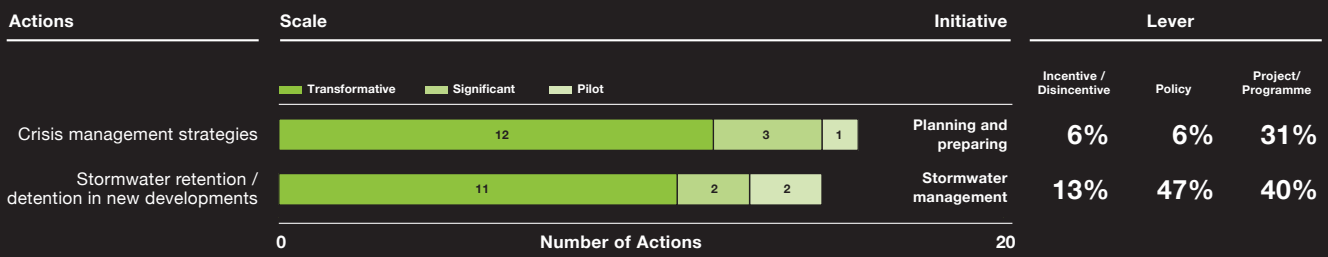
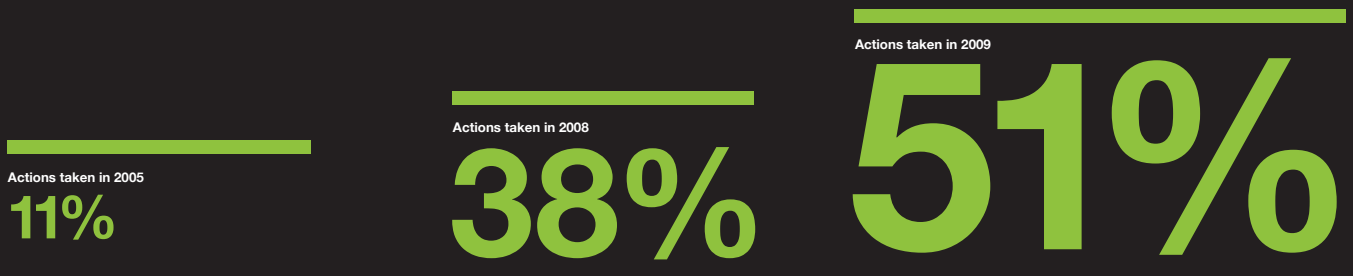




1.4 Collaboration works - the C40 is making a difference

Research for this report demonstrates that the C40 is making a significant difference in improving the scale and speed with which cities take climate action. The table opposite shows the escalation in action among member cities since the C40 was founded in 2005.

Indeed, in the five years since the C40 organisation was founded, cities have worked to transform policies and infrastructure to improve energy efficiency and other resource use. More than 4,734 climate change actions are currently in effect across C40 cities, with a further 1,465 under active consideration today. 335 distinctly different actions, spreading across all sectors, have been taken by at least one city.

1.5 There is considerable opportunity to accelerate climate action across C40 cities

There remains considerable opportunity to accelerate carbon reduction and climate adaptation measures across C40 cities. The table opposite summarises the existing actions C40 cities are planning to expand, as well as the new actions they aim to begin. With an understanding of where mayors have powers and influence, the C40 can help to facilitate the transfer of knowledge and scaling of action.

Actions implemented and planned by C40 cities

Sector	Implemented	Planned Expansion	New Planned
Transport	919	470	248
Existing Buildings	1,343	688	372
Waste Management	783	412	272
Water	192	66	76
Energy Supply	268	147	178
Outdoor Lighting	121	73	33
Planning and Urban Land Use	388	201	67
Food And Urban Agriculture	97	64	10
ICT	105	65	47
Finance and Economy	66	34	43
Climate Adaptation	452	275	119
Total	**4,734**	**2,495**	**1,465**

REPORT OVERVIEW

THIS SECTION PROVIDES SOME OF THE HEADLINE FIGURES FROM THIS RESEARCH EFFORT CARRIED OUT ACROSS THE C40 CITIES

It helps to demonstrate the five key themes of this report:

- C40 cities are important to tackling climate change
- C40 mayors have the power to take climate action
- C40 cities are already taking significant climate action
- Collaboration across the C40 is making a difference
- There is considerable opportunity to do more

C40 CITIES ARE IMPORTANT TO TACKLING CLIMATE CHANGE

People

297 MILLION

Global emissions

CO_2 10%

Global GDP

18%

Mayors own or operate city roads

26

Mayors regulate commercial buildings

17

Mayors own or operate streetlights

23

Mayors own or operate bus services

19

Mayors own or operate residential waste collection

20

Mayors set the vision for distributed energy

10

Mayors set or enforce land use planning approvals

15

C40 MAYORS HAVE THE POWER TO TACKLE CLIMATE CHANGE

BREAKDOWN OF IMPLEMENTED ACTIONS VS LEVERS USED

CITIES ARE USING DIFFERENT LEVERS TO DELIVER ACTION

Project / Programme

58%

Policy / Regulation

28%

Incentive / Disincentive

14%

HIGH GDP C40 CITIES

Project / Programme

50%

Policy / Regulation

30%

Incentive / Disincentive

20%

LOW GDP C40 CITIES

Project / Programme

71%

Policy / Regulation

22%

Incentive / Disincentive

7%

Climate actions

4,734

Actions to cut CO_2 from buildings

1,343

Actions to deliver low carbon transport

919

Cities' cycle lane networks

22

Cities' reducing water supply leaks

16

Cities' retrofitting municipal buildings

23

Cities' solar homes programmes

10

Cities' commercial waste reduction programmes

23

C40 MAYORS ARE ALREADY LEADING ACTION TO TACKLE CLIMATE CHANGE

Measures to generate less CO_2 from waste

783

Bus Rapid Transit systems

13

Low emission streetlight schemes

20

Landfill gas capture schemes

13

Electric car programmes

10

COLLABORATION WORKS, THE C40 IS MAKING A DIFFERENCE

The C40 has helped to accelerate climate action through collaboration.

The majority of climate actions have been implemented by member cities since they have been working together in the C40 from 2005.

Actions taken in 2005/6

11%

Actions taken in 2008/9

38%

Actions taken in 2009/10

Actions planned to cut emissions from buildings

372

Actions planned for low carbon transport

248

Projects to manage waste more carbon efficiently

272

New low carbon energy actions

178

AND THERE ARE OPPORTUNITIES TO DO MORE

METHODOLOGY

This effort analyses the C40 cities' powers, current actions and future plans in nine sectors of activity, each of which correspond to a chapter in this report:

- Transport
- Existing Buildings
- Waste Management
- Water
- Energy Supply
- Outdoor Lighting
- Planning and Urban Land Use
- Food and Agriculture

These categories were supplemented by two cross-cutting themes:

- Information and Communication Technology (ICT)
- Finance and Economy
- Adaptation and Resilience

1.1 REPORT COMPONENTS AND STRUCTURE

Within each sector, we have analysed three key components:

- Major 'initiatives' (which include a number of distinct and supporting climate 'actions')
- Specific 'actions' which are the basic level of climate related efforts by cities for this report
- 'Assets' over which power could be exercised within a 'sector' (for example buses are an asset within the transport sector)

Each sector and cross-cutting theme has its own chapter, each of which follows the same pattern:

- Overview of the sector
- Description of powers of C40 mayors over the sector
- The most frequently implemented initiatives as reported by C40 cities
- Analysis of actions taken within these initiative categories
- The scale at which actions have been taken
- The levers used to implement the various actions
- A summary of key findings
- Summary of actions C40 cities are planning to implement or to expand in the future

1.2 METHOD OF DATA COLLECTION

The report is based on a comprehensive survey (delivered via questionnaire) of C40 participating cities conducted between March and April 2011. The effort was undertaken by Arup on behalf of the C40. The authors of this report would like to express their thanks to the C40 cities, and the staff of the C40 and the Clinton Climate Initiative for their time, expertise and engagement which made this data collection effort possible in such a short space of time.

Data was collected by a team of 46 Arup researchers across 22 global offices. Initial research from existing and available knowledge was utilised to prime the each city's questionnaire with data, and the remaining gaps were filled-in through meetings with city officials, with ongoing follow up communication to complete the survey.

Self-reported carbon emissions data were provided by 18 cities through the Carbon Disclosure Project, whose "Measurement for Management" report serves as a companion to this publication. Where gaps existed, additional feeder research was utilised.

The questionnaire for each city contains 5,931 separate data points. The structure of the questionnaire was divided into four major parts, per sector:

1. Overview data about the sector
2. Powers over assets related to the sector
3. Initiatives and actions related to the sector
4. Any additional information regarding actions or public engagement

By specifying terminology for initiatives and actions we were to be able to synthesize actions between cities for aggregate and intercity analysis. Recognizing that not all local actions can fit under the banner of each specific initiative as asked within the survey, every effort was made to align the questions with pre-existing knowledge of what broad initiatives cities could identify their actions with.

1.3 OVERVIEW DATA

The survey asked 507 baseline data questions, from basic information about the city and Mayor (eg population, GDP, Mayoral budget), to high-level data for each of the sectors under consideration (eg. transport modal split, square meters of built space, waste generated per annum, etc). This data was used to validate the questionnaire responses and to better enable comparisons between cities, which are included throughout the report. Some of the data has been represented throughout the report and in the individual city profiles, which are published as an appendix to the online version of this report.

A detailed write up of the methodology for the data analysis is available in Appendix A.

01.

TRANSPORT

1.1 INTRODUCTION

Globally, transport is the sector where greenhouse gas emissions are rising most quickly. Demand for oil is set to rise from 84.7m barrels per day (bpd) in 2008 to 105m bpd in 2030. The transport sector will account for 97% of this increase, as the global number of road vehicles nearly doubles from just over 1 billion in 2010 to 2 billion in 2020.[1]

The vast majority of C40 cities are feeling the impact of this trend in the form of rising road traffic demand. For example, there are now 6 million vehicles on the roads in Delhi NCT, a number which is increasing at the rate of 1,000 per day.[2]

Mayors have to balance rising desire for mobility, with attempts to reduce congestion and pollution. Based on the findings of this survey, transport is one of the areas where C40 mayors have, on average, the strongest powers and so significant ability to reduce emissions and enable more efficient mobility based on public transportation, walking and cycling, alongside low carbon personal vehicles.

For the purpose of this report, the transport sector has been split into three main categories:

- **Personal Transport Modes and Taxis** – includes initiatives and actions undertaken by cities relating to private cars and motorcycles, taxis, motorised rickshaws, cycling and walking.
- **Passenger Transit within the City** – includes initiatives and actions undertaken in public transport modes: buses, light rail and trams, heavy rail, and passenger ferries and river boats.
- **Passenger and Freight Transport to and from the City** – includes aviation, highways, intercity rail, ports, and freight trucks.

Figure 1.1 shows the breakdown of planned and implemented actions by category of analysis. Actions on passenger (mass) transit within the city are the highest, reflecting the stronger powers of mayors in this area, followed by personal transport modes and taxis.

[1] International Energy Agency estimates – need report date, source
[2] *International Association of Public Transport (UITP): http://www.slideshare.net/jaaaspal/increasing-capacity-on-existing-infrastructure-in-delhi*

FIG 1.1 TRANSPORT: BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED BY C40 CITIES

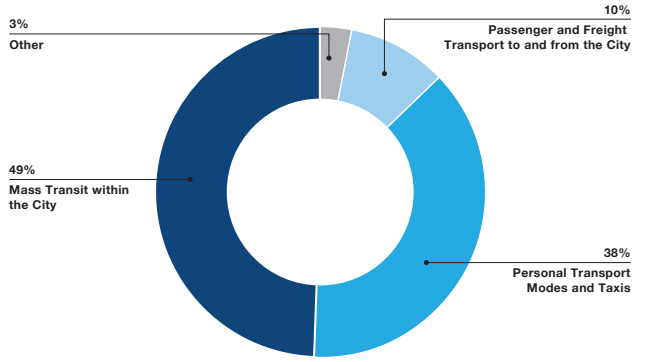


FIG 1.3 TRANSPORT MODAL SPLIT

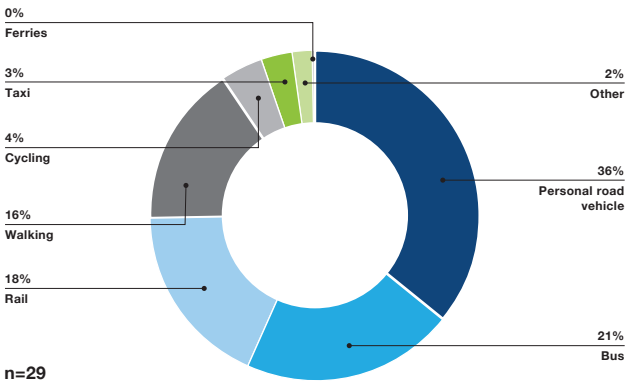


FIG 1.2 TRANSPORT CO_2e EMISSIONS PER CAPITA VERSUS CITY POPULATION DENSITY

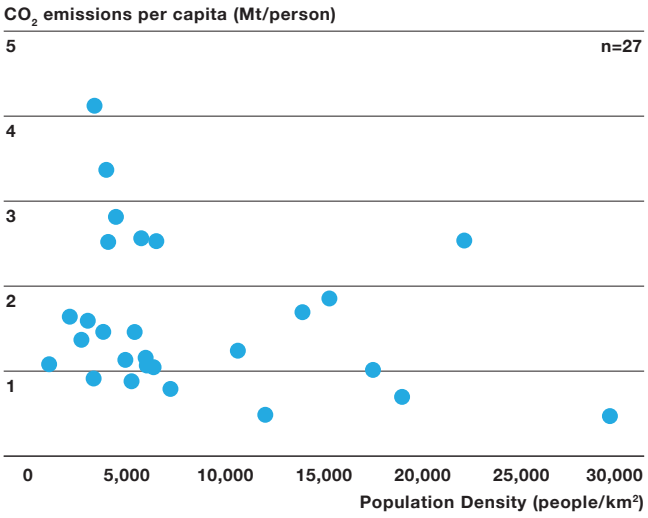
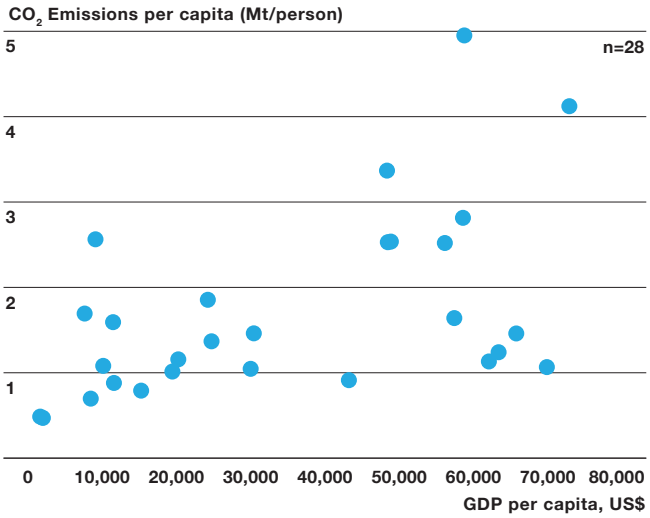


FIG 1.4 PER CAPITA TRANSPORT CO_2e EMISSIONS AVERAGE VERSUS GDP



1.2 OVERVIEW

C40 cities emit over 300 metric tons of CO_2 per year from the transport sector. Seventeen out of thirty-six responding cities, spanning all regions and GDP levels, have in place special CO_2 targets for transport.

1.2.1 Density, GDP and transportation emissions

Figure 1.2 indicates that there is a strong correlation between density and levels of per capita carbon emissions from transport. Generally, cities with higher densities record lower transport emissions and 19 cities have in place 'compact cities' policies for this reason (see Planning and Urban Land Use Chapter X for more details).

There is also a correlation between GDP and per capita emissions from transport in C40 cities (see figure 1.4), however it is not as straightforward. For example, cities such as Hong Kong, New York and London have some of the highest per capita GDPs in the world and yet record relatively low per capita carbon emissions because of their density and extensive public transport systems. But in general, the cities with the highest emissions from transport are among those with the highest GDP, and those with the lowest GDP tend to have lower emissions from transport.

These two sets of figures illustrate that initiatives by C40 mayors, who on average have strong powers over both transport and urban planning, can make a real difference in reducing greenhouse gas emissions from transportation.

1.2.2 Modal split

The modal split (percentage breakdown of trips made using different modes of urban transport) in C40 cities shows strong reliance (59%) on public transport (mass transit), cycling and walking.

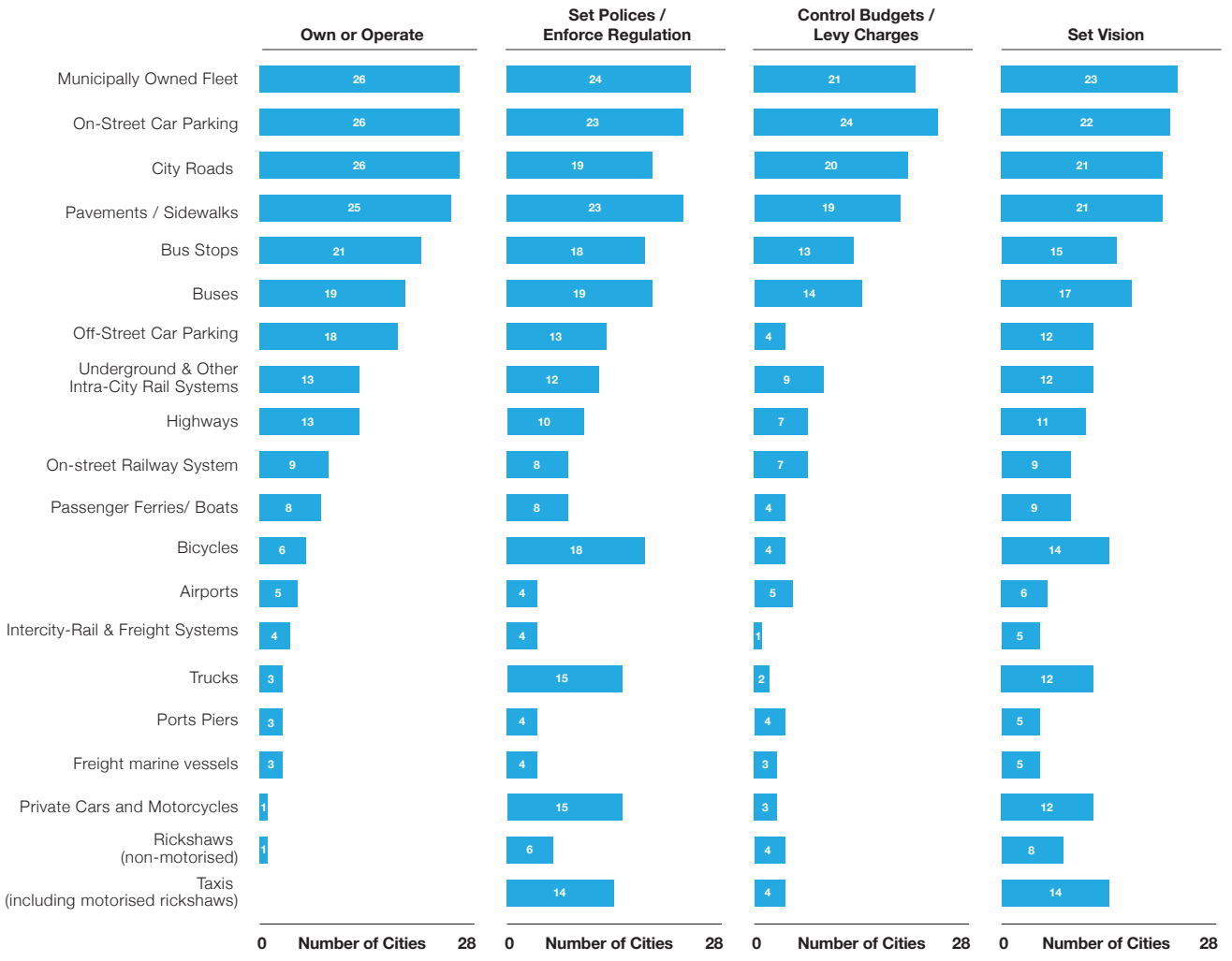
1.3 POWERS

C40 mayors exercise strong powers over the transport sector. Figure 1.5 lists the number of cities that have powers across a typical range of municipal transport assets. It shows the C40 mayors have the strongest powers are over city roads, pavements and sidewalks and on-street car parking. Twenty six city governments enjoy direct ownership and operation of some or all of these three asset sets (25 in the case of pavements / sidewalks), and 27 cities have the power to set and enforce policies across them.

This direct control is critical because it enables mayors to take such steps as introducing cycle lanes, congestion charging (road pricing), bus rapid transit (BRT), and electric vehicle charging infrastructure.
Typically mayors also exercise strong control over the major public transport services and taxis, although this is often through regulation and policy setting rather than direct ownership (with the exception of buses, where 19 mayors own and operate bus services).

Again this is critical because it enables mayors to expand public transport services (mass transit), giving citizens a real alternative to using private road vehicles which tend to have higher carbon emissions and, in excessive numbers, cause traffic congestion and air pollution.

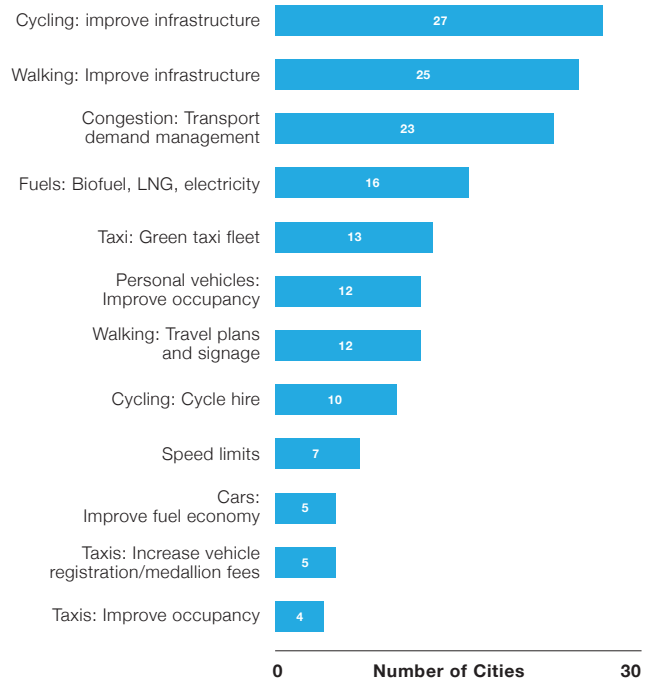
FIG 1.5 C40 MAYORS' POWERS: TRANSPORT



1.4 PERSONAL TRANSPORT MODES AND TAXIS

Figure 1.6 shows the number of cities that have undertaken at least one action under the 13 categories of 'initiative' in the Personal Transport Modes and Taxis section of the survey.

FIG 1.6 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES IN PERSONAL TRANSPORT MODES AND TAXIS?



Cycling infrastructure records the largest number cities delivering actions in any initiative category, followed by improving walking facilities (pavements and sidewalks, pedestrian crossings, pedestrian phases on traffic lights etc), and traffic demand measures. This is consistent with the average powers available to mayors as indicated above – 26 out of 36 mayors have strong control over city roads and pavements (sidewalks).

Within each of the 'initiative' categories in the survey is a large number of possible actions cities could take. Figure 1.7 sets out the findings from the survey, along with an indication of the levers mayors have used to implement these actions.

It is notable that 22 out of 76 cycling infrastructure actions are at the pilot stage, indicating that a significant amount of scaling up of activity is taking place at the moment as a result of the high profile of cycling initiatives within the C40.

The vast majority of actions in this category of initiatives have been delivered as 'projects or programmes', consistent with the fact that mayors can exercise direct control over many of the relevant assets. The one exception to this rule is in relation to transport demand management, where a variety of policies, incentives / disincentives, and programmes have been utilised.

1.4.1 Findings in focus: Personal Transport and Taxis

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and / or there is significant scope for scaling up activity.

One can see that, while there have already been a lot of 'transformative' initiatives, there is considerable scope to scale-up actions. In many cases, cities are starting pilot projects of initiatives that have already proved a success in other C40 member cities. This is particularly true in areas where mayors have weaker powers, such as attempts to encourage a shift to hybrid and electric vehicles, but also in relation to many of the cycling infrastructure projects where mayors do have strong powers, but considerable expansion is planned.

Because of their direct control of relevant assets such as roads and pavements, mayors are able to deliver most actions through direct projects and programmes, although many are also backed up by policy / regulation. The use of financial incentives / disincentives is more selective, for example the use of registration fees that vary depending on vehicle efficiency, congestion pricing, and incentives to switch to hybrid vehicles. 71 percent of actions related to reducing speed limits are regulations or policies and all are 'significant' or 'comprehensive', indicating that they apply across the whole city. This is consistent with the finding that 25 mayors have the power to set or enforce regulations across city roads. Cycle infrastructure actions are predominantly projects or programmes demonstrating the strong powers of mayors in this area.

[3] NB it is recognised that in a small number of cities' taxis are a municipally run service. Similarly, in cities such as Addis Ababa, the term 'taxis' can refer to a 5 seat vehicle taking a single passenger or group of passengers to a single destination, to a 12 seat vehicle carrying a number of individuals to separate destinations. For the purposes of this analysis, only the former have been included in the 'taxi' category and the latter are treated as part of bus services.

FIG 1.7 ACTIONS, SCALE AND LEVERS: PERSONAL TRANSPORT

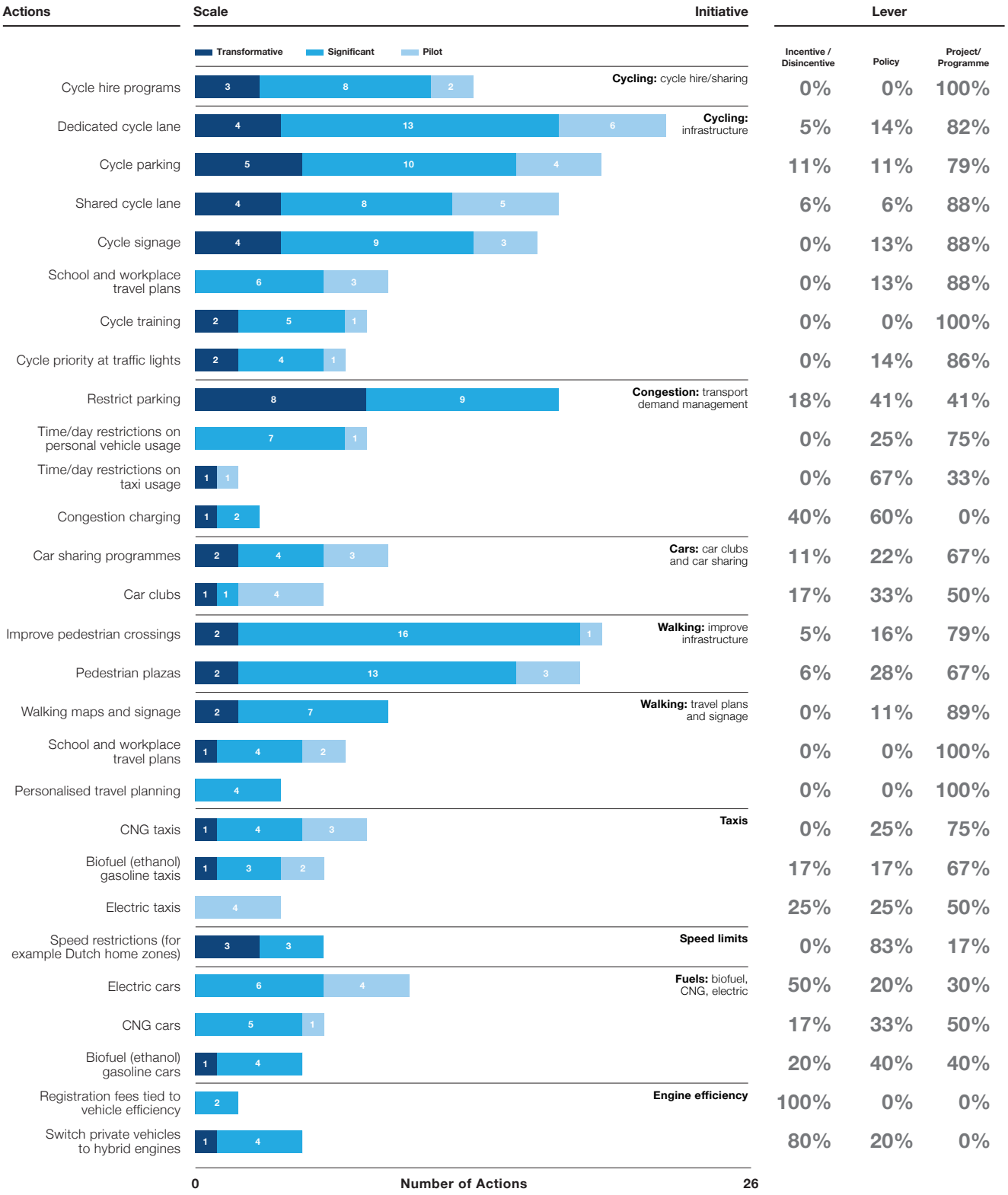


Figure 1.7 lists all actions recorded in the Personal Transport Mode and Taxis section of the survey. This includes all methods of transport which are delivered privately, for example, walking, cycling, driving private motor vehicles, as well as taking taxis. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive / transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

1.4.1.1 Return of the bike

It is hard to imagine that 'cycle friendly infrastructure' would have recorded the highest number of actions if this survey had been conducted prior to the formation of the C40 in 2005. The exposure of member cities to the successful cycling policies of affiliate cities like Copenhagen and Amsterdam, where 36% and 22% respectively of trips to work or education are made by bicycle, has clearly had an impact.

The most critical power utilised by mayors to develop cycling infrastructure is ownership and/or management of city roads. The majority of cities which have this power are developing cycling infrastructure initiatives, but opportunity exists to further increase activity through the C40 network.

- East Asian C40 cities register the highest modal share for cycling, with Hanoi at 25%, Shanghai 23% and Beijing 18%. But with the exception of Berlin (13%), there are no cities in Europe, North America, or Oceania that achieve even half the average of 4.5% for the C40 as a whole (Philadelphia is the highest in North America at 2.2%, Melbourne is top in Oceania at 1.8%). Lima has the highest recorded modal share for cycling in Latin America at 10%.
- 22 cities have cycle lanes, totalling over 9,370 km and this is growing.
- 27 cities have implemented at least one action to develop cycle-friendly infrastructure from the following range of actions: dedicated cycle lanes, shared cycle lanes, cycle signage, cycle parking, cycle priority at traffic lights, school and workplace travel plans, and cycle training.
- Cycle parking, cycle signage, dedicated cycle lanes and cycle lanes all record a large number of transformative actions, indicating that many mayors have applied these actions on a city-wide basis. Nine cities are piloting a combined total of 22 actions to develop cycle-friendly infrastructure and another 5 are considering developing cycle infrastructure, indicating the strongest momentum of any of the initiatives in the personal transport and taxi sector.

1.4.1.2 Cycle hire / cycle sharing programmes

The high profile success of the Paris 'Velib' cycle hire scheme, which started in 2007, has clearly had an impact, with subsequent significant/comprehensive schemes in 5 cities: Bogota, Chicago, London (2010), Mexico City (2010), and Toronto (2010).Two cities, Delhi and Seoul, have pilot projects underway.

Another 5 cities are considering cycle hire/share programmes, namely Beijing, New York, São Paulo, Philadelphia and Sydney.

This globe-spanning list suggests that cycle hire is now seen as a cost-effective method of congestion and carbon emission relief across the geographies.

In all cases, cycle hire is delivered as a programme by the city (usually with a private sector partner), reflecting that mayors are utilising their control over city roads to deliver this action.

1.4.2 Transport demand management

London's Central London Congestion Charging scheme, introduced in 2003, has reduced vehicle numbers in the central business district by over 70,000 per day, cutting carbon emissions in the zone by 15%. The success of this scheme was a major focus of the first C40 workshop, on transport, in 2007 and has encouraged two affiliate cities, Stockholm and Milan, to introduce comprehensive congestion charging schemes in 2006 and 2008 respectively.

- 23 cities have implemented at least one action in transport demand management from the following range: zonal congestion charging, vehicular congestion charging, time/day restrictions on personal vehicle usage, restricting parking, and time/day restrictions on vehicle usage.
- 3 cities – Beijing, Rome and Seoul - operate time/day restrictions on cars entering the central business district. Berlin operates a Low Emission Zone scheme which restricts entry to the most polluting cars, as well as lorries and vans.
- 3 cities – Bogota, Madrid and Rome – have introduced time / day restrictions on taxis, but 19 other cities have powers to regulate taxis. A much larger number of cities appear to have some of the powers to deliver congestion pricing than has implemented such schemes: 26 mayors own and operate city roads and 27 have powers to regulate them, but only 8 have implemented either zonal or vehicle congestion charging.
- Of all the potential initiatives to undertake in Transport, congestion charging showed up most frequently (four times) as discontinued, that is mayors had prepared plans for a scheme which were later stopped.

1.4.3 Electric vehicles

There is a huge amount of interest among C40 mayors to replace petrol and diesel powered cars with electric vehicles.

Clearly, the emissions reduction benefits of electric vehicles is heavily affected by the carbon intensity of the electricity grid (in cities like Warsaw, for example, where coal is the primary form of energy for electricity, electric buses at least have been estimated to create higher greenhouse gas emissions than diesel/petrol models). However, as national governments around the world shift to lower carbon and renewable energy, electric cars are likely to play a major role in reducing carbon emissions from transport.

The major perceived barrier to electric vehicles is so-called 'range anxiety' – the fact that current electric vehicles are generally only able to travel up to 100km without recharging the battery. The vast majority of trips in an urban setting, however, are significantly less than this. Electric cars are highly suitable for commuters, who can drive to work and leave their vehicle re-charging until they need to return home. Electric cars are, therefore, highly suitable for most cities.

City governments can play a major role, for example developing electric vehicle charging infrastructure and providing financial incentives to encourage faster take up of electric vehicles, such as making it free for electric vehicles to drive in the Congestion Charge Zone in London (a saving of US$16 per day).

Despite the high levels of interest in electric cars among C40 mayors there has to date been a relatively low level of activity. A total of 10 cities have implemented actions of which 4 are pilots. A further 3 cities (Rome, Shanghai and Tokyo) have plans to develop electric car projects in the future.

There is, however, considerable opportunity for other cities to follow suit.

1.4.4 Green taxis

The most frequently used lever to create green taxi fleets in C40 cities is regulatory action and policy making. Twenty three cities have the power to regulate and/or enforce regulations over taxis. The scale of actions to reduce emissions from taxis is, in this context, fairly low and there is significant opportunity to scale up actions, and with more than 1.4 million taxis on the roads in the C40 network the potential impact is great.

16 cities have taken at least one action from the following range to green their taxi fleets: biofuel (ethanol) gasoline, Compressed Natural Gas (CNG) and electric vehicles.

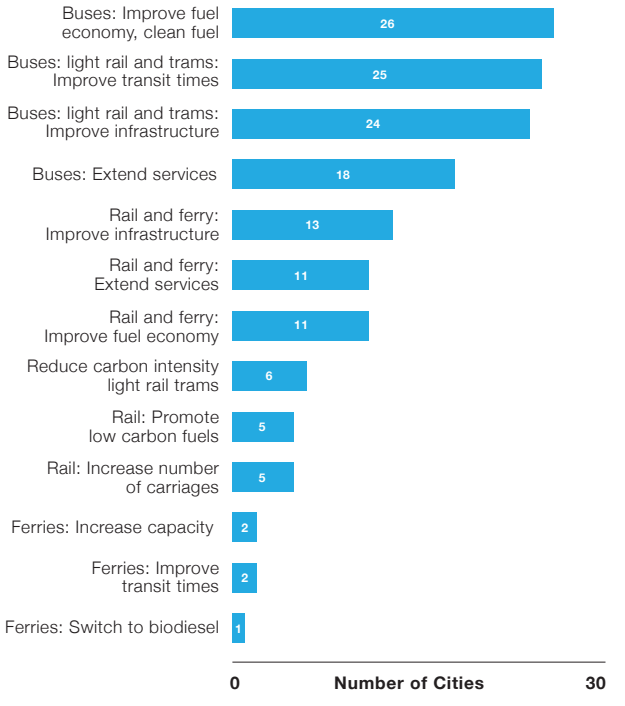
Only a relatively small number of these actions are comprehensive and 7 cities which regulate taxis have yet to take any steps to introduce low carbon vehicles. Beijing is the only city which has undertaken actions on all three types of green taxis listed above.

Converting taxis from petrol or diesel to Compressed Natural Gas is the most popular action, followed by the use of biofuels. Delhi NCT has, for example, caused its entire fleet of tuk-tuk taxis to be converted to CNG. However, there is clearly an increasing focus on electric taxis, recording the largest number of pilots related to greening taxis.

1.5 MASS TRANSIT (PUBLIC TRANSPORT) WITHIN THE CITY

Figure 1.8 shows the number of cities that has undertaken at least one action to reduce emissions from mass transit (actions are grouped into a small series of 'initiatives'). Mass transit includes: buses, light rail systems, underground rail systems, and ferries.

FIG 1.8 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES ON MASS TRANSIT WITHIN THE CITY?



The initiatives where most mayors have taken actions relate to buses. Bus services present opportunities because of their typically lower cost but high impact compared to other mass transit modes, and the high degree of control typically enjoyed by city mayors. The majority of mayors and their agencies own and/or operate bus services (19 cities) or regulate them (20 cities).

FIG 1.9 ACTIONS, SCALE AND LEVERS: MASS TRANSIT WITHIN THE CITY

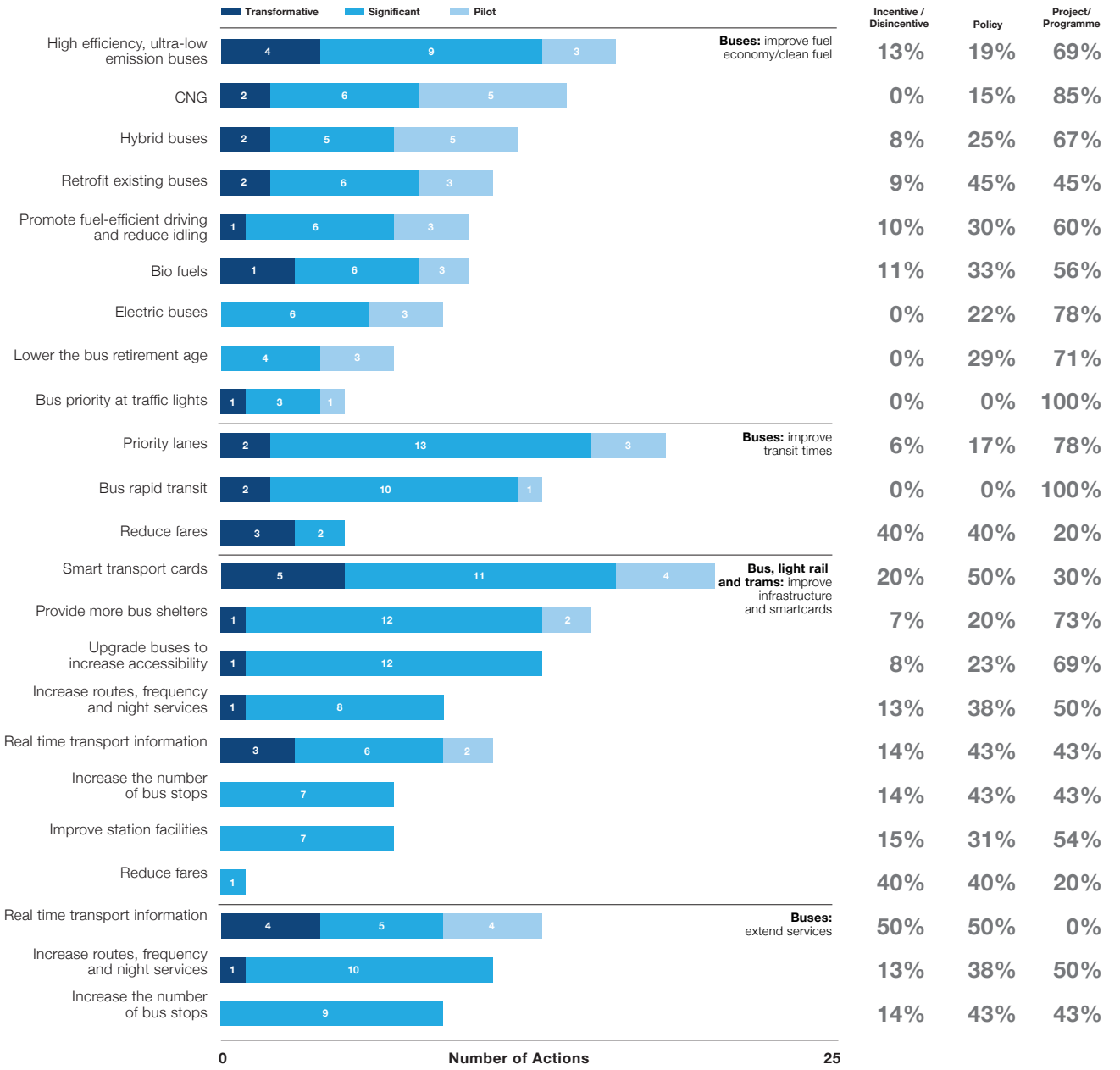
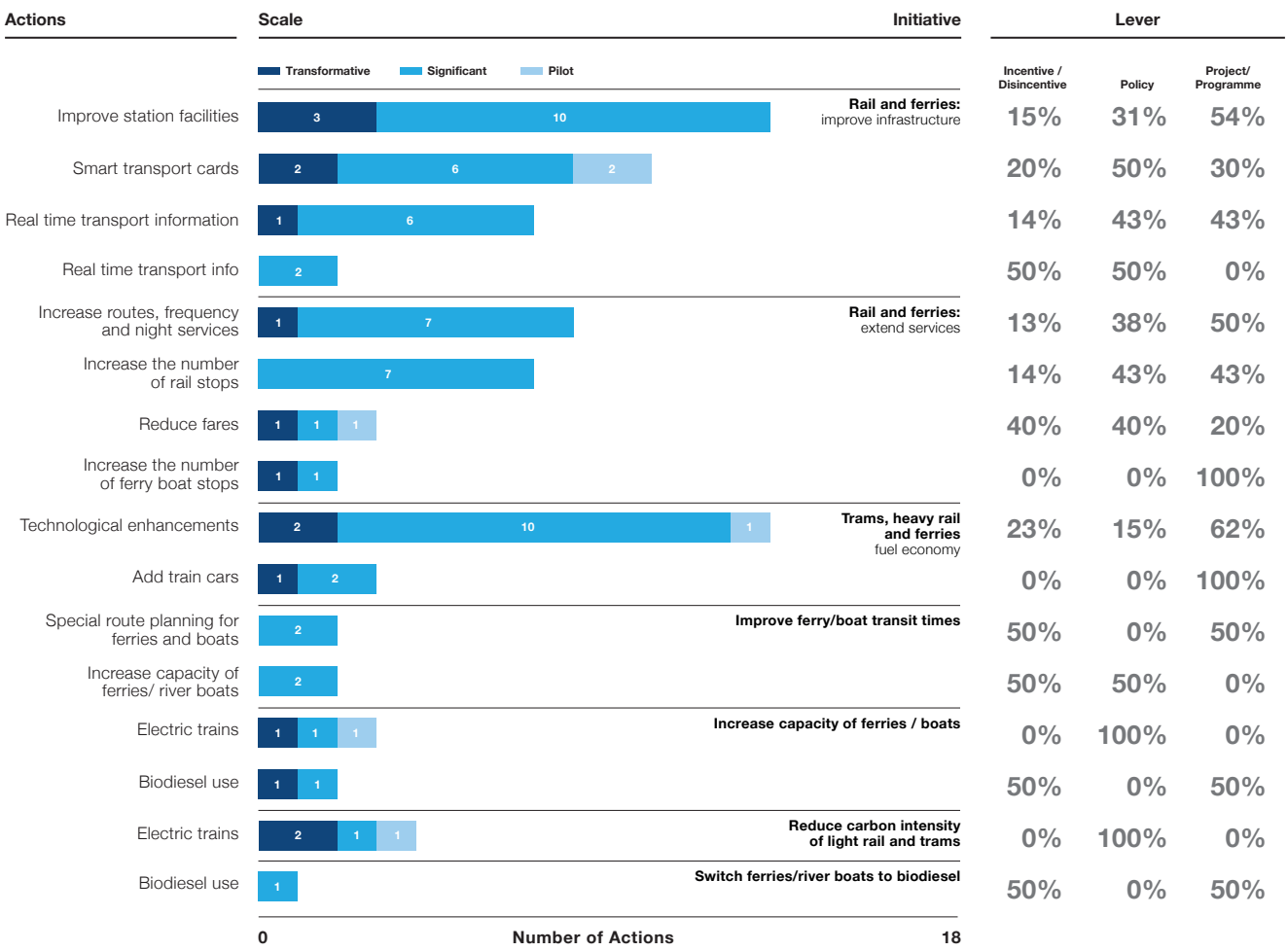


FIG 1.10 ACTIONS, SCALE AND LEVERS: MASS TRANSIT WITHIN THE CITY (2)



Figures 1.9 and 1.10 list all actions recorded in the Mass Transit within the City' category of initiatives. This category includes all of the services which come under the heading of 'mass transit' or 'public transport', such as buses, trains, and trams. The scale at which action has been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

The greatest number of actions has been reported on improving fuel economy and reducing CO_2 emissions from buses, reflecting the strong powers mayors enjoy over roads and mass transit modes.

Most actions reported are at the significant or the transformative scale, although a high number (29) of pilots is also reported indicating that there is still a lot of opportunity to scale up activity.

Large numbers of actions have been taken to increase the reach of bus services, including 35 actions to increase routes, frequency and night services and 29 actions to increase bus stops. Similarly, there are significant numbers of actions to improve bus stops, introduce bus priority lanes, and provide more bus shelters. A high proportion of these are transformative/comprehensive actions indicating that mayors are taking city-wide steps to increase the scale and standard of bus services to attract more people to public transport. Mayors are using multiple powers to achieve these actions – over both bus services and/or city roads.

Steps are also being taken to improve integration between transport modes, with the use of 'smart tickets' becoming increasingly popular following the success of the Hong Kong 'Octopus' and London's 'Oyster' cards.

The majority of actions are programmes, particularly where mayors have a lot of relevant powers, such as over roads. Where mayor's do not typically own or operate services, such as ferries and boats, actions are more likely to be implemented using policy mechanisms instead of projects and programmes.

1.5.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and/or there is significant scope for scaling up activity.

1.5.1.1 Bus Rapid Transit

Bus Rapid Transit (BRT) refers to high-speed bus services, usually operating from the city suburbs to the central business district, often with segregated bus lanes and metro-style passenger access, with sheltered bus stops elevated above the road.

The Bogotá Transmilenio was started in 1998 and now attracts 1.4 million passengers per day using its 850 buses, reducing travelling time by 32%, reducing gas emissions by 40%, and making zones around the highways safer thus decreasing accident rates by 90% throughout the system.

BRT systems have now been introduced in 13 C40 cities with 8 cities planning their introduction. The most notable development is in Latin America where all six member cities have implemented or plan to introduce bus rapid transit systems. This demonstrates the benefit of knowledge sharing between cities, in which the C40 has played a part. With the exception of Bogota and Los Angeles, all of the BRT systems for which the date of commencement of services has been recorded occurred after the creation of the C40 network.

1.5.1.2 Low carbon buses

Steps to introduce low carbon buses or improve the fuel economy of petrol and diesel vehicles are being taken by around half of C40 cities. A large number of actions, particularly for hybrid and electric buses, are at the pilot stage. This is consistent with the relatively new and rapidly developing nature of the low carbon vehicle market. One would expect to see levels of action continuing to increase in this sector.

- The introduction of ultra-low emission buses is the most popular action taken by cities to improve the fuel economy and reduce CO_2 from bus operations, with 16 cities having introduced these buses.
- Fourteen cities have introduced CNG buses, 12 cities have undertaken hybrid buses – with an even split between pilots and transformative, followed by 10 cities who have introduced biofuel buses and 9 cities who have introduced electric buses.
- There is considerable scope to increase activity in this sector across the network

1.5.1.3 Smart card ticketing

Smart card ticketing provides cities with a number of benefits:

- The opportunity to better integrate mass transit services, making it easier for passengers to transfer between different modes such as buses, metros and rail.
- Invaluable trip data that makes it easier to improve service efficiency.
- The ability to introduce fares incentives, for example to encourage more passengers to use services outside of peak times.

With 34 separate actions, smart card ticketing records the highest level of activity in this section of the survey. Activity in this area is spread across the globe, but there is clearly a concentration of activity in the East Asia region with:

- Beijing, Hong Kong, Seoul and Tokyo account for nearly one third of the actions that are already in effect (10 out of 35), and half of those listed as comprehensive or transformative.
- 21 cities have registered at least one smart card action currently in effect.
- 21 of the 35 actions are listed as ‘programmes’, indicating a degree of city control.

1.6 PASSENGER AND FREIGHT TRANSPORT TO AND FROM THE CITY

Figure 1.11 shows the number of cities that has undertaken at least one action in the eight categories of ‘Initiative’ in the Passenger Transport and Freight category.

FIG 1.11 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN PASSENGER AND FREIGHT TRANSPORT TO AND FROM THE CITY?

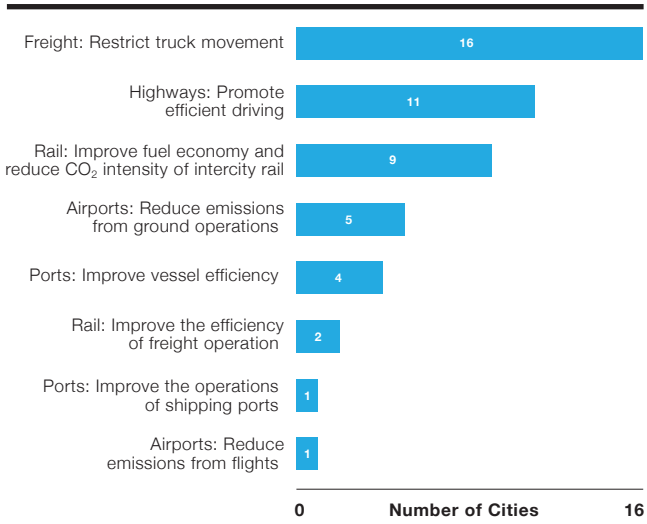
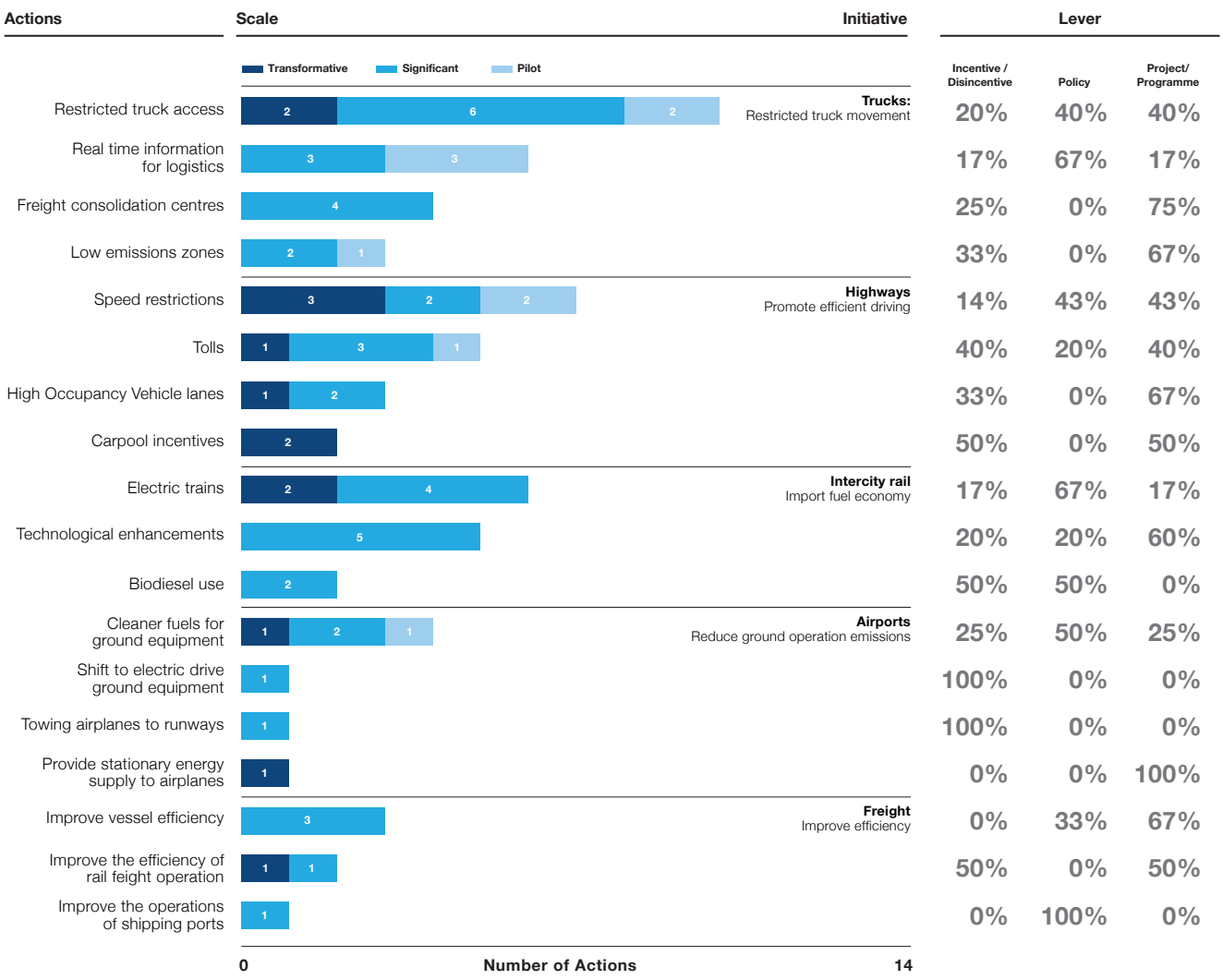


FIG 1.12 ACTIONS, SCALE AND LEVERS: TRANSPORT – PASSENGER/FREIGHT



The initiative with the greatest number of cities delivering actions is low emission zones and freight consolidation centres, followed by the promotion of fuel efficient driving. There are only a small number of cities taking actions over ports and their operations, but this is nevertheless a major issue for a small number of member cities and has been the focus of a dedicated C40 conference in Rotterdam.

Figure 1.12 breaks these initiatives down by scale and type. The scale at which action has been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

There are fewer actions recorded in this section than in the rest of the transport sector, reflecting lower mayoral powers on average. At the level of individual actions, restricting truck access is the most popular action, followed by freight consolidation centres implemented by 6 cities and real time information for logistics implemented by 6 cities. Real time information for logistics records the largest number of pilots.

Actions are evenly split between policy measures and projects/programmes and a high number of pilots is reported suggesting the potential for scale up. Overall, a broader range of tools is used in this category with a mix of incentives, policies and project/programmes reported.

1.6.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and/or there is significant scope for scaling up activity.

1.6.1.1 Low Emission Zones

Four cities have implemented Low Emissions Zones, which restrict the movement of freight and other heavy goods vehicles based on emissions standards (in Berlin's case this has now also been extended to the most polluting cars). These have all been implemented to address chronic air pollution (NOx and PM10) but can also have an impact on carbon emissions.

To date, low emission zones proliferate among European C40 cities but not elsewhere: Berlin, London, Paris and Rome have all implemented such zones. All these C40 member cities were able to draw upon the experience of Stockholm, an affiliate member of the C40, and its extensive and successful Low Emission Zone. Indeed, London and Stockholm developed strong bilateral ties between their respective transport departments, with London learning from Stockholm's experience of Low Emission Zones before it began its low emission zone in 2008, while Stockholm studied London's introduction of congestion charging before introducing a similar scheme in 2006.

1.7 FUTURE PLANS

Figures 1.13 to 1.15 show the actions that cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation. Dedicated cycle lanes is the most popular action to be expanded further, followed closely by smart transport cards and improved pedestrian crossings. Actions under consideration and in planning by cities include cycle hire programmes, electric cars and congestion charging. These emerging actions are high priorities for C40 cities in the future.

C40 mayors have considerable powers over the transport sector and have already taken many significant steps to use them to reduce emissions from transportation. There is, however, very considerable opportunity for the C40 network to collectively accelerate emissions reduction from transport through sharing best practice and jointly developing thinking in new areas such as electric vehicles.

FIG 1.13 ACTIONS BEING EXPANDED OR PLANNED: PERSONAL TRANSPORT MODES AND TAXIS

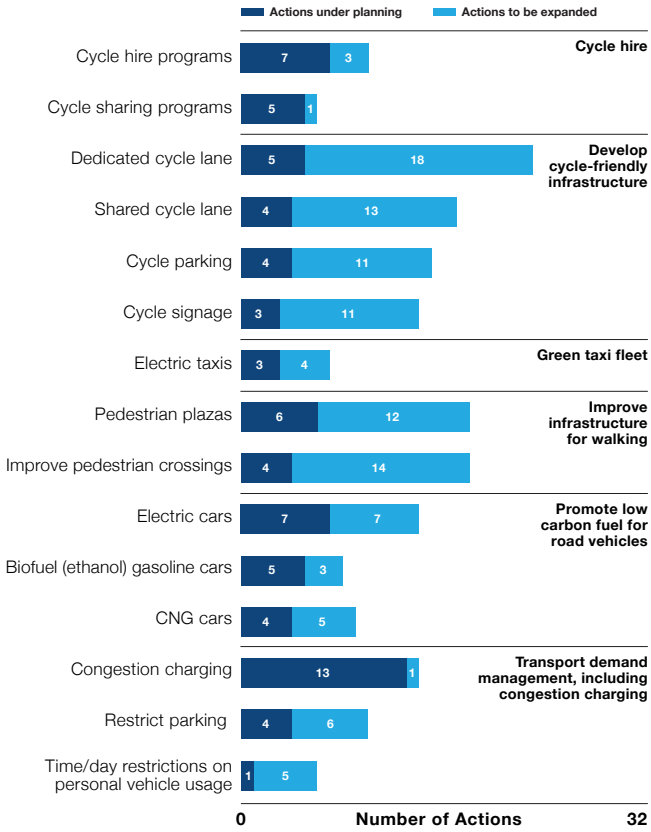


FIG 1.14 ACTIONS BEING EXPANDED OR PLANNED: PERSONAL TRANSIT WITHIN THE CITY

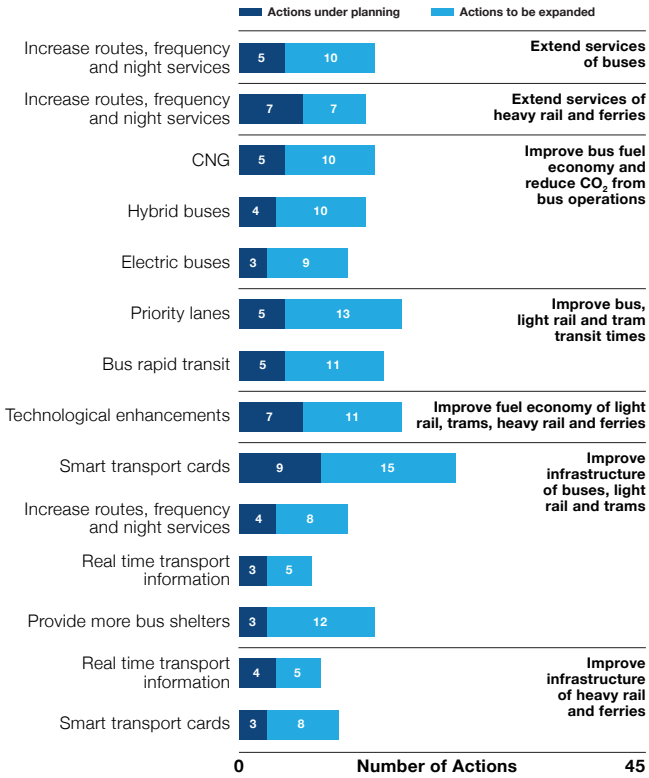
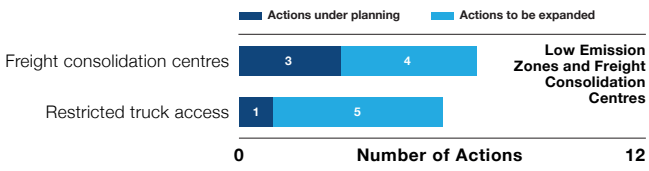


FIG 1.15 ACTIONS BEING EXPANDED OR PLANNED: PASSENGER AND FREIGHT TRANSPORT TO AND FROM THE CITY



02.

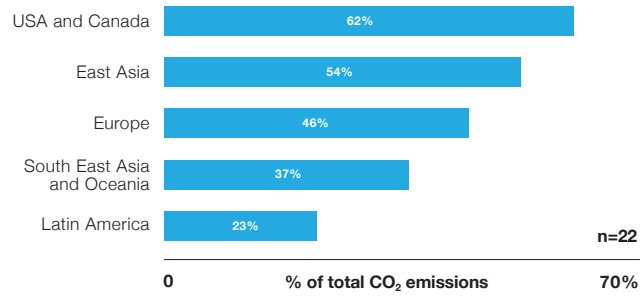
EXISTING BUILDINGS

2.1 INTRODUCTION

On average, energy used in buildings accounts for 45% of C40 cities' carbon emissions. This proportion, however, varies considerably across members cities (see figure 2.1). For example, in New York the figure is 78% compared with just 12% in São Paulo. This can be attributed to a number of factors including climate (New York has both very cold winters, requiring considerable heat energy, and hot summers requiring cooling, while São Paulo's climate means very little demand for heating), cultural differences, and occupancy levels.

In many highly developed C40 cities it is estimated that more than half of all existing buildings will still be in use in 2050[1] – by which time global average emissions will need to have halved to meet international targets. The emissions reduction activities in these cities, therefore, are likely to need a considerable focus on reducing energy demand in existing buildings.

FIG 2.1 PROPORTION OF CITY EMISSIONS FROM BUILDINGS ACROSS C40 CITIES



'Retrofitting' buildings – refurbishing them – can have dual benefits and is generally a more cost and carbon effective method of improving energy efficiency than tearing down and building anew. Reducing energy use in buildings can have a multiplier effect in terms of reducing carbon emissions. Some industry experts estimate that every unit of electricity saved in the home or office translates into three units saved at the power plant, because of the inefficiencies of transmission and distribution.[2]

[1] 'Existing Building Survival Strategies', Arup, 2010
[2] Christophe Juillet, Schneider Electric, presentation to the Mayor of Rome's 'Third Industrial Revolution' workshop, Rome, December 2010

Buildings need to be redesigned not only to reduce emissions, but also to adapt to future climate change, for example the urban heat island effect that is experienced in many C40 cities.

In cities that have been developing rapidly in the 21st century, the focus is more on how to design low-carbon new buildings. For example, in Addis Ababa, an enormous construction programme is underway with the proportion of people moving from un-planned 'shanty towns' to more formal living, declining from 80% to 40% and the city administration plans to expand these efforts. A similar situation is likely in many other African, Latin American and Asian cities. Analysis of steps C40 cities are taking to build new low carbon buildings is set out in Chapter 7, Planning and Urban Land Use.

Based on the powers C40 cities tend to have over different building types, the buildings sector has been broken down by buildings categories into the following sections for the purposes of this report:

- Public residential
- Private residential
- Municipally owned buildings (non-housing)
- Commercial
- New buildings [reported on in full in the Planning and Urban Land Use chapter of this report]

Figure 2.3 shows the breakdown of planned and implemented actions by category of analysis. As can be seen, actions across the different sectors have actually been reported in comparable quantities.

Most actions in the buildings sector apply across a number of building categories in many cities. For example, Mumbai has carried out heating and cooling efficiency programmes across four categories: public residential, private residential, municipal offices and commercial offices.

Similarly, some cities have implemented comprehensive retrofit initiatives under the banner of a single programme, such as Berlin's public and private building retrofit programme. For these reasons, multiple actions under an initiative have been recorded reflecting the true scale of implementation.

2.2 OVERVIEW

Figure 2.2 shows average building CO_2 emissions (residential, commercial and industrial) compared to GDP per capita. While 9 cities with a lower than the C40 average GDP per capita reported lower than the C40 average buildings emissions, there are nevertheless 3 lower GDP per capita cities with higher than average building CO_2 emissions levels. All three cities are in East Asia – Hong Kong, Seoul, and Shanghai.

Conversely, for high GDP per capita cities, while most are reporting high average CO_2 emissions from buildings, this is by no means the absolute rule. A number of high GDP cities – Madrid, Rome, Paris, and Berlin, for example - reported lower than average CO_2 emissions from buildings.

FIG 2.2 AVERAGE EMISSIONS FROM BUILDINGS ACROSS C40 CITIES

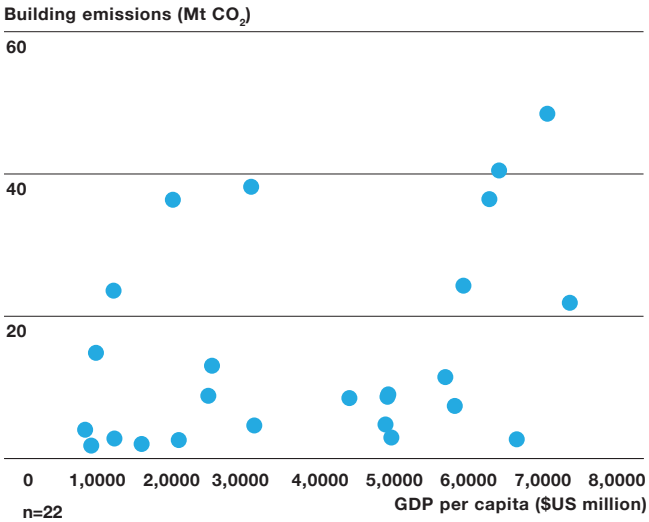
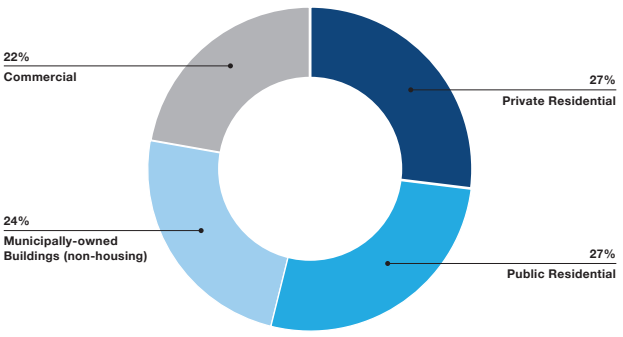


FIG 2.3 EXISTING BUILDINGS: BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED BY C40 CITIES



2.3 POWERS

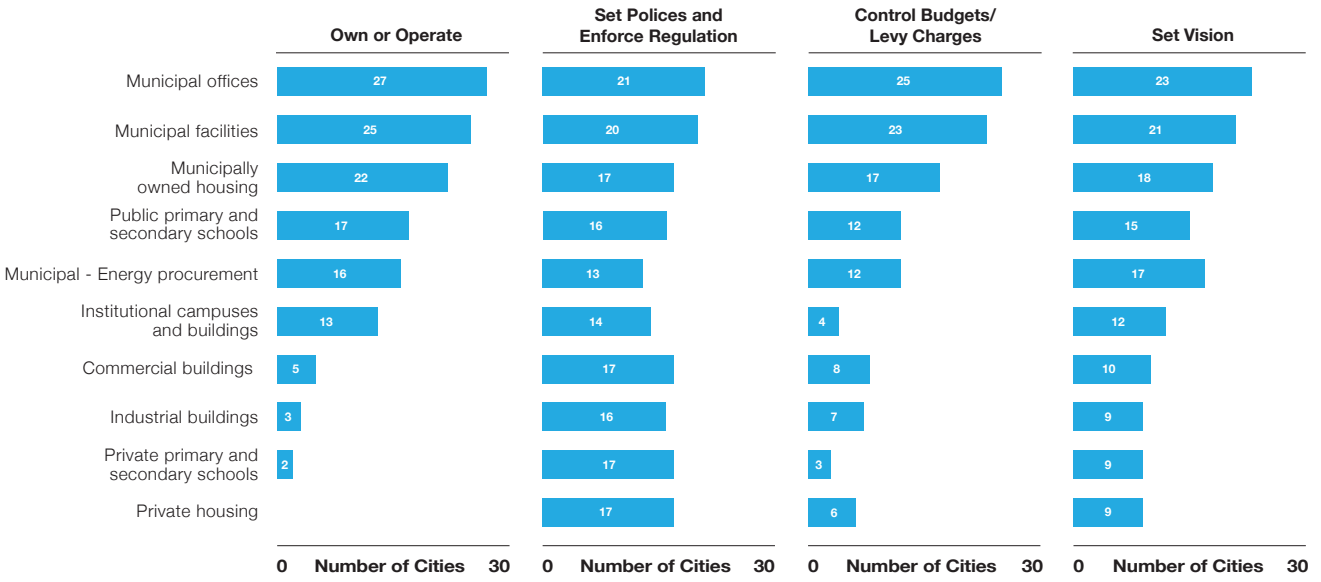
Overall, mayoral powers in the building sector are strong among the C40 cities. More than half of city governments reported ownership or operation powers over public sector building stock, including municipally-owned office and other facilities, and public sector housing.

Specifically, 27 city governments own or operate (either in full or partially) their municipal buildings. 25 own or operate other municipal facilities (such as leisure centres) and 22 own or operate municipal housing. Along with direct ownership or operational control, the range of other powers on public sector buildings is also strong among C40 city cities.

C40 mayoral powers to set policies and enforce regulation over private sector buildings are relatively strong. 17 cities reported powers to set policies and enforce regulation over private sector residential and 17 over private sector commercial – indicating that initiatives and actions in the private sector are also within the power of some city governments.

It is notable that while mayoral powers of ownership, operation, budget control, levy setting, and vision setting vary considerably across different building types, mayoral powers to set or enforce policies and regulations are consistently fairly strong.

FIG 2.4 C40 MAYORS' POWERS: EXISTING BUILDINGS



2.4 PUBLIC AND PRIVATE RESIDENTIAL BUILDINGS

The two figures (figure 2.5 and figure 2.6) show the number of cities that have undertaken at least one action under the category of 'initiatives' in the public and private residential building section.

FIG 2.5 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES ON PUBLIC RESIDENTIAL BUILDINGS?

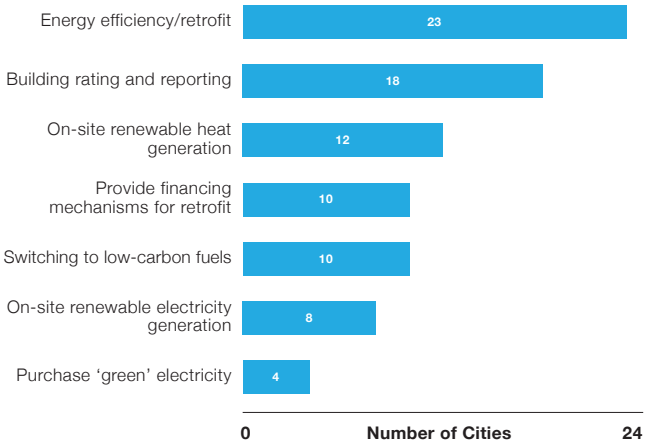
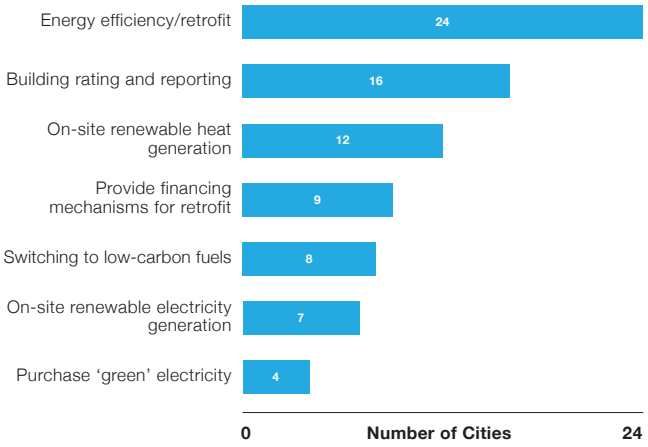


FIG 2.6 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES ON PRIVATE RESIDENTIAL BUILDINGS?



Public and private sector residential initiatives were separated out in the survey due to the different powers city governments generally tend to have over public and private housing.

However the survey results showed that in the majority of cases, cities that are taking action on one residential type (either public or private) are also taking action on the other, regardless of the fact that city governments reported weaker powers over the private than the public stock.

The most popular initiative for both the public and private residential stock is on energy efficiency/ retrofit, with 23 cities taking action on the former and 24 on the latter. This can mean anything from improving insulation and double/triple glazing, to switching to LED lighting, or installing building management systems, and automatic lighting controls. With the exception of one city, the same cities are reporting action on both residential types on energy efficiency/ retrofit.

The second most popular initiative on both the public and private residential stock is building rating and reporting, with 18 cities reporting this action for public residential buildings and 16 for private residential. Only 6 cities which are taking action in public residential are not doing so also for private housing.

For both on-site renewable heat generation and on-site renewable electricity, the number of cities reporting actions is comparable for both public and private residential buildings, with largely the same cities taking action in both cases. The same is true of action reported on financial mechanisms for retrofit.

FIG 2.7 ACTIONS, SCALE AND LEVERS: PUBLIC RESIDENTIAL BUILDINGS

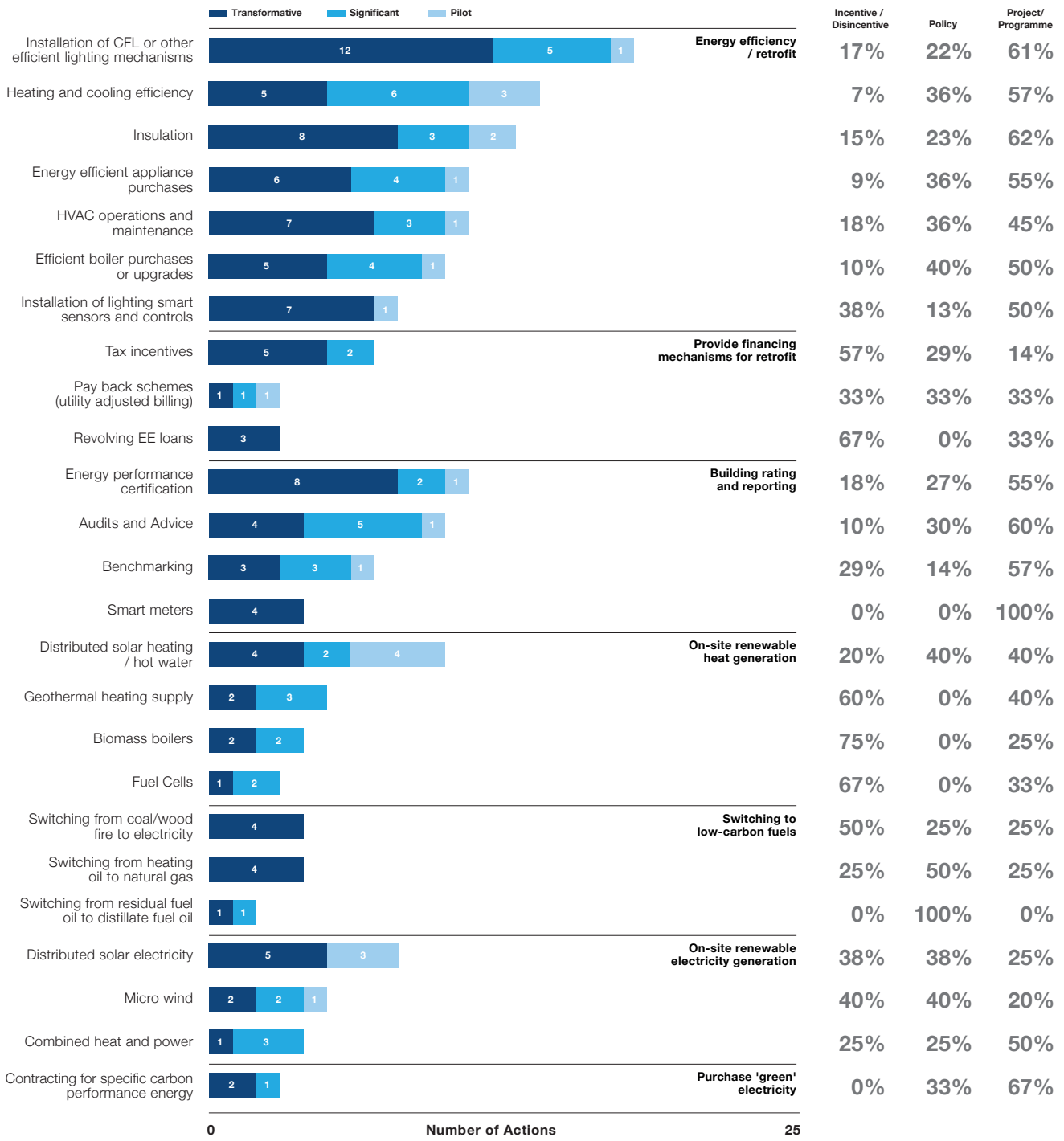


Figure 2.7 lists all actions recorded in public residential buildings. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

FIG 2.8 ACTIONS, SCALE AND LEVERS: PRIVATE RESIDENTIAL BUILDINGS

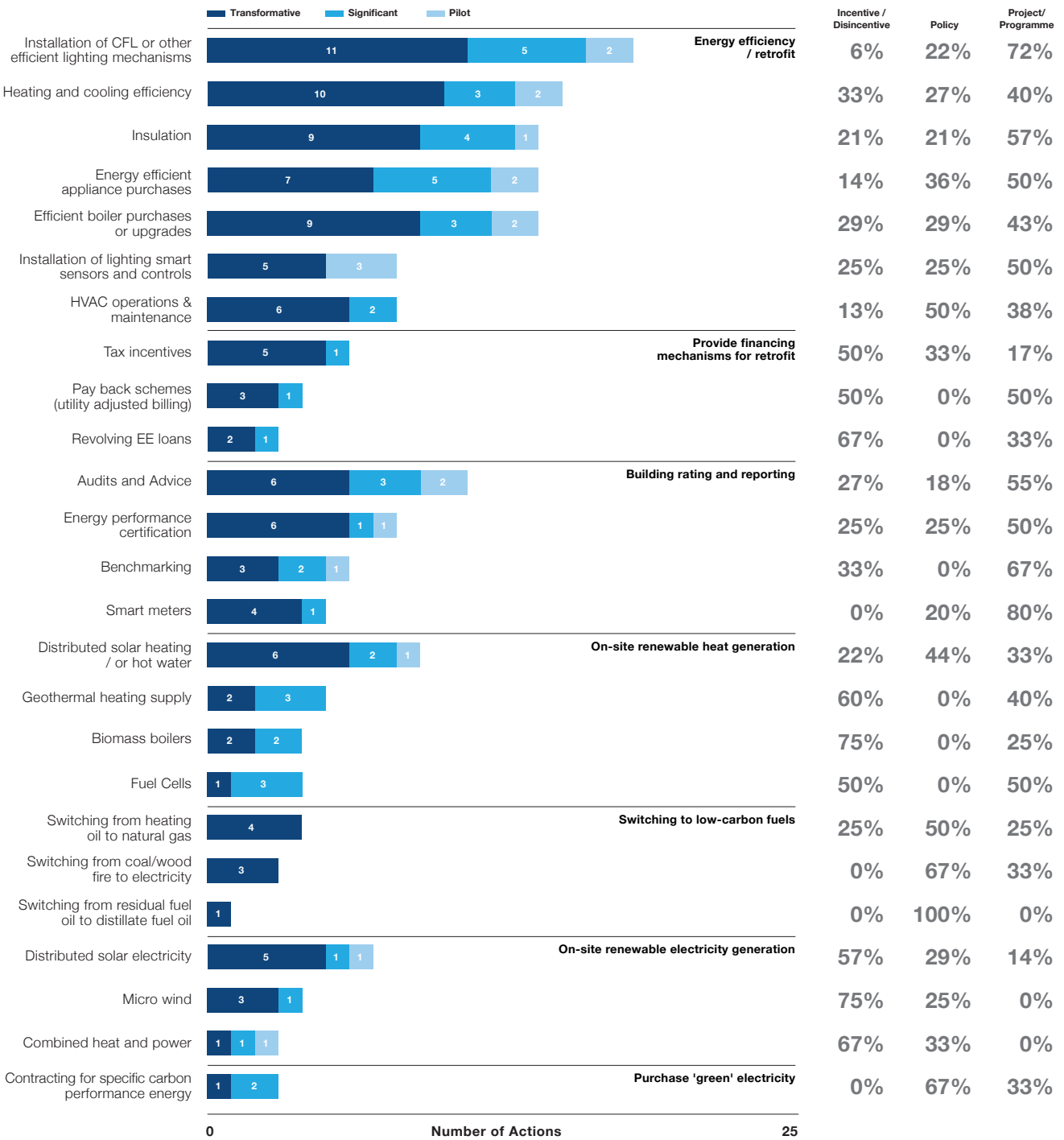


Figure 2.8 lists all actions recorded in private residential buildings. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

Generally, actions were comparable across the public and private housing stock, in terms of both total numbers of actions and their scale, with most actions across the board reported as transformative.

The main difference between the public and private residential categories is that the private residential recorded more incentives as the main lever for mayors to induce action than the public sectors which tended to record more policies and projects/ programmes.

2.4.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are already taking notable action.

2.4.1.1 Energy efficiency/ retrofit

Most actions in both the public and private residential sector were reported in the energy efficiency / retrofit category. In both types of housing, the most popular actions are:

- Installation of compact fluorescent lightbulbs (CFL) or other efficient lighting mechanisms
- Heating and cooling efficiency
- Insulation
- Energy efficient appliance purchases

Seventeen actions related to the installation of CFL or other efficient lighting mechanisms were reported in public residential buildings and eighteen actions in private housing. In both cases the primary lever is projects / programmes, suggesting that mayors are delivering city-wide actions to make energy efficient lightbulbs available at a cost discount or for free.

Fourteen actions were registered relating to improving heating and cooling efficiency in public residential buildings, and 15 actions in private housing. The lever in this case show some variance, with a third of actions in the private sector being delivered via financial incentives / disincentives, whereas actions relating to public sector buildings are being delivered mostly through policy (36%) or projects/ programmes (57%).

One city which is typical in having implemented a range of initiatives across both public and private sectors is Chicago. In 2009, the Chicago Climate Action Plan (CCAP) partners formed the Chicago Retrofit Steering Committee to develop a comprehensive implementation plan across the residential, commercial, and industrial sectors. To date 13,341 housing units and 393 commercial and industrial buildings have been retrofitted to be more energy efficient. These two initiatives achieved energy savings of at least 21%[6].

The City of Houston has also delivered a residential energy efficiency programme in Pleasantville, providing free retrofits worth approximately $1,400 on average to 5,300 low income homes between 2006 and 2009, in partnership with local energy utility, Centrepoint[7].

Toronto's 1,892 high rise buildings produce 40% of Toronto's residential emissions. Toronto Atmospheric Fund's TowerWise programme works with building owners and managers to improve the energy performance of high rise buildings, and lower emissions. Program elements include a collaborative outreach approach involving major stakeholders in both the rental apartment and condominium sectors.

2.4.1.2 On-site renewable energy generation

On-site renewable energy and heat generation can be an option both for reducing greenhouse gas emissions from residential buildings and cutting residents' fuel bills. The commercial viability of such measures varies considerably across C40 cities, depending on renewable energy resources (solar irradiance, wind speeds etc) and the existence or not of market levers such as feed in tariffs, which provide financial rewards for small scale renewable energy generation.

It is, therefore, difficult to generalise across the C40, but the most popular actions in both public and private residential are:

- solar heating / hot water, with 10 actions in the public residential and 9 actions in private residential sectors
- distributed solar electricity, with 8 actions in both public and private housing, although the levers used to implement actions were more likely to involve financial incentive mechanisms for private housing (57%), and policies and projects for the public sector (62%).

[3] *Chicago Climate Action Plan Progress Report, http://www.chicagoclimateaction.org/pages/research___reports/8.php*

2.5 MUNICIPALLY OWNED BUILDINGS (NON RESIDENTIAL) AND COMMERCIAL BUILDINGS

Figure 2.9 shows the number of cities that have undertaken at least one action in initiatives under Municipally-owned Buildings (offices, schools etc). Figure 2.10 shows the number of cities that have taken at least one action in initiatives under Commercial Buildings.

FIG 2.9 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES ON MUNICIPALLY OWNED BUILDINGS?

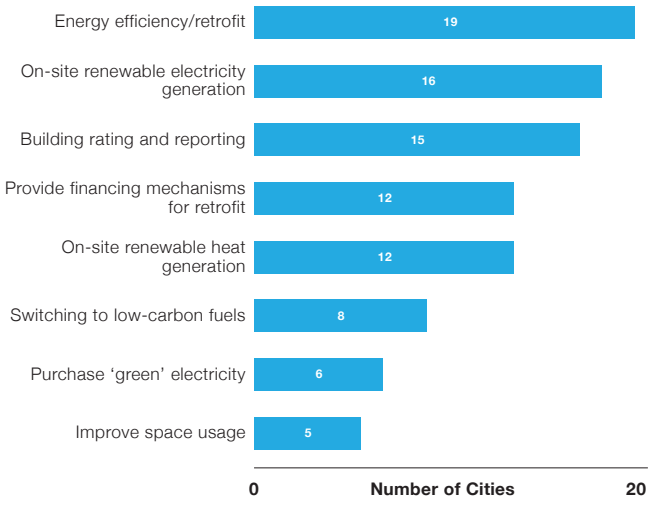
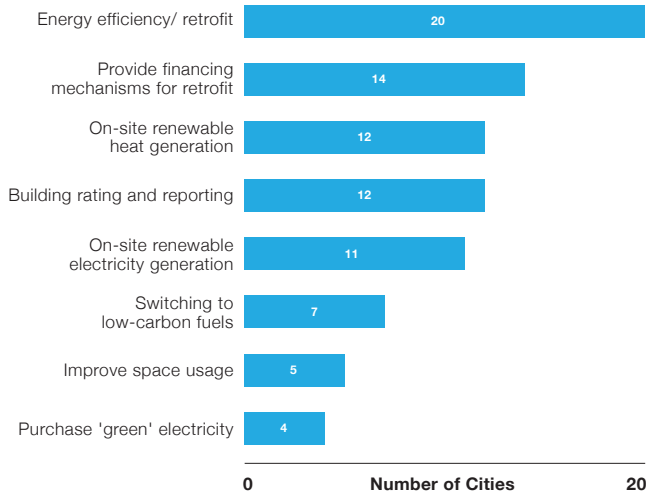


FIG 2.10 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES ON COMMERCIAL BUILDINGS?



The two categories of buildings were separated in the survey due to the different set of powers city governments generally have over municipally-owned buildings on the one hand, and commercial buildings on the other.

However, on average, the number of cities taking action on municipal buildings is comparable to the number of cities taking action on commercial buildings. Furthermore, similar to the findings in the public and private residential sector, the cities taking action on municipal buildings tend in general to also be taking action on commercial buildings, with the most notable exception being on-site renewable energy generation.

The most popular initiative among C40 cities on both municipal and commercial buildings is on energy efficiency / retrofit. Across both categories, the same cities are generally taking action on both building types.

The second most popular initiative for municipally-owned buildings is to support on-site renewable electricity generation (16 cities), whereas for commercial buildings the second ranked initiative is financing mechanisms for retrofit (14 cities).

Fifteen cities reported action on rating and reporting standards for municipal buildings and 12 for commercial buildings.

FIG 2.11 ACTIONS, SCALE AND LEVERS: MUNICIPALLY OWNED BUILDINGS

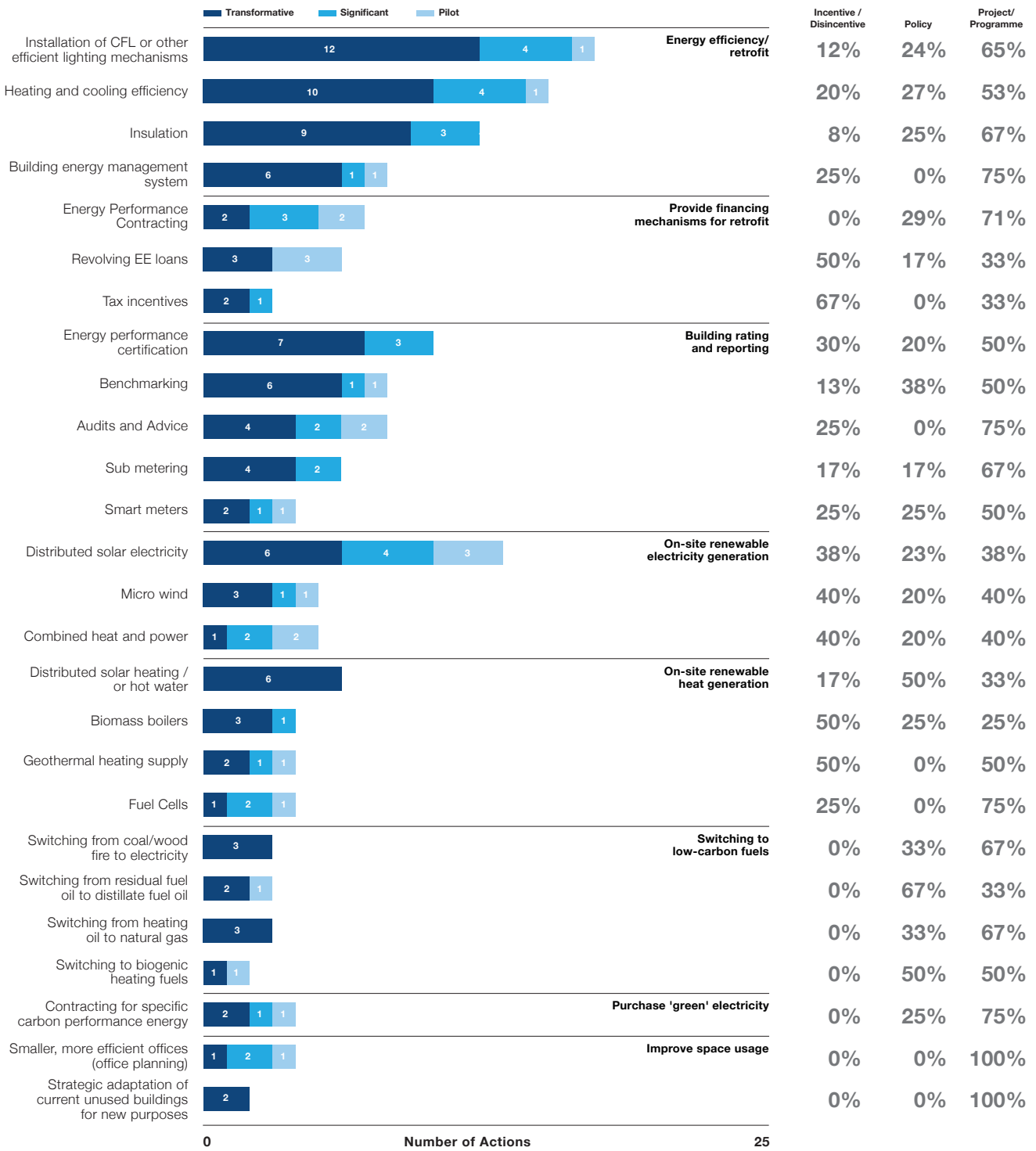


Figure 2.11 lists all actions recorded in Municipally-owned buildings (non housing). The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

FIG 2.12 ACTIONS, SCALE AND LEVERS: COMMERCIAL BUILDINGS

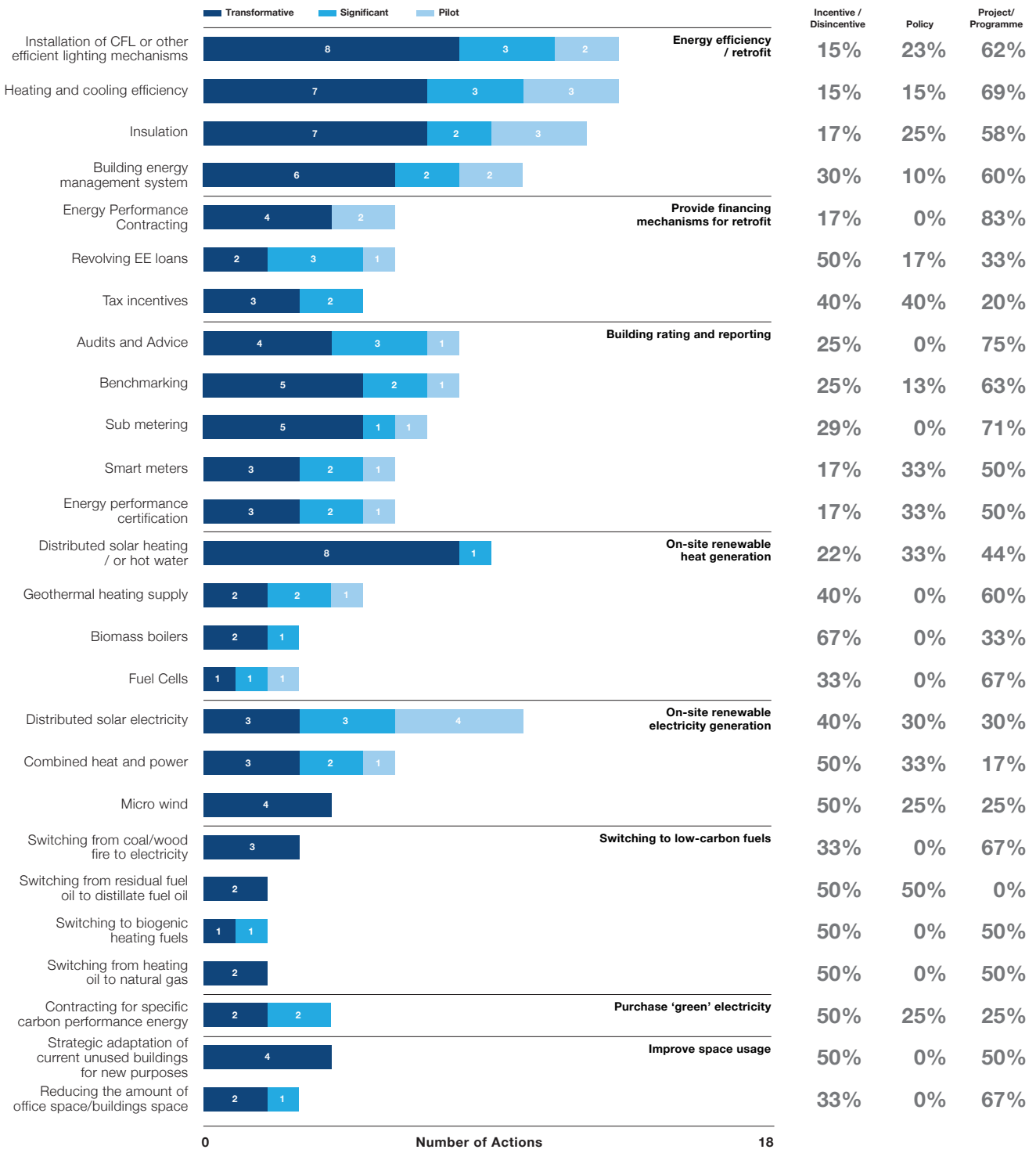


Figure 2.12 lists all actions recorded in commercial buildings. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

What is striking across the board is the number of actions which cities declare to be 'comprehensive / transformative' in relation to both municipal and the commercial sector properties.

The primary difference between the way that actions are being delivered across the public and commercial sectors is that projects/programmes are the norm in the former, whereas financial incentives/disincentives play a much more prominent role in the latter. This is consistent with the different powers available to mayors in each sector – strong ownership and operational control over municipal buildings, and a reliance on regulation setting and enforcement over commercial properties.

2.5.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are already taking notable action.

2.5.1.1 Energy efficiency/ retrofit

In both municipal buildings and commercial buildings, the most popular actions under the energy efficiency/ /retrofit category are:

- Installation of CFL or other efficient lighting mechanisms
- Heating and cooling efficiency
- Insulation
- Building energy management systems

Overall, the municipal sector records a higher number of actions than the commercial sector and a higher number of transformative actions although the split in the lever – incentive, policy and project/programme – is comparable across the two building types.

Twenty-six C40 city governments own and operate municipal buildings. For these mayors retrofitting municipal properties can provide multiple benefits:

- Cutting greenhouse gas emissions
- Reducing energy bills and so releasing funds for the additional low carbon measures
- Improving working conditions and productivity

A good example of a city municipal building retrofit project is the Melbourne Council House 2 (CH2). This multi-award winning and inspirational building has reduced CO_2 emissions by 87%, electricity consumption by 82%, gas by 87% and water by 72%. The building purges stale air at night and pulls in 100% fresh air during the day. The building exterior moves with the sun to reflect and collect heat, and turns sewage into usable water. The building has improved staff effectiveness by 4.9% and will pay for its sustainable features in a little over a decade.

2.5.1.2 Building rating and reporting

In municipal buildings, the most actions and most transformative actions were reported in the following order:

- Energy performance certification
- Benchmarking
- Audits and advice

In the commercial building sector, the most total actions and most transformative actions were reported in the following order:

- Audits and advice
- Benchmarking
- Sub metering

Overall, the municipal sector records a higher number of actions than the commercial sector and a higher number of transformative actions although the split in the delivery mechanism – incentive, policy and project – is comparable across the two building types.

Building rating and reporting is used by C40 city governments to set standards in order create a market for energy efficient building. In some cases the emphasis is primarily on reporting, based on the assumption that tenants will choose buildings where the energy bills are likely to be lower, as long as they are provided with the information on which to make such decisions. Similarly, large corporations and public authorities will wish to avoid the potentially negative public image associated with a building with a poor energy efficiency rating.

In other cases, city or national governments go a stage further and attempt to shift the market through imposing penalties on buildings with low building ratings, either restricting their rental activity or directly levying fines.

A good example of building rating and reporting is the Green Hong Kong Carbon Audit campaign, introduced by the Environmental Protection Department, which provides a systematic approach for building operators to account for and report on greenhouse gas emissions and identify areas of improvement. As a highly densely populated city, Hong Kong has one of the highest carbon contributions from energy used in buildings among the C40 cities and has focussed on reducing this as a priority of its climate change action plan. To date, 228 organisations are taking part.

[4] *http://www.c40cities.org/bestpractices/buildings/melbourne_eco.jsp*

2.5.4 Providing financial incentives for retrofit

In both municipal buildings and commercial buildings, the most actions under this initiative were reported in the following order:

- Energy Performance Contracting
- Revolving energy efficiency loans
- Tax incentives

On Energy Performance Contracting, 7 cities reported action on municipally owned buildings – 2 transformative, 3 significant and 2 – compared to 6 in commercial buildings – 4 transformative and 2 pilots.

Energy Performance Contracting is one cost-effective method of delivering comprehensive building retrofit programmes. This can have slightly different meanings in different cities, but in broad terms it describes a method of financing measures such as fitting insulation, building managements systems, and low energy lighting, by leveraging future energy savings against initial capital costs. For example, a private sector operator will take on the cost of delivering a retrofit programme in return for a guaranteed annual payment from the building owner or tenant, funded out of the energy bill savings that result from the retrofit measures.

Such practices have been strongly promoted by the C40 and the Clinton Climate Initiative following the launch of a public building retrofit initiative at the 2007 New York C40 summit. As a result seven cities have instigated energy performance contracting actions for municipally owned buildings and 6 for commercial buildings.

One of the exemplar cities on which the C40/CCI programme was based was Berlin. Here the city government, in partnership with Berlin Energy Agency (BEA), has project managed the tendering of retrofit contracts for 1,400 public and private buildings. CO_2 reductions of an average 26% are written into the public retrofit tenders so that the Energy Systems Companies (ESCOs) delivering the retrofit measures must deliver sustainable solutions. In total, CO2 reductions of more than 60,400 tonnes per year are reported, along with annual energy bill savings of US$14 million.

2.5.5 On-site renewable energy generation: municipally owned buildings

Sixteen cities reported taking a total of 23 actions to deliver building integrated renewable electricity generation on municipal buildings under the city's ownership. Over half of these (13) are related to distributed solar electricity and are predominantly carried out by cities with high levels of solar radiance. Furthermore, 12 cities reported taking a total of 18 actions to deliver building integrated heat generation on municipal buildings.

The City of Melbourne has delivered one of the more high profile of such projects, installing 1,328 photo-voltaic panels on the root of its famous Queen Victoria Market. The market is the largest tourist attraction in the state of Victoria, but while the photovoltaic panels themselves go largely unseen by the thousands of people who flock to the stalls, a real-time display lets shoppers know how the market is being powered. The installation saved an estimated 1,700 tonnes of carbon from its installation in 2003 to 2009.

2.6 FUTURE PLANS

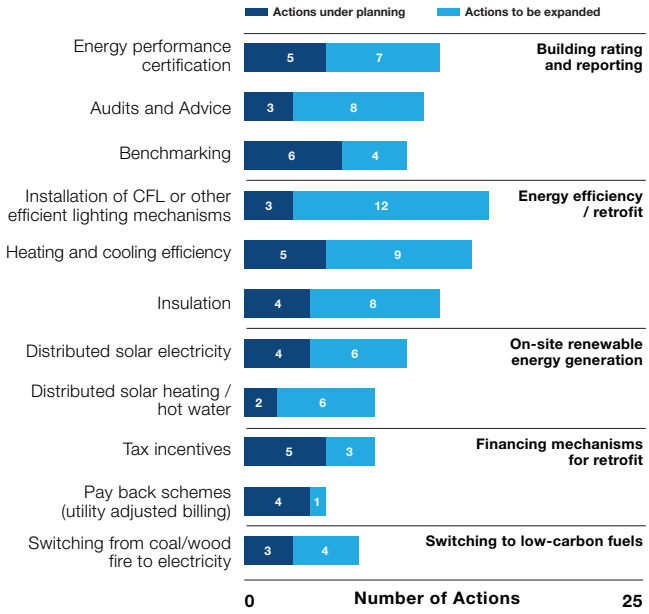
Figure 2.13 shows the actions cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation.

In commercial buildings, benchmarking and energy performance certification are the most popular actions, followed by incentives mechanisms for retrofit such as tax incentives. In the municipal building sector, most popular action for future plans are in audits and advice and energy performance certification, followed by on-site renewable energy generation.

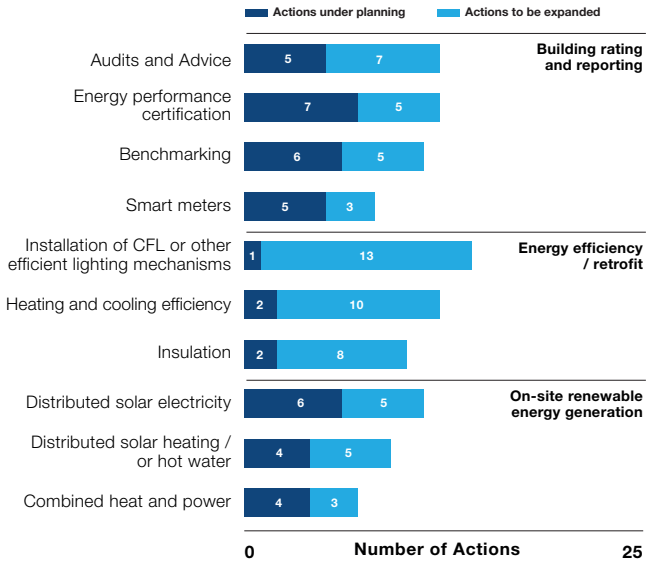
In the housing category, most popular actions for the future are on building rating and reporting, and specifically on energy performance certification.

FIG 2.13 CURRENT AND FUTURE PLANS

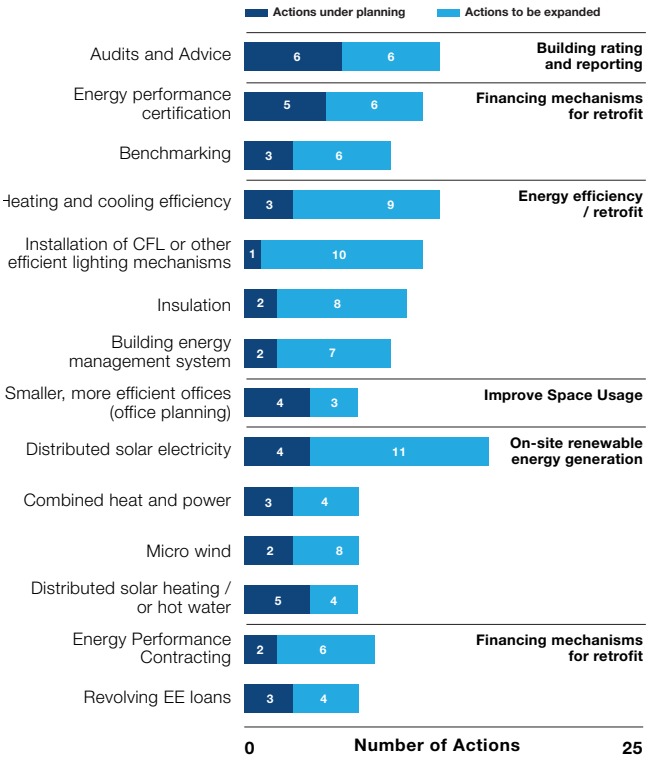
PUBLIC RESIDENTIAL BUILDINGS



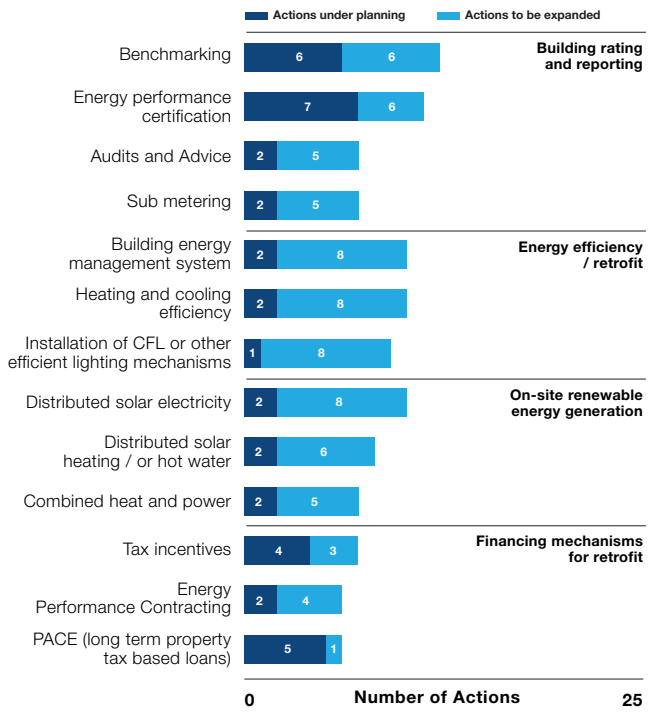
PRIVATE RESIDENTIAL BUILDINGS



MUNICIPALLY OWNED BUILDINGS



COMMERCIAL BUILDINGS



03.

WASTE MANAGEMENT

3.1 INTRODUCTION

Globally, waste accounts for around 3% of greenhouse gas emissions. In some C40 cities, where energy use is lower than the global average, this figure can be considerably higher (see figure 3.4).

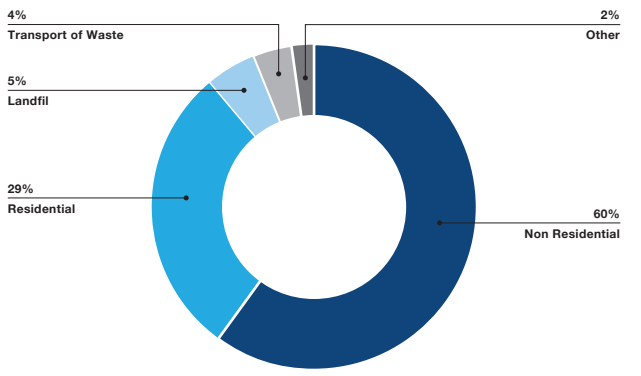
In addition to producing greenhouse gas emissions, waste can be a health hazard and the disposal of waste can be expensive, especially in countries where available landfill sites have been largely exhausted.

By reducing the amount of waste that is produced (re-using products or avoiding the need to purchase new products) both the total quantity of waste and the energy use associated with manufacture of products can be cut. Some types of waste can also be recycled or, in the case of organic waste, turned into compost. A large proportion of waste material can be converted into energy, through a variety of processes including incineration with heat capture, anaerobic digestion, mechanical and biological treatments (these treatments are considered in Chapter 5, Energy Supply).

Based on the powers C40 cities tend to have over different aspects of a typical urban waste management system, the waste sector has been broken down into the following sections for the purpose of this report.

- Residential waste – given that mayors tend to have most powers in waste over the residential sector, the residential sector has been analysed on its own.
- Non-residential waste – includes commercial, industrial, commercial & demolition and food & agriculture.
- Landfill – facilities for the disposal of waste in the ground.

FIG 3.1 WASTE: BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED BY C40 CITIES



3.2 OVERVIEW

The figures 3.2 and 3.5 indicate that waste is generated and managed in very different ways across the C40 cities.

FIG 3.2 TOTAL WASTE GENERATED IN C40 CITIES BY EACH REGION

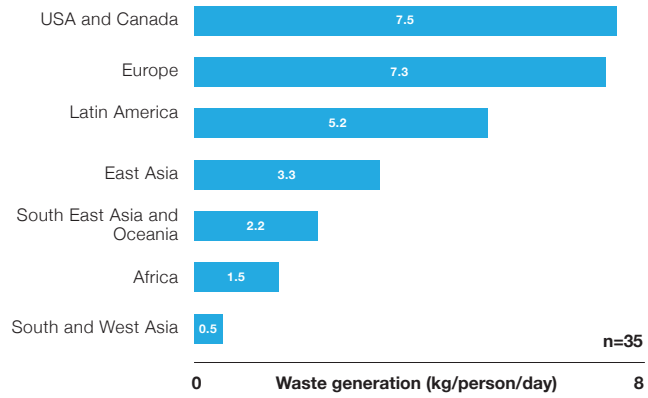


FIG 3.3 AVERAGE CO_2E EMISSIONS PER CAPITA FROM WASTE: C40 CITIES

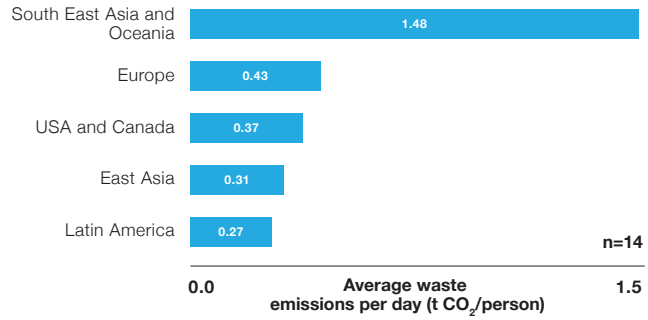


FIG 3.4 PROPORTION OF CITY CO_2E EMISSIONS ATTRIBUTABLE TO WASTE

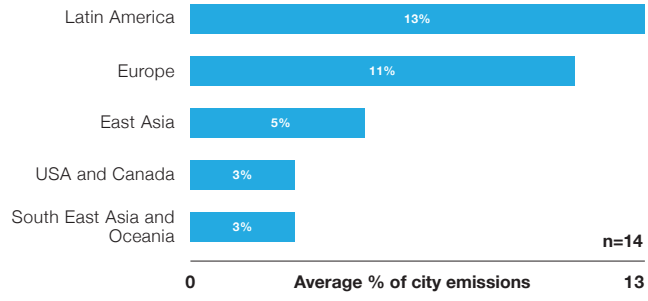
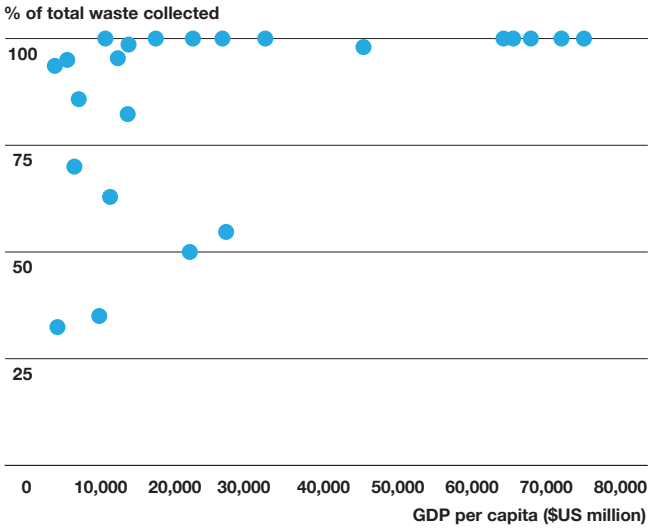


FIG 3.5 PROPORTION OF WASTE COLLECTED ACROSS DIFFERENT C40 CITIES



The greatest quantity of waste generated per person in the C40 surveyed cities is in the USA and Canada (7.5 kg/person/year), followed by those in Europe (7.3 kg/person/year).

Looking at carbon emissions from waste (figure 3.3) however, the picture is different, with the South East Asian C40 surveyed cities ranking highest at over 1 tonne per person – more than double that of any other region. This is likely to be related to methods of waste treatment – the two cities in South East Asia and Oceania which provided data send over 70% of their waste to landfill, which produces high emissions in the form of methane.

Looking at the same data from a third angle, average CO_2e emissions from waste as a proportion of total greenhouse gas emissions, C40 cities in Latin America rank highest at 13%, a little above European member cities at 11%, with South East Asia and Oceania (5%), USA and Canada (3%) and South East Asia (3%) much lower. This reflects the relative importance of other sources of emissions, for example in São Paulo emissions from energy supply and buildings are relatively low compared with New York. However, it does affect the relative importance given by individual C40 mayors to waste as part of their climate change programmes, and it helps explains why, for example, a Latin American city like São Paulo has taken more significant action in converting waste to energy compared to other cities in the C40.

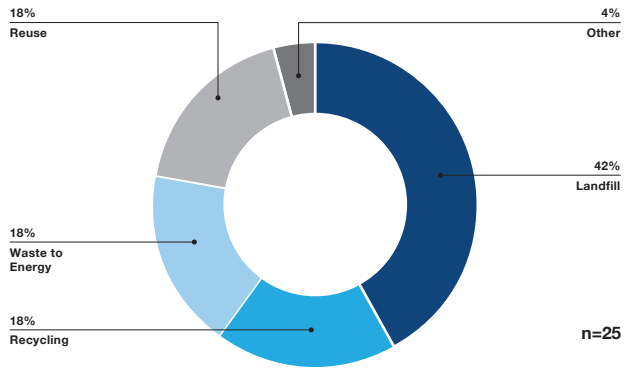
The proportion of waste collected by C40 cities varies considerably, from just over 25% to 100%. There is very strong correlation between levels of GDP and the proportion of waste collected, with the wealthiest cities implementing the most comprehensive waste collection services. While every city surveyed has some sort of formal waste collection service, these figures do not take account

collection and processing that takes place in many lower income cities. In Addis Ababa, for example, the city estimates that over 10,000 people earn a living in the informal waste collection, re-use and recycling trade.

3.2.1 Waste targets

Twenty three cities (88% of those that responded) have targets to reduce the quantity of municipal waste and / or to reduce greenhouse gas emissions from waste, indicating that this is a high priority for the vast majority of cities. These targets are often very specific and tough to meet, for example Johannesburg set targets to cut CO_2e emissions from waste by 15% by 2010; 25% by 2012; and 70% by 2022; Warsaw has separate targets for reducing electronic waste, packaging waste, and end-of-life vehicles.

FIG 3.6 WASTE: BREAKDOWN MUNICIPAL SOLID WASTE TREATMENT



3.3 POWERS

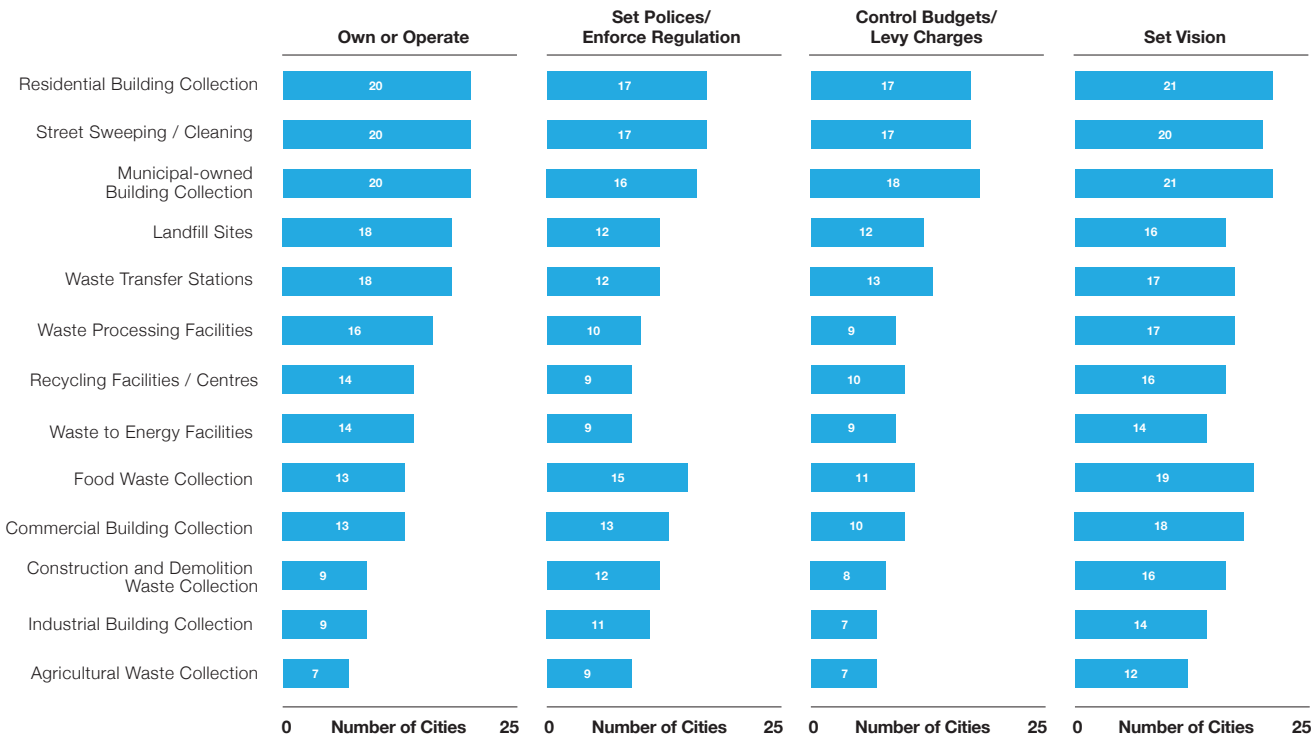
On average, C40 mayors exercise strong powers over the waste sector, especially over residential and municipal building waste collection, and street cleaning where 20 cities respectively own and operate these functions. A smaller but still significant number (13) own and operate waste collection from commercial buildings, and 18 cities set the vision for commercial waste collection, even if not all of them are directly responsible for implementing it.

Many mayors also have strong powers over waste treatment, with 18 cities owning and operating landfill sites and transfer stations, plus 14 that own and operate recycling facilities and waste to energy plants.

C40 city governments also tend to have the ability to affect waste policy through controlling budgets or setting levies and charges (24 cities have this power in residential waste collection, for example).

Across the different categories of intervention, the majority of mayors (14 to 21 out of a sample size of 27 for this sector) are responsible for setting the vision for waste management in their city.

FIG 3.7 C40 MAYORS' POWERS: WASTE



3.4 RESIDENTIAL WASTE

Figure 3.8 shows the number of cities that have undertaken at least one action in each of the listed categories of 'initiative' in the Residential Waste sector. Consistent with the powers available to most mayors, the initiatives where the largest number of cities have taken action relate to waste collection and prevention.

FIG 3.8 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN WASTE: RESIDENTIAL?

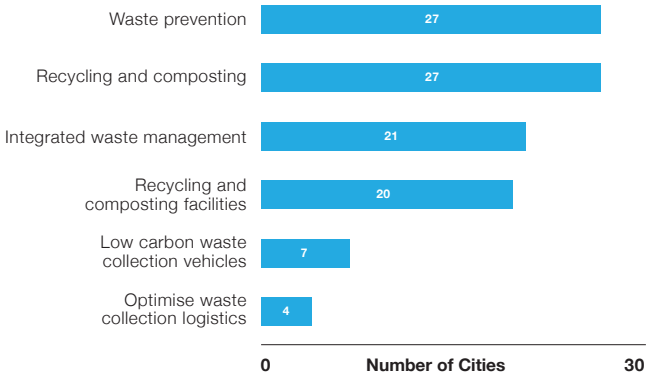


FIG 3.9 ACTIONS, SCALE AND LEVERS: WASTE MANAGEMENT (RESIDENTIAL)

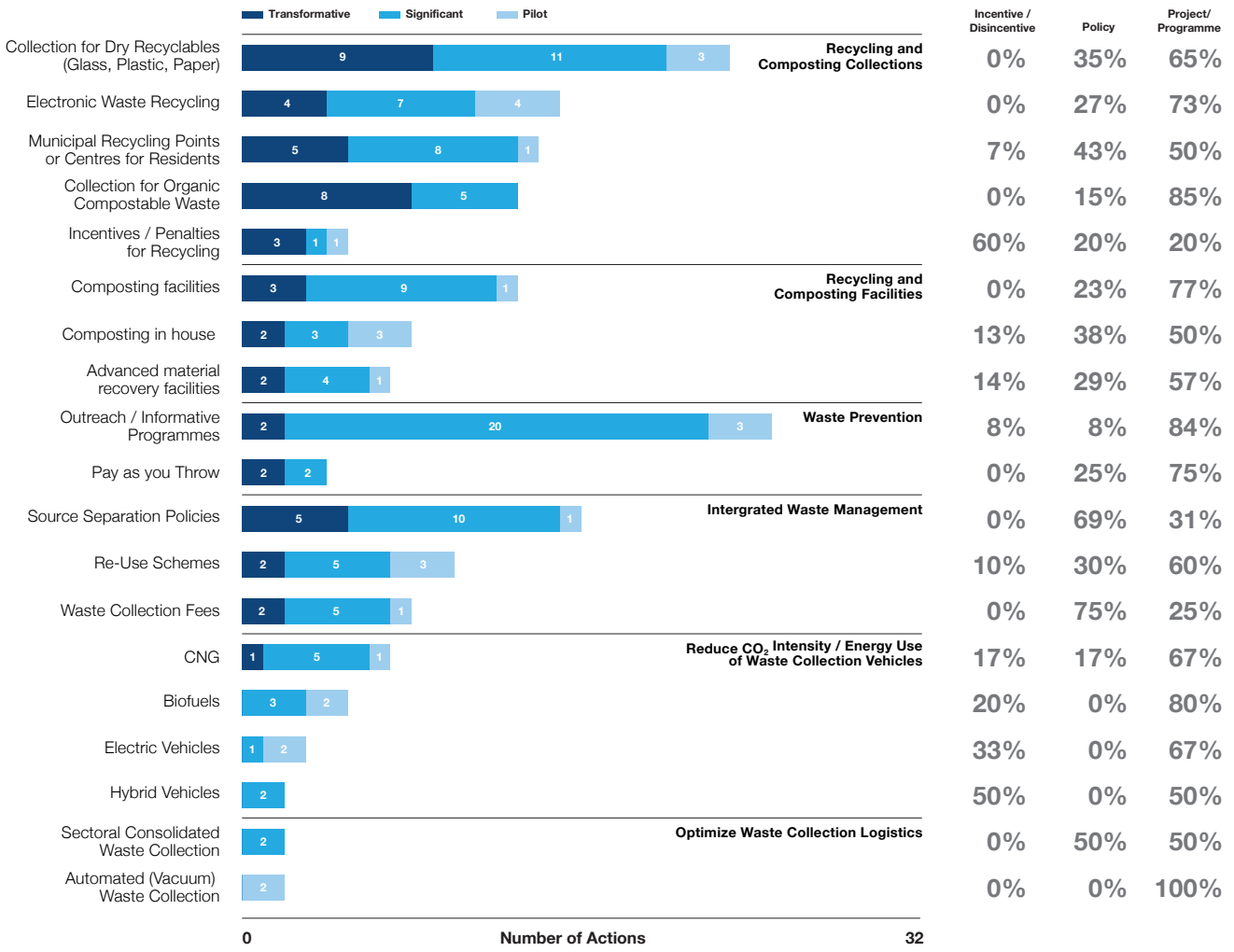


Figure 3.9 lists all actions recorded in the Residential Waste Sector. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive / transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or programmes.

With 25 separate actions recorded, 'outreach/information programmes' – usually efforts to encourage residents to recycle and separate waste – has the most activity. Only 2 of these actions are registered as 'comprehensive', suggesting scope for increasing activity.

Interestingly, the number of cities taking action on both this and the second highest action, 'collection for dry recyclables', is greater than those who have direct ownership or operational responsibilities for residential waste collection. It demonstrates that C40 mayors are taking waste management seriously and are using all available levers at their disposal. In this case of waste collection, 35% of actions use policy levers, rather than the programmes that tend to typify operational control.

Generally, however, the type of action utilised by cities is predominantly 'projects and programmes', reflecting the fact that many cities own and operate facilities or collection and so are able to directly implement actions themselves.

There are, however, 4 cities that have only begun pilot projects to collect recyclable material and a further 12 for whom data on activity was not available for this survey, suggesting that there is still scope to expand this form of waste collection across the C40 network.

3.4.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are already taking notable action.

3.4.1.1 Price mechanisms to reduce waste and increase recycling

One area that appears to have considerable potential for scaling up action, is the use of price mechanisms to reduce waste and increase recycling.

Of the 20 cities which have powers of ownership and operation of residential waste collection, only 5 are recorded as already having implemented incentives / penalties to recycle, with one city having a project at the planning stages. This suggests an opportunity to scale up activity in at least 15 C40 cities.

Some cities that have the power to levy new taxes are using these to discourage waste. For example, in 2007 Hong Kong put in place an 'Environmental Levy on Plastic Shopping Bags'. As a result there is a charge of 5 cents (US$) on each plastic shopping bag to reduce their use.

3.4.1.2 Compostable waste

Organic waste forms a significant proportion of total waste, particularly in less developed cities, or the informal settlements within cities. In Addis Ababa, for example, over 70% of waste is organic.

Organic waste creates methane, a powerful greenhouse gas, if it is sent to landfill, but if it is collected separately it can either be converted into energy through processes such as anaerobic digestion (see Energy Supply chapter), or re-used as compost. This latter option is often particularly well suited to less developed cities which tend to still have a measure of urban agriculture (see Planning and Urban Land Use chapter).

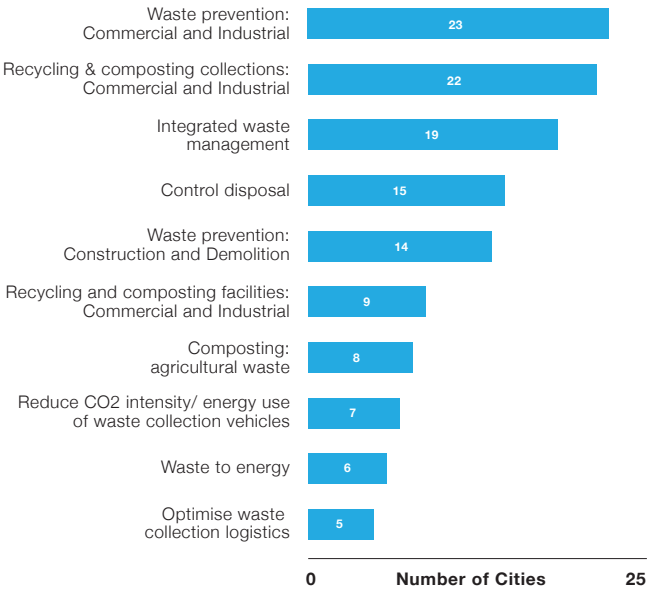
Chicago City Council amended an ordinance governing small-scale, residential-type, compost operations in 2007 to encourage more composting. The city now publishes a guide for residents on how to compost.

In Addis Ababa, the mayor has supported a number of small scale community composting projects, which serve the significant and growing urban agriculture which the city also encourages.

3.5 NON-RESIDENTIAL WASTE

Figure 3.10 shows the number of cities that have undertaken at least one of the 35 actions in the 10 categories of 'initiative' in the non-residential waste sector. Twenty three cities have initiatives to prevent the creation of waste from commercial and industrial activities.

FIG 3.10 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN WASTE: NON RESIDENTIAL?



Twenty-two cities collect dry recyclable and compostable goods from commercial waste, a similar number to that for residential waste, and indeed a majority of cities have initiatives relating to the collection of both commercial and residential waste, reflecting the fact that 13 of the 20 cities that own and / or operate residential waste collection also have similar powers over commercial waste collection. However, only 4 of these cities are recorded in the survey as taking significant/comprehensive actions in both sectors.

The largest number of actions in this initiative are 'comprehensive', suggesting that these practices are well embedded in many cities. But there are also 5 pilot projects (not including industrial) and 9 cities that have implemented a combined 15 actions which are significant but not yet comprehensive.

A mixture of policy / regulation and programmes is used to deliver the actions. Policy/ regulation tends to be used more frequently in relation to attempts to increase the re-use of products and to reduce packaging; and also in relation to the construction sector. For example 75% of waste permitting and construction waste recycling actions are policies / regulations.

There is proportionally a high number of pilot programmes relating to re-use and packing policies, suggesting this is a relatively new area for many mayors.

3.5.1 Findings in focus

The section below highlights in more detail initiatives or actions where C40 cities are either already taking notable action and / or there is significant scope for scaling up activity.

3.5.1.1 Waste prevention / outreach

Greenhouse gases are produced at every stage in the production of goods, from the extraction of raw materials, transport, manufacturing and use, to the final treatment of waste and its disposal. The global consumption of key raw materials is rising fast.

Twenty-three C40 cities have taken initiatives to reduce the amount of waste that is produced from the commercial sector. In terms of emissions reductions achieved this can be one of the most powerful actions in the waste sector. The highest number of actions recorded is for outreach / information programmes (29). Cities that have strong powers over commercial waste collection are more likely (16 out of 29) to engage in outreach programmes than those which have more limited powers or none. Those cities which have engaged in comprehensive outreach programmes tend also to record the highest rates of recycling, such as Los Angeles (62% recycling rate) and Toronto (44% recycling rate).

3.5.1.2 Waste collection

Six cities in this survey collect less than 75% of city waste. Two of these have only limited powers over waste collection. While there is a correlation with GDP and it is the less wealthy cities that have the lower rates of collection, nevertheless there are some cities which have achieved very high levels of waste collection despite relatively low GDP. For example, Bogota, Rio, Beijing, Hanoi and Delhi NCT all collect over 90% of waste, with Shanghai, and Lima collecting over 80%.

There are also 6 cities which have strong powers over commercial waste collection but which have not delivered actions on any of the following: source separation; electronic waste recycling and municipal recycling points for businesses.

3.5.1.3 Electronic waste collection

Discarded electronic products form a growing part of waste materials. Electronic waste collection is now taking place in 18 cities, although the actions here are less comprehensive than might be expected.

FIG 3.11 ACTIONS, SCALE AND LEVERS: WASTE MANAGEMENT (COMMERCIAL)

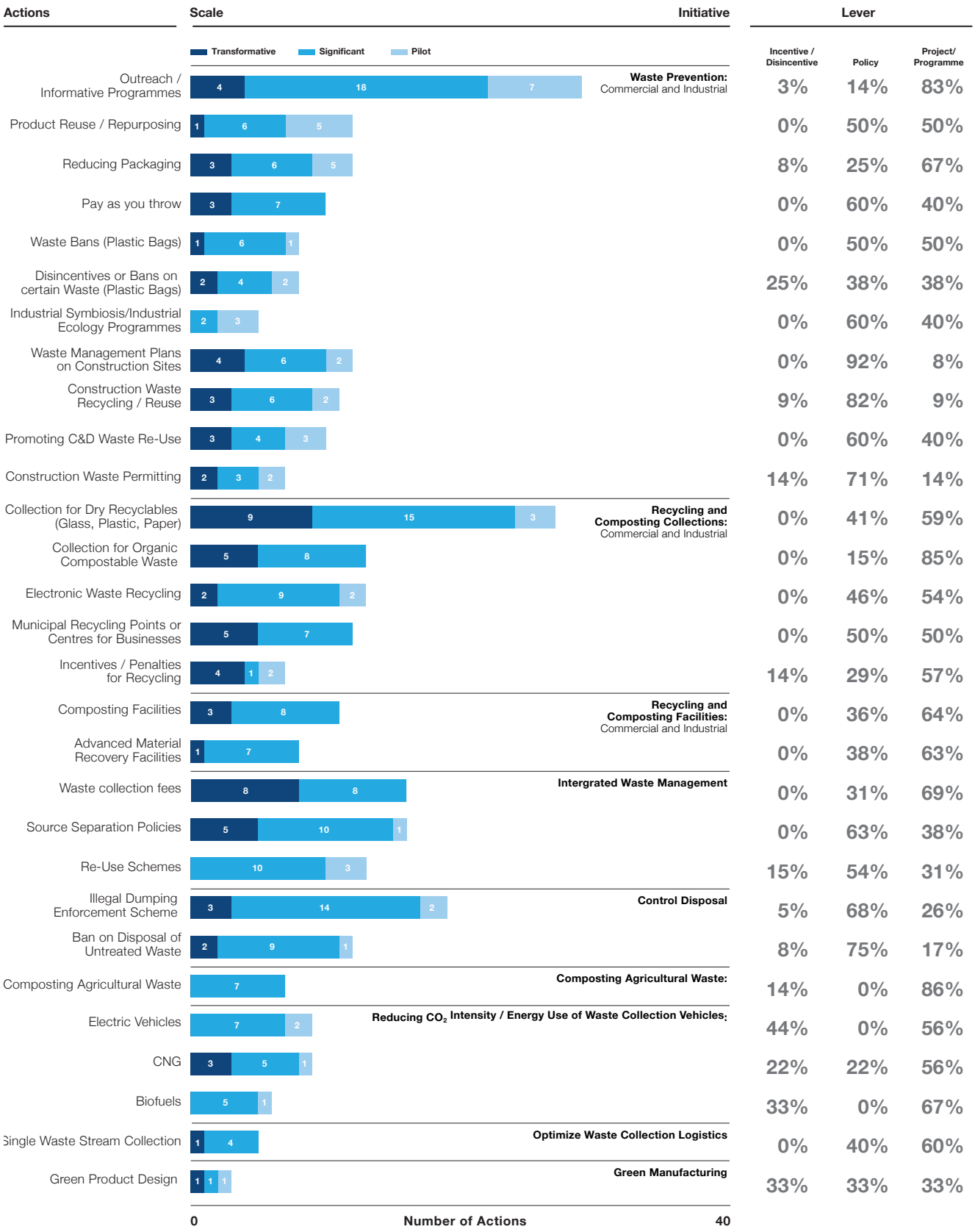


Figure 3.11 lists all actions recorded in the Commercial (ie Non-Residential) Waste sector. This sector includes waste from commercial, construction and industrial sources. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly: pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or programmes.

3.6 LANDFILL

Figure 3.12 shows the number of cities that has undertaken at least one of the actions in the 5 categories of 'initiative' in the landfill sector. Seventeen cities have taken actions to reduce emissions from landfill.

FIG 3.12 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN WASTE: LANDFILL?

FIG 3.13 ACTIONS, SCALE AND LEVERS: WASTE MANAGEMENT (LANDFILL)

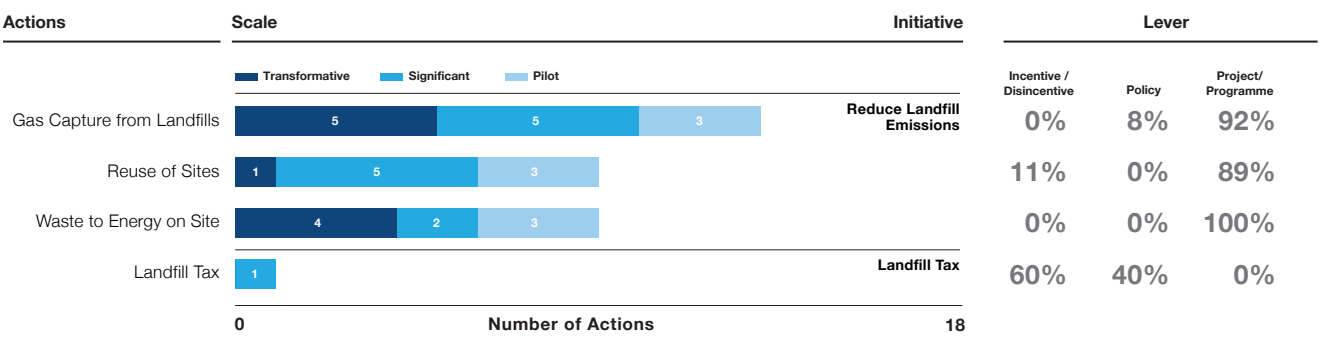


Figure 3.13 lists all actions recorded in Landfill Sector. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive / transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or programmes.

Eighteen C40 cities own and operate waste landfill sites. It is, therefore, a sector in which many cities can make a real difference to reducing greenhouse gas emissions. This is particularly important in Latin America, where 14% of total GHG emissions come from waste, primarily from methane emissions from landfill.

Thirteen cities have put in place schemes to capture gas from landfills, of which 10 are comprehensive or significant programmes and 3 are pilots. Five cities have implemented a landfill tax or levy (although many other cities have landfill taxes imposed by regional or national governments) and 4 are using other price mechanisms to discourage landfill.

3.6.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action.

3.6.1.1 Reducing waste to landfill

Based on data received from 19 cities, the average percentage of waste that is sent to landfill from C40 cities is 57%.

When organic waste decomposes at landfill sites it produces methane, a gas which has a global warming potential 23 times higher than carbon dioxide. The proportion of biodegradable waste varies from city to city, but as an example the European average is 60-70% of municipal waste. Reducing waste sent to landfill, or where this is not possible in the short term capturing the methane it produces and burning it to generate energy, is important for most C40 cities.

This is a problem that unites cities with very different levels of wealth and across all regions. For example, London and New York send 47% and 64% of waste to landfill respectively, not dissimilar to Shanghai's 54% and Johannesburg's 55%. Paris, at 11% and Seoul at 21% provide the lowest rates of waste to landfill, however there are affiliate cities of the C40 that have even more impressive records. For example, by putting in place an integrated programme over many years, Copenhagen now sends less than 2% of waste to landfill; in 1988, over 40% of its waste was sent to landfill. Half of Copenhagen's waste is now recycled and maximum use is made of waste to generate heat for the city's district heating network.

3.6.1.2 Landfill gas capture

During past years, 10 million citizens of São Paulo have been producing 15,000 tonnes of waste on a daily basis. While the city's two landfills, Bandeirantes and São Joao, were reaching their maximum storage capacity, São Paulo City Hall had to deal with environmental concerns over the methane produced by waste decaying and social complaints by the surrounding boroughs that wanted the landfills to be closed down.

Through a public bid, São Paulo City Hall gave a concession to a holding company Biogas Co. to install thermoelectric power plants to burn biogasses emitted by decaying waste from the landfills in order to produce clean energy and prevent GHG being emitted into the atmosphere.

By capturing and burning the methane gas, the landfills generate more than 175,000 MWh in each power plant, the equivalent to 7% of the electricity consumed in the city.

3.7 FUTURE PLANS

Figure 3.14 - Figure 3.16 show the actions cities are planning to either expand if they are already implementing them, and actions cities are considering for implementation. It demonstrates that C40 cities have considerable additional or new actions planned to reduce emissions from waste.

Plans to extend or introduce outreach programmes to reduce the generation of waste stand out as an area where large numbers of actions are planned (7 new and 23 expansion plans for commercial waste, and 1 new and 20 expansion plans for residential waste).

The number of planned new or expanded actions for source separation (a total of 32 if you add residential and commercial waste together), and for electronic waste (33 taking residential and commercial waste jointly) also stand out.

FIG 3.14 WHAT RESIDENTIAL ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?

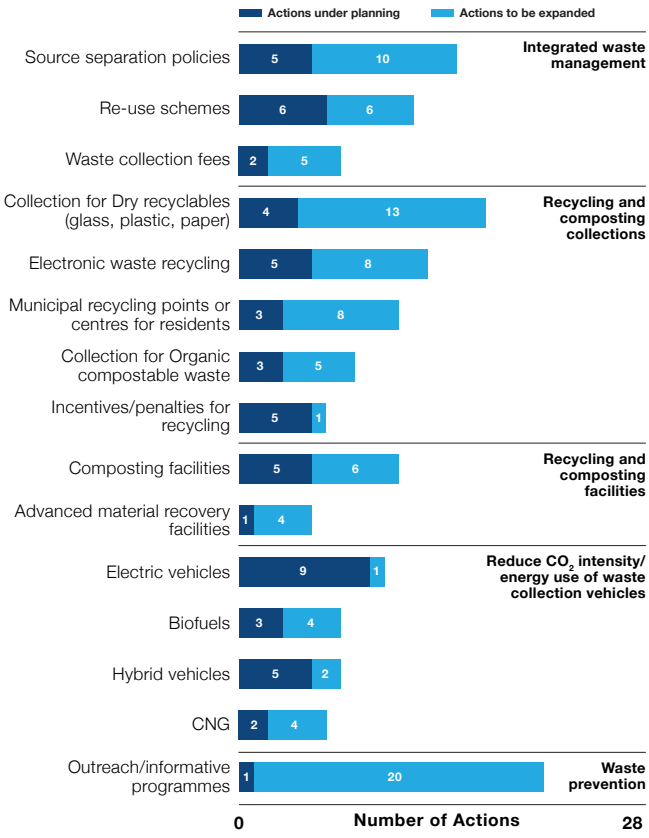


FIG 3.15 WHAT NON RESIDENTIAL ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?

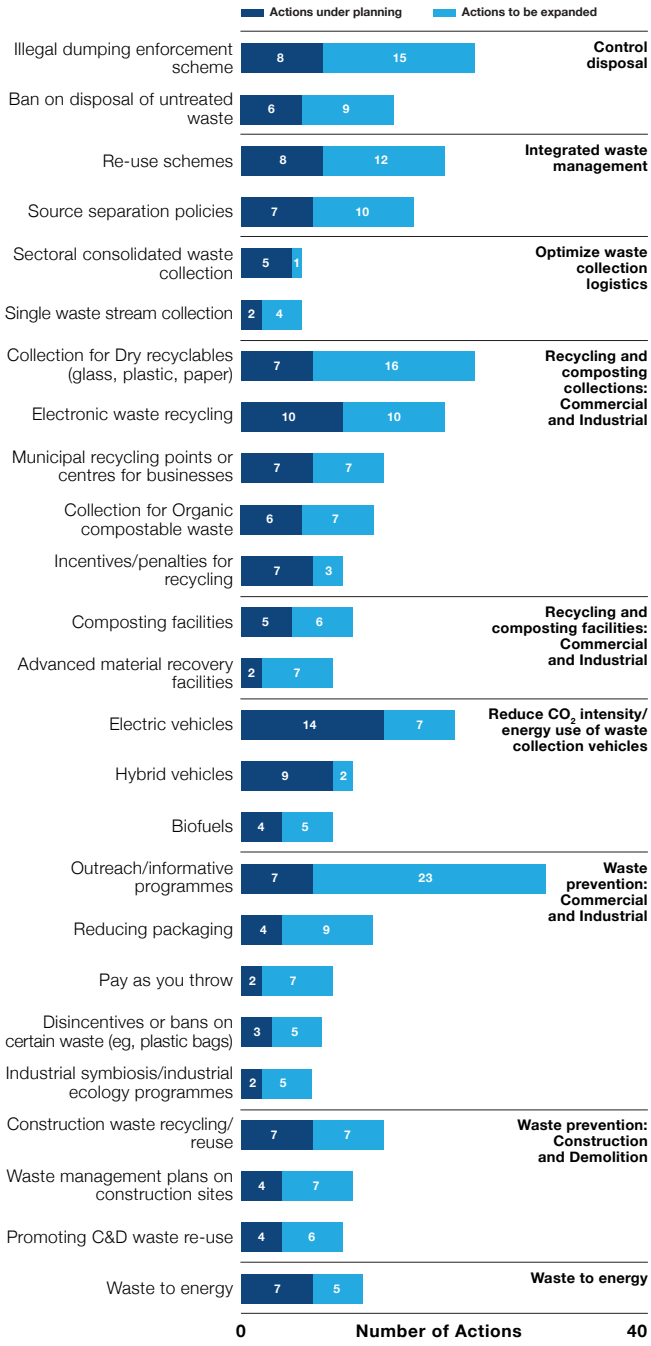
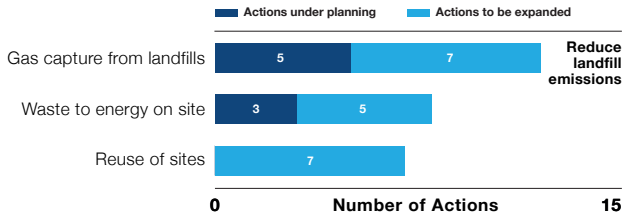


FIG 3.16 WHAT LANDFILL ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?



04.

WATER

4.1 INTRODUCTION

Water is one of the single most important resources for a city - and it is a resource that poses a range of significant challenges for mayors across the globe. For cities in drought or low precipitation areas in particular, water is a precious asset which needs to be conserved and managed efficiently and sustainably. In contrast, other cities face the opposite problem: heavy precipitation that brings floods which overwhelm city infrastructure, damage homes and spread water-borne diseases, impacts which will only be intensified with climate change.

Some cities suffer from both drought and flooding during different seasons. Furthermore, a number of C40 cities in developing economies are striving to ensure all residents have access to clean water and adequate sanitation, while others are facing massive costs for rehabilitating ageing infrastructure.

Water is essential not only for supporting human health and well-being, but also for enabling agriculture and industry to thrive. It is estimated that irrigation of crops accounts for about 70% of all water withdrawals in the world[1]. The water sector can have a significant impact on carbon emissions, particularly for cities where water needs to be transported over long distances or requires significant treatment to be potable (such as desalination or recycling).

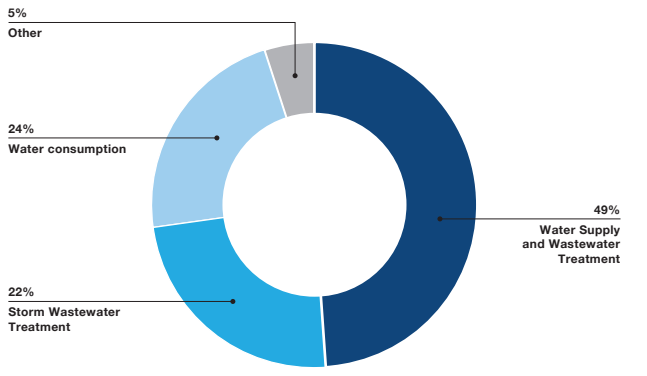
There is a strong connection between energy and water: producing, treating and pumping water requires a significant amount energy. Due to the high "embodied" energy in water, actions that can help reduce water use can contribute significantly towards the reduction of greenhouse gas emissions.

The water sector has been split into three main categories for the purpose of this report:

1. **Water Supply and Water Consumption** - which includes initiatives and actions undertaken by cities relating to demand reduction, water efficiency, and recycling;
2. **Wastewater** - which includes initiatives and actions undertaken by cities relating to methane recovery, sewerage connection fees and waste to energy; and
3. **Stormwater Management** - which includes initiatives and actions undertaken by cities relating to sustainable urban drainage and streetscapes. Stormwater Management is also covered in the Adaptation section.

Figure 4.1 shows the breakdown of planned and implemented actions by category of analysis used in this report. The majority of actions which cities have focused on relate to water supply and consumption, in particular water demand reduction. This reflects not only the strong powers mayors have over water assets, but also the recognition of water as a precious resource to be conserved for future generations.

FIG 4.1 BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED IN THE WATER SECTOR

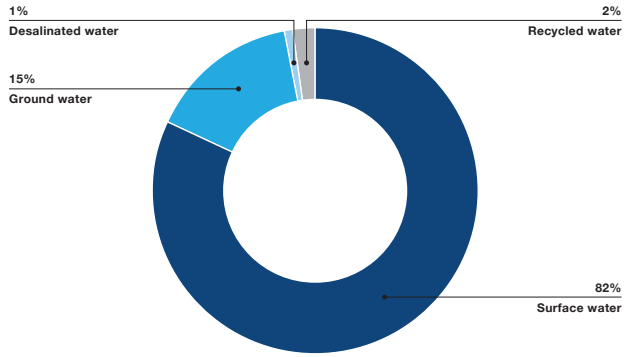


[1] UN, World Water Development Report, 2003

4.2 OVERVIEW

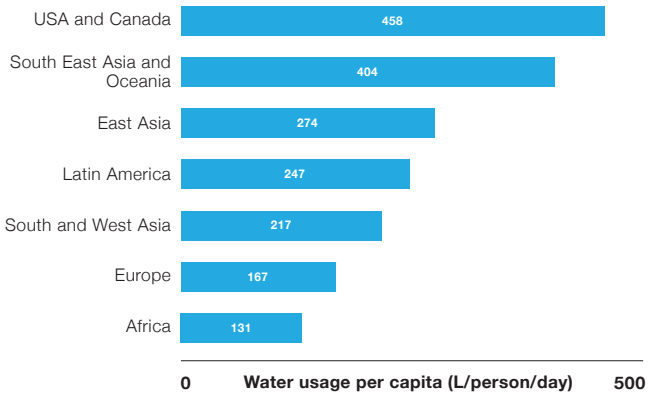
C40 cities rely primarily on surface water for their water supply sources. Only a few have turned to alternative sources such as desalinated water and recycled water. Notable exceptions to this are Beijing and Sydney, which have high reliance on recycled water (18% and 7% respectively) due to the severe water shortages faced by both cities.

FIG 4.2 WATER SUPPLY BREAKDOWN OF C40 CITIES



Water use varies significantly across the C40 cities, with higher use reported in USA and Canada and South East Asia and Oceania.

FIG 4.3 AVERAGE WATER USE PER CAPITA PER DAY (LITRES) IN C40 CITIES

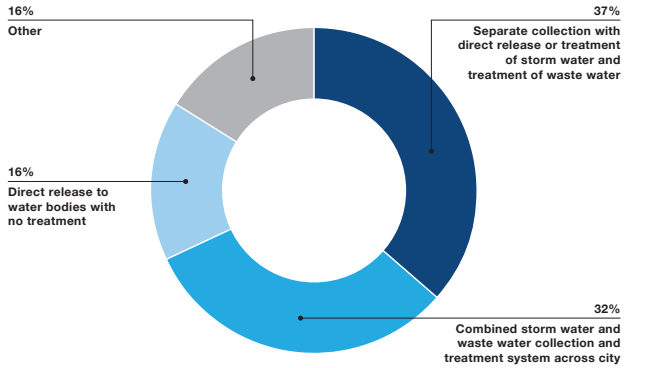


Metering water consumption is essential to monitoring and reducing usage. About 70% of cities have mandatory metering for domestic water use, while over 90% have mandatory metering for commercial or industrial users.

C40 cities reported that the average proportion of the population with access to adequate sanitation is 87%, although it should be noted that the sample size of 30 excludes six cities in developing countries.

In terms of wastewater and stormwater treatment, a slightly larger proportion of cities have separate systems for wastewater treatment and stormwater treatment or direct release. Three cities reported direct release with no treatment.

FIG 4.4 HOW IS STORMWATER TREATED IN CITIES?



4.3 POWERS

On average, C40 mayors exercise relatively strong powers over the water sector (see figure 4.5) across different functions and different elements of power. The strongest average powers are over water supply where 18 cities own or operate this infrastructure.

Overall the results in water sector assets show an all or nothing scenario: mayors either tend to have very strong powers across ownership/operation, policies/enforcement, budget/revenue control, and vision setting, or they have no powers at all. This shows that where the mayor does have powers over water supply and treatment, there is opportunity to have a strong impact, and with other cities an alternative approach may be required.

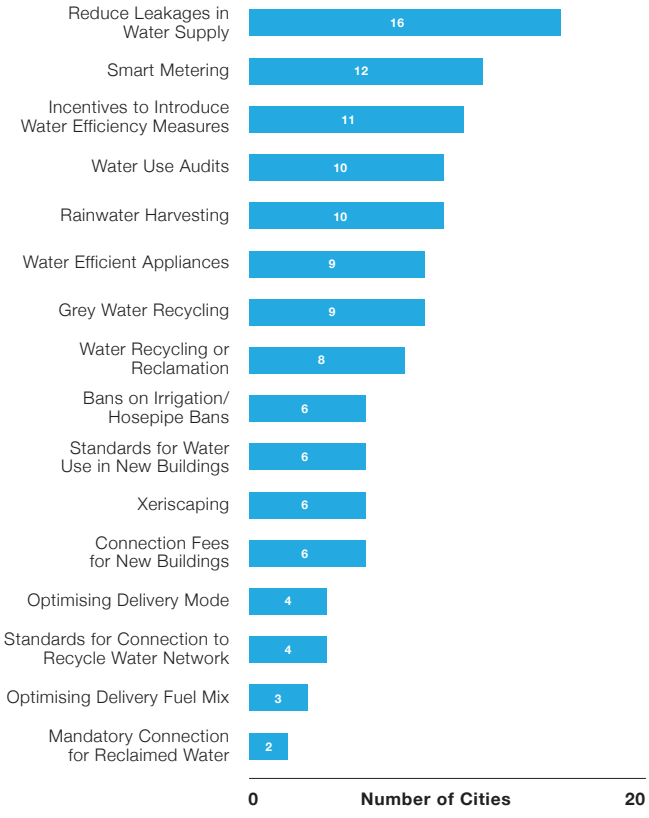
FIG 4.5 C40 MAYORS' POWERS: WATER

4.4 WATER SUPPLY & CONSUMPTION

Figure 4.6 shows the number of cities that have undertaken at least one action under the 14 types of initiatives in Water Supply and Consumption. As shown in the figure, cities have focused strongly on water conservation and efficiency, followed by actions to expand alternative water supply.

It should be noted that 4 cities provided data showing that 10% or more of the population does not have access to a potable water supply in their home. The immediate priority in these cities involve the provision of potable water, a category not included in the survey.

FIG 4.6 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES ON WATER SUPPLY AND CONSUMPTION?



Cities have focused mostly on reducing leakages, smart metering, incentives for water efficiency, and water use audits. In terms of scale, these four actions have been classified as transformative or significant, indicating they have been extensively implemented across cities.

Over half of all actions have been projects / programmes and half of actions are 'transformative / comprehensive', reflecting that they are capital-intensive or city-wide initiatives. Actions that have been less popular are those relating to reducing CO_2 in water delivery and standards and programmes for mandatory connections to recycled water network. It is interesting to note that few actions have been carried out to establish standards for water use in new buildings, despite many cities having strong powers to set and / or enforce building codes.

While many transformative actions have been carried out in water supply and consumption, there is considerable opportunity to expand activity in this area. C40 cities tend to have strong powers in the water sector, but have been slower to take action. Most actions have been carried out between only 5 and 15 cities, indicating that many C40 cities have not made water use reduction a priority and that they possibly have not seen the connection between water and carbon emissions. Most actions have been transformative and significant in scale, so there is potential for knowledge sharing from leaders in this area.

Few cities have used policy levers, despite the fact that 14 cities are able to set policies in water supply, and fewer have used incentives / disincentives despite the fact that 17 have powers relating to budgetary control and revenue sources. However, given the capital intensive nature of water use and supply initiatives, and the fact that many require city-wide programmes, it is not surprising that most actions have been implemented through projects / programmes.

4.4.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and / or there is significant scope for scaling up activity.

4.4.1.1 Leak reduction

Cities can lose huge amounts of their often energy-intensively produced potable water due to leakage from pipes during distribution. This is true across the C40 network, from a high GDP city like London, whose nineteenth century pipe-work is now being upgraded to plug a leakage rate of over 25%, to Addis Ababa where poor quality pipes are being replaced as the city's GDP continues to rise and a 50% leakage rate can be improved.

Wasting potable water can be triply expensive, because it costs money to purify and distribute water, increases greenhouse gas emissions, and is also a major issue for those cities that are threatened with droughts. The number of drought-threatened cities is rising due to climate change. Tackling water leakage is thus both a climate mitigation and adaptation issue.

Sixteen cities have delivered programmes to reduce leaks from water supply pipes, of which 75% have used projects and programmes, reflecting ownership and operational control of the assets, while 19% have used polices and 6% have used incentives / disincentives.

FIG 4.7 ACTIONS, SCALE AND LEVERS: WATER SUPPLY AND CONSUMPTION

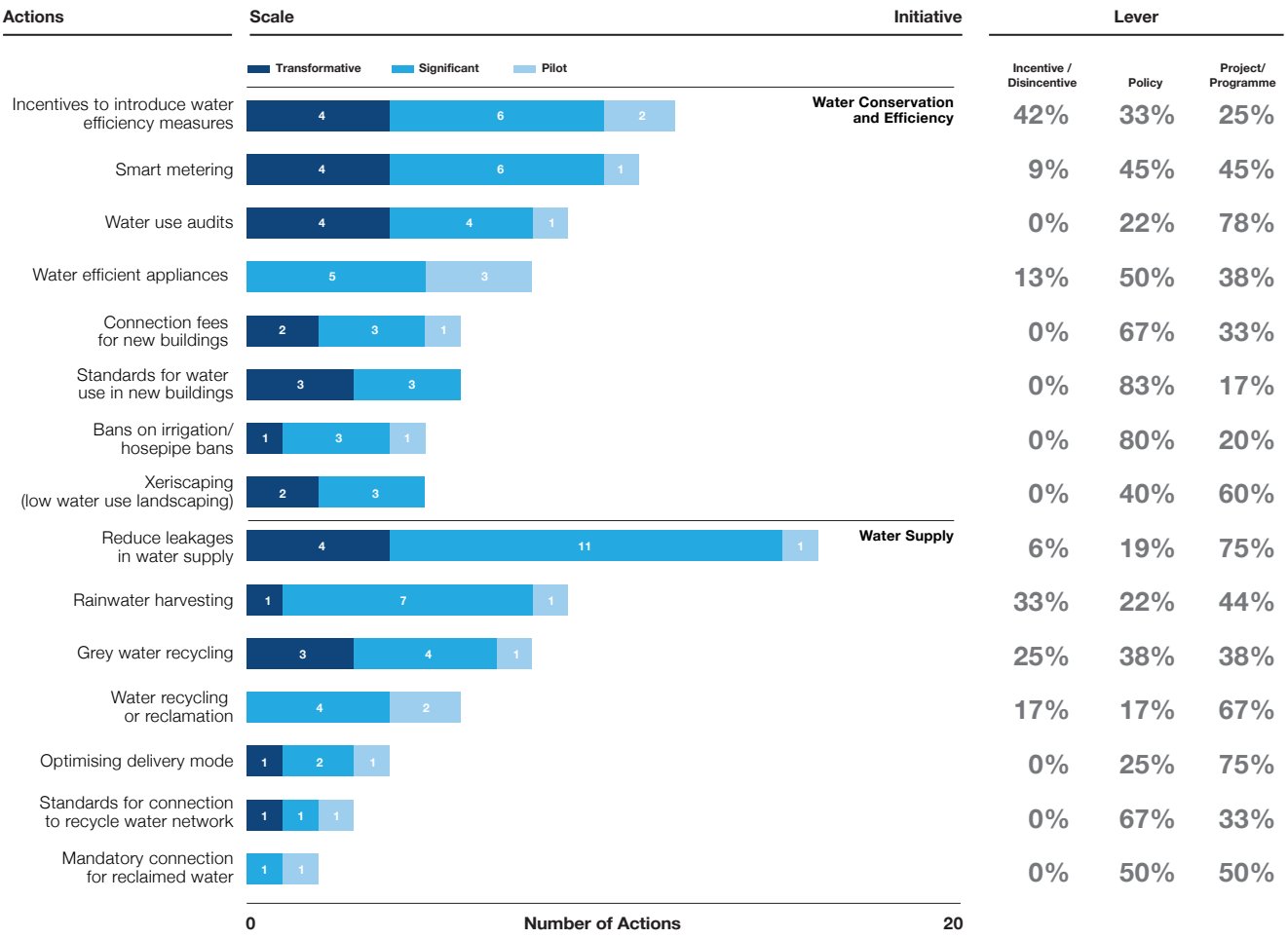


Figure 4.7 lists all the actions implemented for water supply and consumption and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives / disincentives, or policies / programmes.

The C40 cities that are fixing leaks span the globe and all levels of GDP. Tokyo, where the mayor owns and operates most of its water supply, is regarded as one of the world-leaders in tackling water leakage, where a systematic approach to detecting and repairing leaks has helped to reduce the leakage rate from 20% in 1956 to 3.6% in 2006. This has delivered an associated benefit of reducing carbon dioxide emissions by about 73,000 tCO_2 annually.

In recent years Tokyo has increasingly used electronic technology to constantly monitor pipes for the onset of corrosion, allowing the authorities to repair leaks before they become chronic. Old cast-iron distribution pipes are replaced with ductile cast iron, and services pipes under lead are upgraded from lead to stainless steel.[2]

In Beijing, where the mayor owns and operates all water supply and treatment operations, action is under planning and already taken to protect their water supply for years to come. The government has raised over US$1.2 billion to support rural communities which surround Beijing's water supply, to treat their wastewater. This will ensure the safety of Beijing's drinking water and save the city money in the long term. Similarly, in New York City, a watershed protection program undertaken by the mayor, seeks to purchase land nearby and treat the waste water from communities surrounding its water supply, hundreds of miles away. These relatively low-cost efforts today, save the cities from having to install large, costly water supply treatment facilities in the long-term.

4.4.1.2 Other actions to reduce water consumption and improve water efficiency

The amount of water consumed per person varies considerably across C40 cities. Many mayors have identified in their strategies that there is considerable wasteful use of water (although the definition of what is wasteful tends to vary depending on the relative scarcity of water supplies). Cutting wasteful water consumption can reduce energy demand and carbon emissions, as well as improve a city's resiliency to drought.

Of the cities with the highest levels of water consumption per capita[3] some are taking a variety of actions to reduce the wasteful use of water. These actions range

[2] *C40: http://www.c40cities.org/bestpractices/water/tokyo_waterworks.jsp*
[3] Water consumption per capita data was obtained for 31 cities
[4] Arup research for C40 UrbanLife Melbourne workshop, 2010
[5] *http://www.toronto.ca/watereff/water_saving_kits/indoor_kit.htm*

FIG 4.8 ACTIONS, SCALE AND LEVERS: WASTEWATER

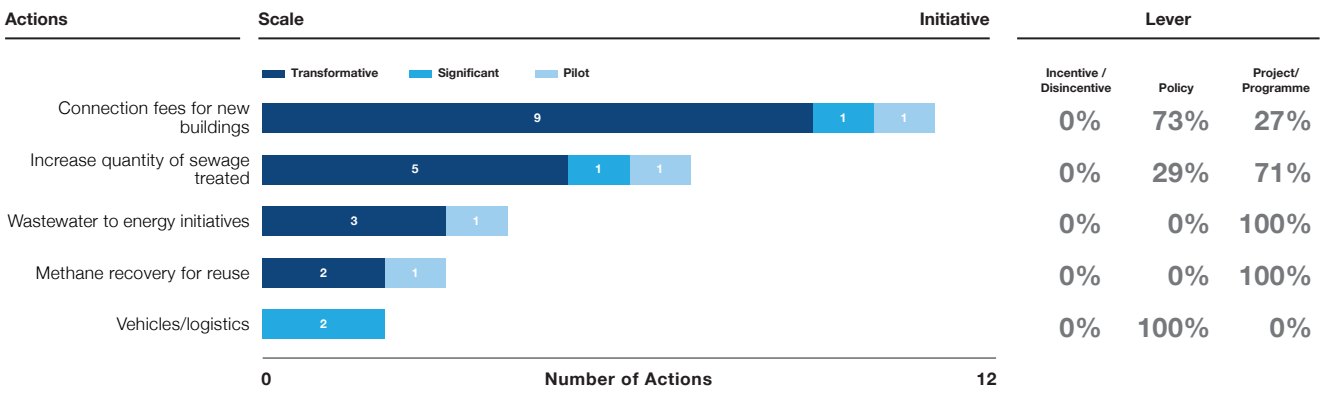


Figure 4.8 lists all the categories of 'Initiative' recorded in wastewater and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives / disincentives, policies, or projects / programmes.

from public information campaigns to utilising pricing mechanisms, but it is perhaps surprising that a relatively small number of cities have taken action in some key areas, for example:

- Only 12 cities are billing for water using household water meters.
- Only 8 have started to roll-out the use of 'smart' water meters, which provide consumers with live information on their consumption, with another three considering to undertake this action.
- Only 6 report having set standards for water usage in new buildings (this very low figure may simply be accounted for by under-reporting).

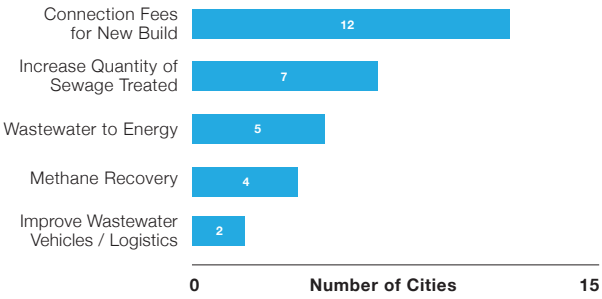
Where cities have made systematic attempts to change water consumption patterns, however, the results have been impressive. The city of Melbourne, for example, used public information campaigns to achieve a reduction in water consumption of 68% of households in a 12 month period between 2007 and 2008.[4]

The City of Toronto has undertaken similar actions and provides 'water efficiency indoor retrofit kits' to residents for US$10.00 at 'Community Environment Day' events. These include a high efficiency showerhead, kitchen swivel aerator, 2 bathroom aerators, 1 pack of leak detection tablets, a teflon tap and a set of installation instructions. This is backed up by public information campaigns which focus on resource efficiency objectives, including water consumption.[5]

4.5 WASTEWATER

Figure 4.9 shows the number of cities that have undertaken at least one action under the five categories of 'initiative' in the Wastewater section of the survey. Few cities have taken action related to wastewater treatment. For those that have, the top priority has been establishing fees for connecting new developments to the sewage network- a prime mechanism for helping cities to fund wastewater infrastructure.

FIG 4.9 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN WASTEWATER TREATMENT?



Most of the actions taken in wastewater have focused on connection fees for new buildings, which have been categorized primarily as policy measures, and increasing sewage treatment, a priority area for many cities in developing nations, which has been undertaken via projects / programmes. This is consistent with the findings on powers indicating cities have strong powers in policy setting and strong budgetary control over wastewater assets.

4.5.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and / or there is significant scope for scaling up activity.

4.5.1.1 Wastewater to energy

Energy can be generated from wastewater, turning an environmental problem into a low carbon solution.

Seventeen cities have ownership or operation control over the wastewater treatment facilities. Of these, only 2 have already implemented actions to reduce extract energy from wastewater, suggesting that there is the potential opportunity for a further 15 cities to deliver similar actions. Through the C40 network, the successful experience of cities that have already implemented wastewater to energy actions can be transferred to other cities facing comparable problems.

FIG 4.10 ACTIONS, SCALE AND LEVERS: STORM WATER TREATMENT

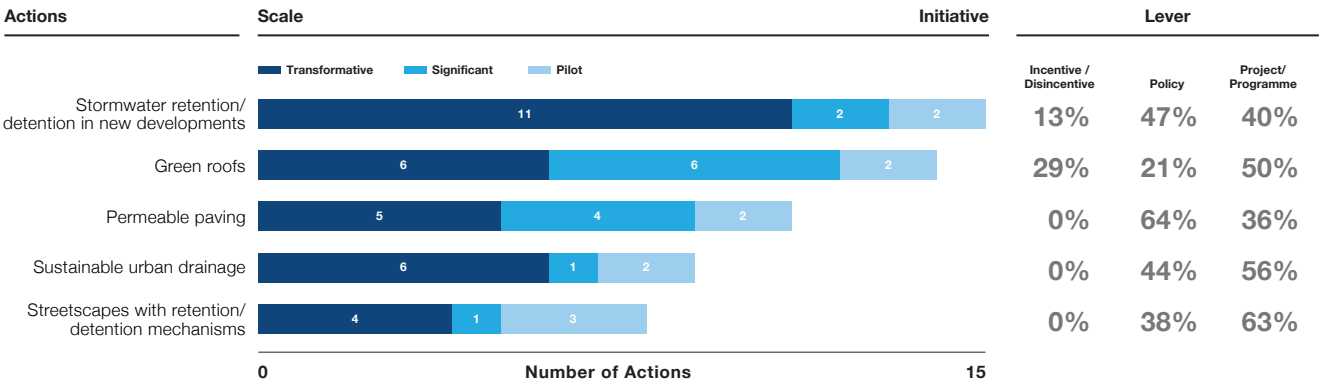
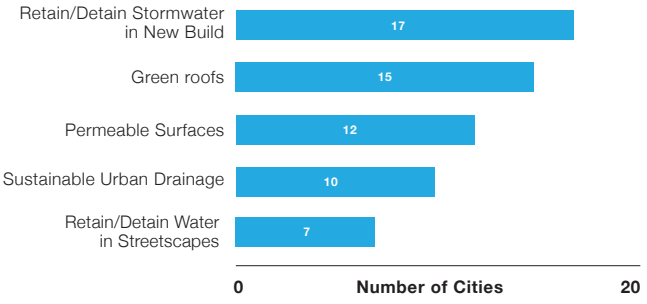


Figure 4.10 presents the actions implemented in Stormwater Management. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive / transformative. On the right of the figure is an indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or projects / programmes.

In Berlin, the mayor uses relatively stronger powers to implement strategies to reduce the electrical demand associated with water supply and wastewater treatment, using the mayor's powers over the sector, including there improvement of existing generation of power and heat from sludge. The mayor of Lima is presented with great opportunity to coordinate with state government targets to treat and capture all of the methane from the wastewater of Lima and nearby Callao. Through World Bank and IFC funded projects for the state-owned water utility (SEDEPAL), Lima is considering to undertake actions to mandate water use audits and smart meters. These complimentary actions will improve the overall efficiency of this region's water cycle.

4.6 STORMWATER MANAGEMENT

FIG 4.11 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN STORMWATER TREATMENT?



The two areas where cities are undertaking the most action is in retaining or detaining stormwater in new developments and green roofs - this corresponds to the strong powers cities have over planning for new buildings. Interestingly, despite many cities having power over roads and green assets, few have implemented actions related to sustainable urban drainage and stormwater retention / detention in streetscapes.

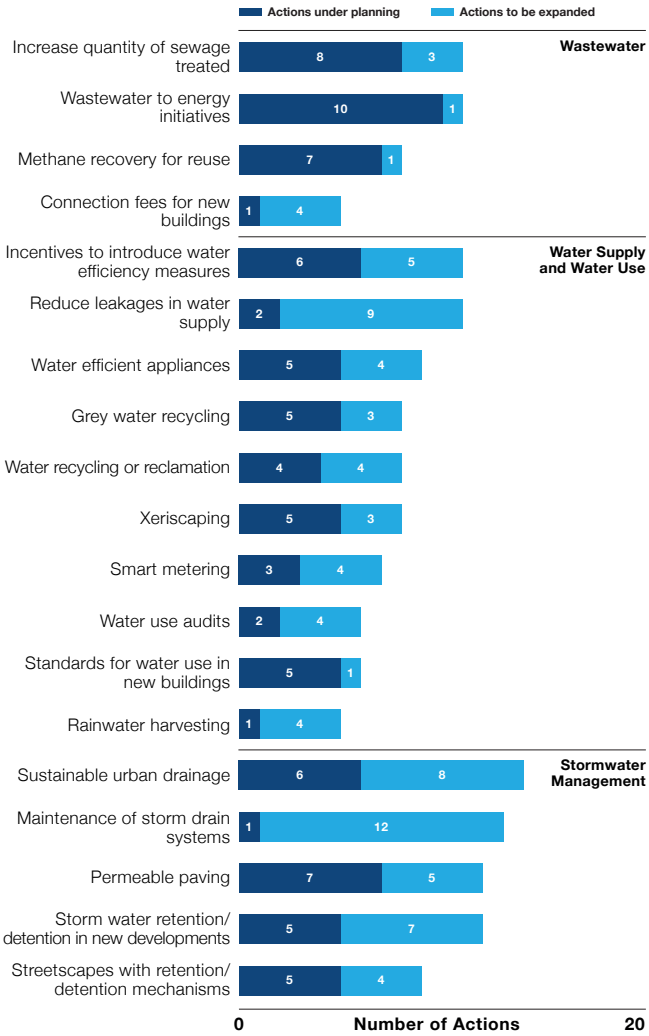
The results show most actions have been taken in stormwater retention / detention in new developments, and they were primarily policies or projects/programmes that are transformative in scale. Green roofs have also been popular, and it is a sign of their acceptance in the marketplace that actions are significant and transformative, rather than pilots. Overall most actions have been projects / programmes or policies, few incentives have been utilised.

Analysis of specific storm-water measures are considered in more detail in the Adaptation chapter.

4.7 FUTURE PLANS

The figure 4.12 shows the actions cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation. Water efficiency and conservation measures including incentive schemes, smart metering and water use audits are the most popular water sector actions across the C40 network. Green roofs, stormwater retention / detention in new developments and grey water recycling are high priorities for cities for the future (these are discussed in detail the 'Adaptation' sector chapter).

FIG 4.12 WHAT ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?



05.

ENERGY SUPPLY

5.1 INTRODUCTION

The main sources of greenhouse gas emissions from urban areas are generated by the consumption of fossil fuels: whether this is from the carbon intensity of the electricity supply, the demand of that electricity, transport of goods or people, or industrial activity. In terms of electricity supply, in 2008, a total of 20,181 terawatt hours (TWh) of electricity was produced around the world, most of which was generated from the combustion of oil, coal, and natural gas.[1]

Electricity consumption varies significantly around the world, with some 1.6bn people – almost one quarter of the world's population – having no access to electricity. Four out of five people without electricity live in rural areas of the developing world. This pattern is set to change as 95% of the increase in the population in the next three decades will occur in urban areas.[2]

The relative reliance on fossil fuels for electricity generation declined from 75% per cent in 1973 to 65% per cent in 2008, while the total amount of energy produced from these sources grew from 4,593 TWh to 13,675 TWh over the same period.[3]

Coal-fired power stations provide 40% of global electricity demand and natural gas 20%. In countries relying heavily on coal consumption for electricity generation, electricity can be the single largest contributor to greenhouse gas emissions.

A variety of low carbon and renewable energy systems can contribute to reducing greenhouse gas emissions. However there are still many challenges to be overcome in relation to the development of these technologies, such as the scale of the shift, the intermittency of renewable flows and uneven distribution of renewable energy resources. C40 cities are providing innovative solutions to these challenges.

[1] Global Report on Human Settlements 2011: Cities and Climate Change, United Nations Human Settlements programme
[2] Drivers of Change: Energy, 2010, Arup
[3] Global Report on Human Settlements 2011: Cities and Climate Change, United Nations Human Settlements programme

Because of the distinctly different set of powers mayors typically hold over various locations of where energy is generated, the energy supply sector has been split into three main categories for the purpose of this report:

- Energy generation inside the city - includes initiatives and actions on renewable energy technologies and incentives, promotion of combined heat and power generation, heat re-use, optimised heat generation and provision of new power project sites.
- Energy generation outside the city – includes initiatives and actions on renewable energy technologies, re-powering or replacement of power stations, provision or encouragement of new power project sites, promotion of combined heat and power generation.
- Transmission and distribution – includes initiatives and actions on reducing distribution losses, reducing transmission losses, smart grids, replacing transformers with low loss variants, reducing distribution loss variants and reducing distribution distances.

Fig 5.1 shows the breakdown of planned and implemented actions by C40 cities by category of analysis. Actions on energy generation inside the city are the highest, followed by energy generation outside the city, and the transmission and distribution.

5.2 OVERVIEW

Figure 5.2 shows energy supply (MWh) per capita per year across the C40 regions. As can be seen, the highest is USA and Canada at 25MWh/person, but with East Asia not far behind as industrial and manufacturing production is increasingly off-shored from Europe and the US.

Targets

Eighteen cities reported having set renewable energy targets, out of a total 23 cities. Some of the city-specific renewable energy targets reported include the following:

- Berlin has a target to annually produce more than 5MW of solar power
- Paris has a target for 30% of energy consumed within the city to come from renewable supplies by 2020
- Toronto has a target to increase renewable electricity generation by 120MW by 2012, 550MW by 2020 and 1000MW by 2050
- Mexico City has a target for 26% of electricity to be generated by renewable sources in 2012
- Tokyo has a target of 20% renewable energy supply by 2020 for the city

As well as renewable energy targets, 12 cities have set specific carbon reduction targets for their energy supply (out of 18) and a further 8 cities (out of a sample size of 20) have a target to increase the scale of their district heating networks.

FIG 5.1 ENERGY SUPPLY: BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED

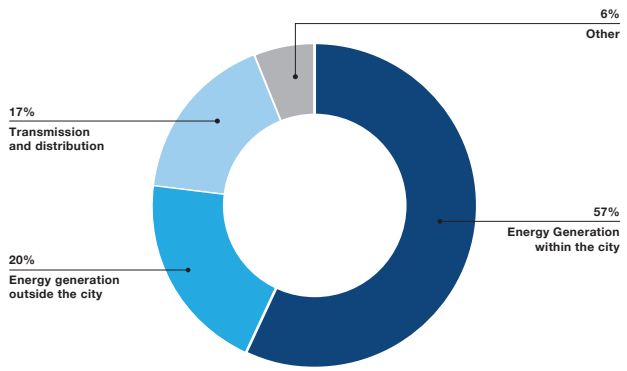
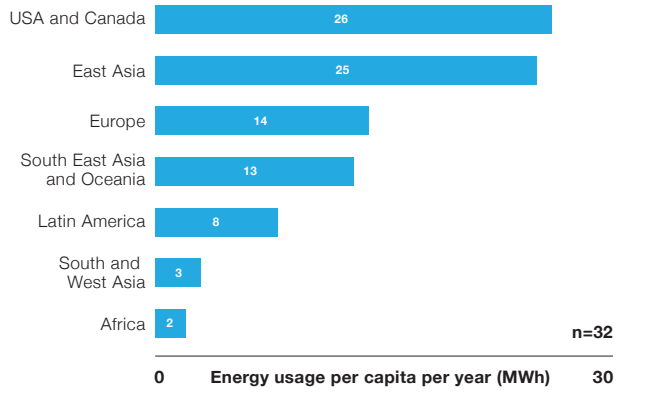


FIG 5.2 AVERAGE ENERGY USE PER CAPITA PER DAY IN C40 CITIES



5.3 POWERS

In general, C40 cities did not register strong powers in the energy supply sector, reflecting the fact that most energy supply infrastructure is controlled by state, regional, or central governments.

A large share of the energy supply for C40 cities are supplied by generation assets outside the city, where the mayors have the weakest powers. Mayors generally are not responsible for operating these assets, nor do they hold strong regulatory authority over them, as they exist outside the jurisdiction of the mayor by definition. The strongest powers cities reported in this sector are related to the ability to set vision, which can be used to unofficially influence higher levels of government who hold most of these powers.

Nevertheless, mayors are able to exercise their power over energy generation within the city. Eight cities reported the ability to set policies/enforce regulation over power generation within the city and 6 cities reported these powers over heat generation within the city.

FIG 5.3 C40 MAYORS' POWERS: ENERGY SUPPLY

5.4 ENERGY GENERATION WITHIN AND OUTSIDE THE CITY

Figure 5.4 and Figure 5.5 show the number of cities that have undertaken at least one action under the categories of 'initiative' in the Energy Generation within the City, Energy Generation outside the City and Transmission and Distribution sections of this report.

More cities have taken action on energy generation within the city boundary as compared to outside the city: 20 cities have implemented initiatives on renewable energy generation within the city, compared to 11 outside the city.

Inside the city boundary, 16 cities reported having incentives for renewable energy generation, 7 reported action on providing or encouraging new power project sites and 7 cities reported action on promoting energy generation via combined heat and power (CHP).

Outside the city, after the generation of renewable energy, the most popular initiative (reported by 5 cities) is the re-powering and replacing power stations (referring to substation upgrades), followed by providing and encouraging of new power generation sites.

FIG 5.4 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES: ENERGY GENERATION INSIDE THE CITY?

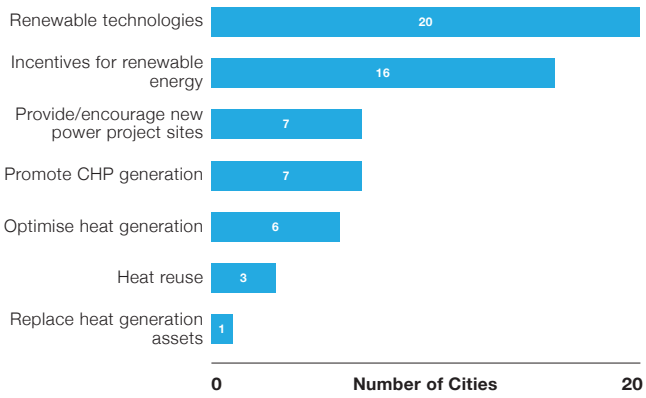


FIG 5.5 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES: ENERGY GENERATION OUTSIDE THE CITY?

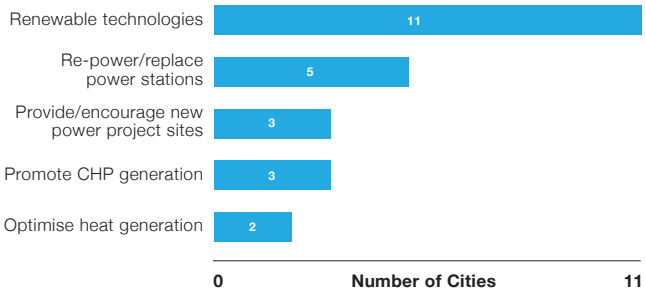


FIG 5.6 ACTIONS, SCALE AND LEVERS: ENERGY GENERATION WITHIN THE CITY

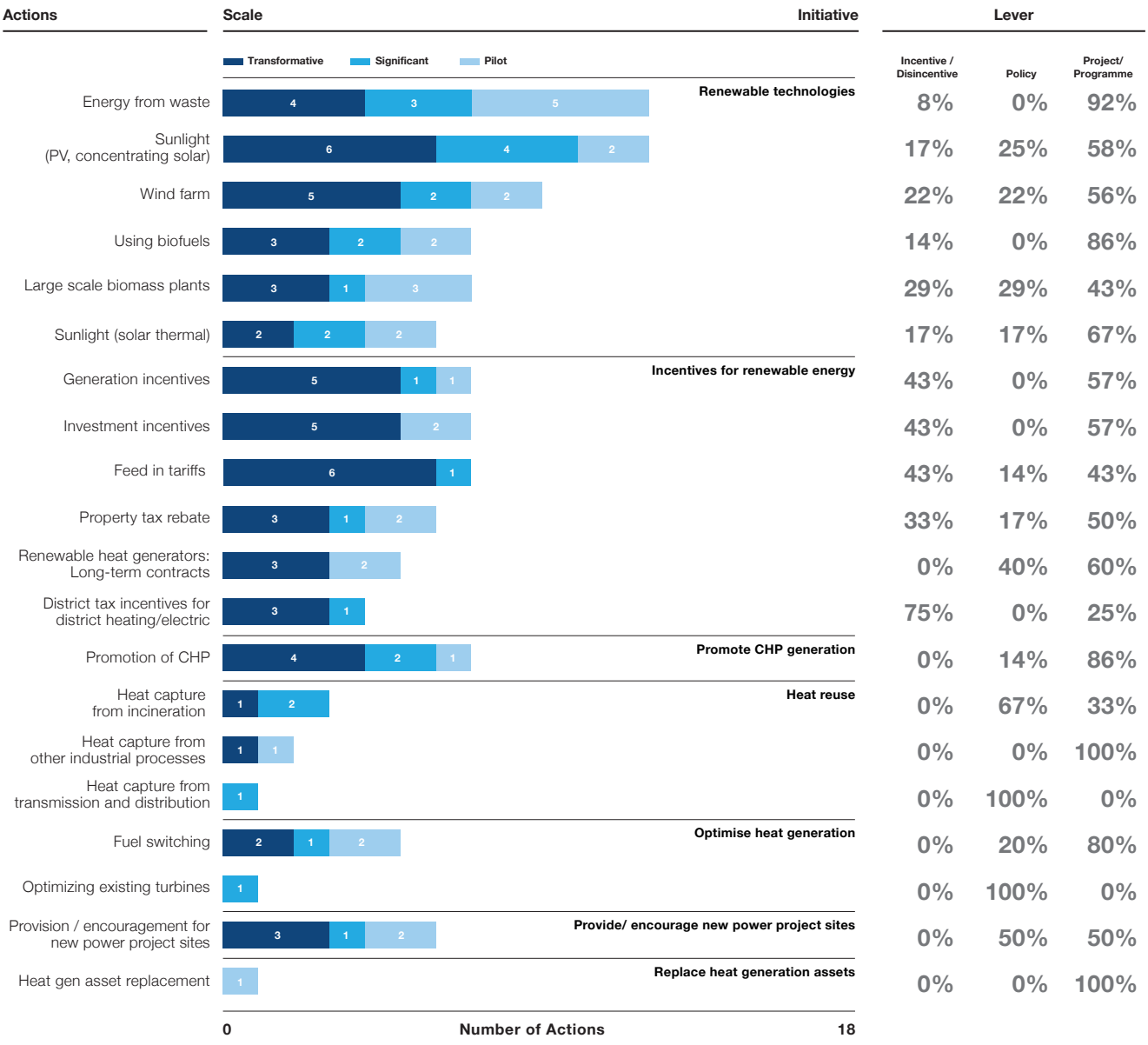


Figure 5.6 lists all actions recorded in the Energy Generation within the City sections …of the survey. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive and transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives and disincentives; policies; or programmes.

FIG 5.7 ACTIONS, SCALE AND LEVERS: ENERGY GENERATION OUTSIDE THE CITY

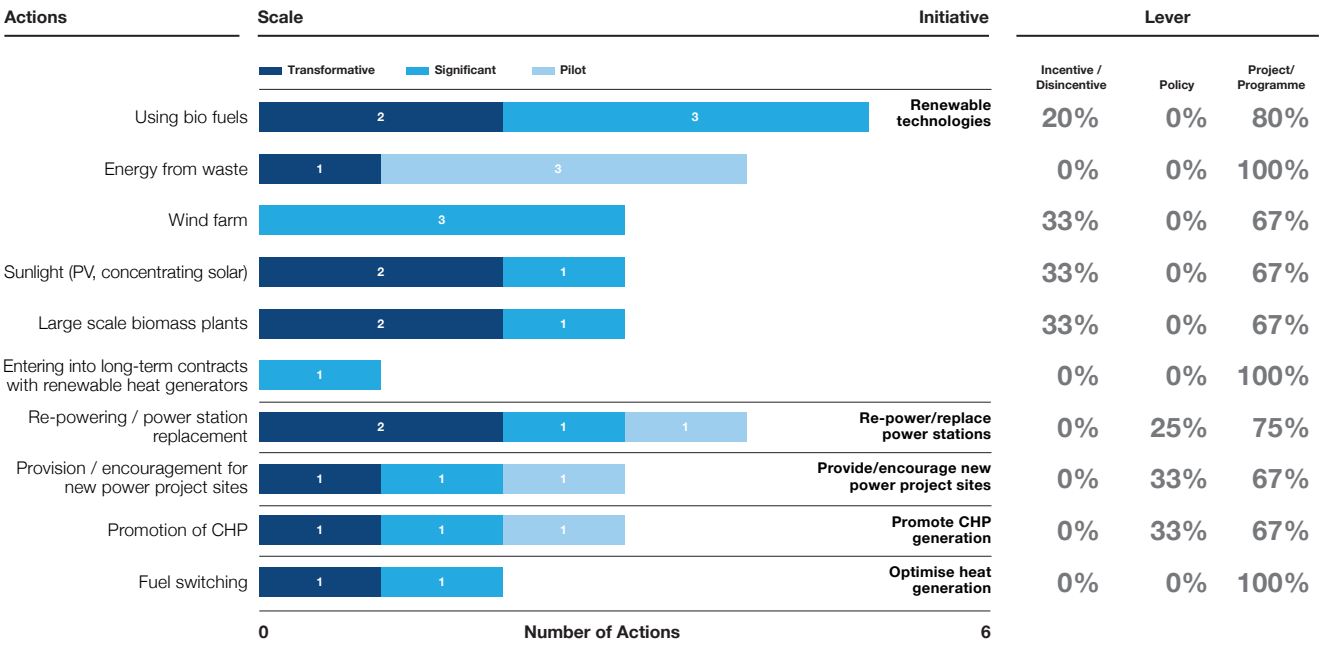


Figure 5.7 lists all actions recorded in the Energy Generation outside the City sections of the survey. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive and transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives and disincentives; policies; or programmes.

Cities are using a wide variety of mechanisms to implement a relatively narrow field of technologies, in order to clean up their electricity supply significantly. Where mayoral powers are stronger and more direct, within city boundaries, is where cities have reported more action in direct implementation. Where mayoral powers are weaker, outside the city boundary, cities have reported a lower degree of action with indirect levers, like incentives and advocacy.

The larger project based actions by mayors like installing photovoltaics (PV)/concentrating solar and wind farms occur within the city, while the smaller encouragement and changes like fuel switching to biofuel occur outside of the city.

5.4.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are already taking notable action.

5.4.2 Renewable energy technologies – inside and outside the city

In terms of energy generation within the city, the most popular renewable energy technologies reported by cities are energy from waste (including anaerobic digestion and gasification/ pyrolisis) and PV/ concentrating solar, followed by wind farms and the use of biofuel. Most actions reported are project/programme based, with a third of windfarms, PV/concentrating solar and large scale biomass actions reported as incentives.

Cities reported 12 actions on energy from waste (including anaerobic digestion and gasification/ pyrolisis) : 4 transformative, 3 significant and 5 pilots. Energy from waste actions were almost exclusively reported as projects/ programmes.

This is consistent with the strong mayoral powers over waste collection and treatment in many C40 cities . In waste collection, powers are especially strong over residential and municipal building waste collection, where 20 cities own and operate these functions. A smaller but still significant number (13) own and operate waste collection from commercial buildings. Many mayors also have strong powers over waste treatment, with 18 cities owning and operating landfill sites and transfer stations, plus 14 that own and operate recycling facilities and waste to energy plants (see Chapter 4: Waste).

In Tokyo, waste incineration facilities are located across 23 wards, including downtown areas. The latest facilities have achieved a power generation efficiency of 20%. Three of the facilities supply heat for district heating and cooling systems.

In terms of PV, 12 actions were recorded by cities looking to clean their energy supply mix, within the city. Notably, Toronto's Exhibition Place is home to the 'world's largest' single solar PV installation on a building, with a capacity of 100KW. Paris has set a target to install 40,000m^2 of PV between 2010 and 2014.

5.4.3 Incentives for renewable energy generation – inside the city

The majority of actions reported are transformative with an almost even split between incentives and projects as the delivery mechanism. Five cities also reported action on entering into long-term contracts with renewable heat generators.

An example of incentive programmes in action is the Los Angeles Department of Water and Power (LADWP) sponsorship of the 'Green Power for a Green L.A.' programme. Customers receive between 20% and 100% renewable energy by paying a small premium on their bill. LADWP buys renewable energy on the open market and delivers it to the grid. The programme's revenues have developed an accumulated balance that will be used to develop and operate a renewable energies plant within L.A.

5.4.4 CHP generation – inside and outside the city

Seven cities reported action on promotion of combined heat and power within the city boundary: most of the actions reported are transformative, with the majority being delivered via projects/ programmes. Three cities reported action on promoting combined heat and power outside the city boundary, with 2 reported as transformative and one as a project.

5.5 TRANSMISSION AND DISTRIBUTION

Figure 5.8 shows the number of cities that have undertaken at least one action under the categories of in the Transmission and Distribution initiative section of the survey.

The highest number of cities reported action in the category of reducing distribution losses, followed by 11 cities which reported action in reducing transmission losses. Furthermore, 5 cities reported action on smart grids.

FIG 5.8 HOW MANY CITIES HAVE IMPLEMENTED CO_2 INITIATIVES: TRANSMISSION AND DISTRIBUTION?

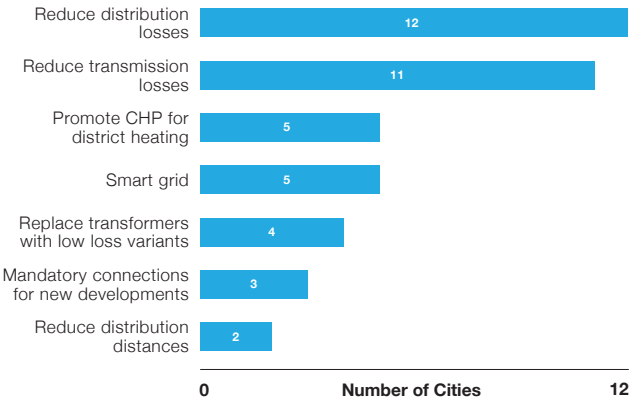


FIG 5.9 ACTIONS, SCALE AND LEVERS: ENERGY DISTRIBUTION AND TRANSMISSION

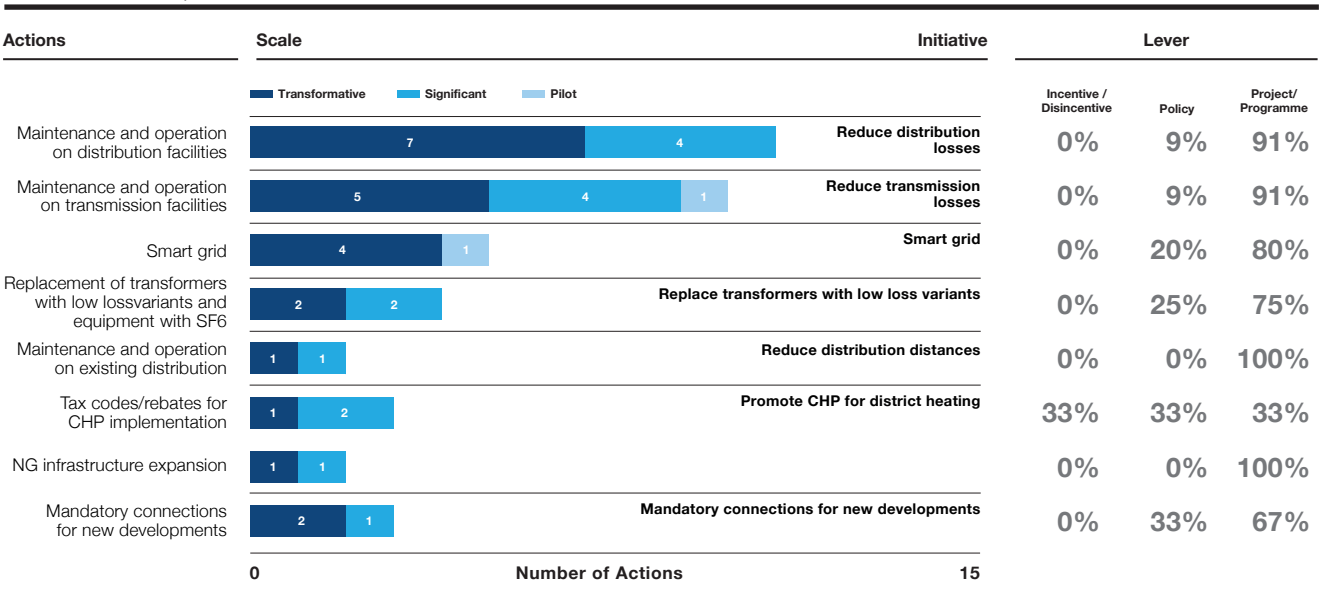


Figure 5.9 lists all actions recorded in the Transmission and Distribution section of the survey. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative whether they are primarily – incentives/disincentives; policies; or programmes.

5.5.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are already taking notable action.

5.5.2 Smart grids

There is considerable interest in the prospects for 'smart grids' in cities. The concept describes an integrated system of electricity supply, all reporting to a highly developed information communication system, such that demand can be managed in the most efficient way possible, smoothing out peaks and troughs and minimising waste and carbon emissions.

To date, however, only 5 cities have reported action on smart grids. Four of the cities reported the action as transformative and one as a pilot, with the majority of smart grid actions being implemented as projects or programmes.

5.6 FUTURE PLANS

Figures 5.10, 5.11 and 5.12 show the actions cities are planning to expand if they are already implementing them, and actions cities are considering for implementation.

Renewable technologies are the most popular actions in terms of future plans, and in particular energy from waste schemes including anaerobic digestion and gasification and pyrolisis; PV and concentrating solar; and biofuels. More cities are planning to expand existing incentives for renewable energy than planning new incentives.

The other popular action for future plans is smart grids, with 18 cities reporting plans to take action of smart grids in the future.

FIG 5.10 CURRENT AND FUTURE PLANS: ENERGY SUPPLY INSIDE THE CITY

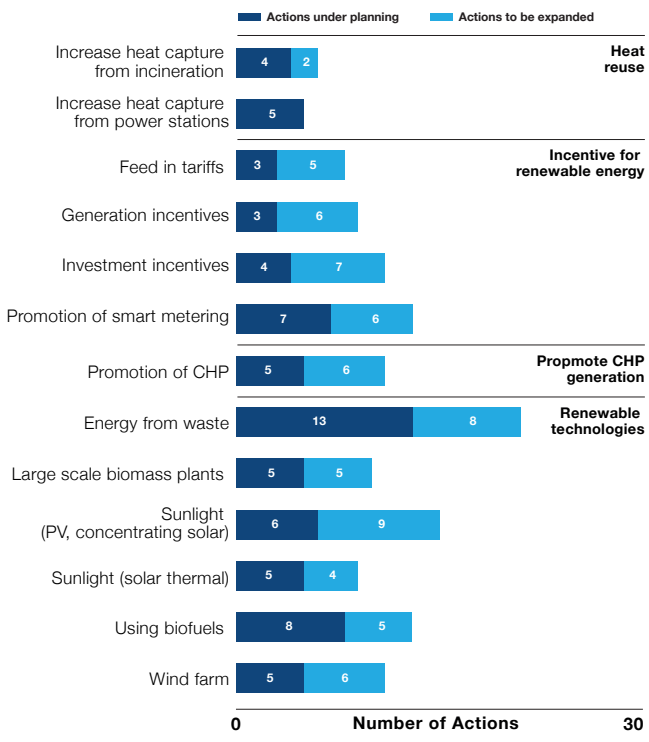


FIG 5.11 CURRENT AND FUTURE PLANS: ENERGY SUPPLY OUTSIDE THE CITY

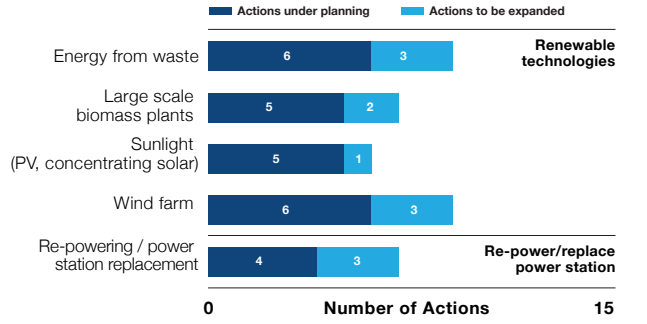
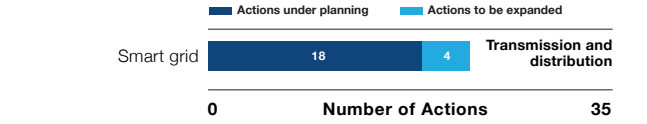


FIG 5.12 CURRENT AND FUTURE PLANS: ENERGY SUPPLY TRANSMISSION AND DISTRIBUTION



06.

OUTDOOR LIGHTING

6.1 INTRODUCTION

Throughout the C40 cities, outdoor lighting accounts for, on average, 19% of electricity consumption, with 75% of all lighting currently installed being of the old, inefficient tungsten variety.[1]

Cities are particularly high consumers of electricity for outdoor lighting. This is an area with potential for energy and carbon savings as most existing lighting is inefficient compared with newly available technologies. For example, leading light-bulb manufacturers estimate electricity used in street lighting could be reduced by as much as 57% through conversion to newer Light Emitting Diode (LED) technology.[2]

Some C40 cities have started to develop plans for replacing outdoor lighting with more energy efficient lighting, as well as optimising the operation of street lighting through smart lighting measures. Outdoor lighting was analysed in two categories; street lighting (both public and private), and traffic lights for the purpose of this study.

6.2 OVERVIEW

Data for the outdoor lighting sector has not been systematically collected across C40 cities to date and so some cities are not included in this survey.

From the data that was collected, 23 of the C40 cities have started to monitor electricity use from street lighting, with 10 cities reporting that they have a target for reducing emissions from outdoor lighting. Most of these cities have also begun to measure emissions from outdoor street lighting as part of their emissions reporting processes.

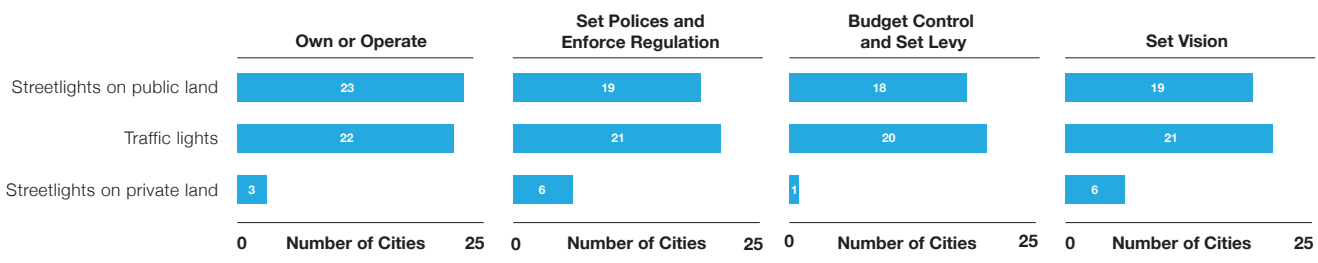
6.3 POWERS

Based on the powers C40 cities tend to have over different types of outdoor lighting, this sector has been broken down into the following categories for the purpose of this report:

- Streetlights on public land
- Traffic lights
- Streetlights on private land

As figure 6.1 demonstrates, on average, C40 mayors have strong powers in this sector, with 23 and 22 mayors respectively owning or operating public streetlights and traffic lights.

FIG 6.1 C40 MAYOR'S POWERS: OUTDOOR LIGHTING

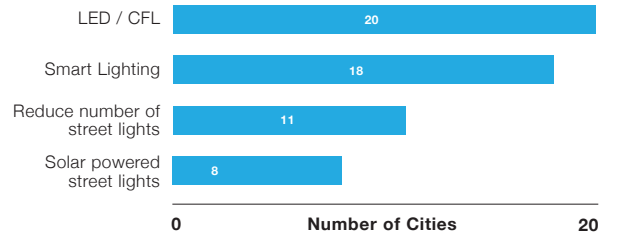


[1] *Philips presentation: 'The Contribution of Energy Efficient Lighting in tackling Climate Change for the City of Monaco- A Triple Win for People, Environment and Economy –', Monaco 8 July 2009*
[2] *Philips, ibid*

6.4 KEY FINDINGS

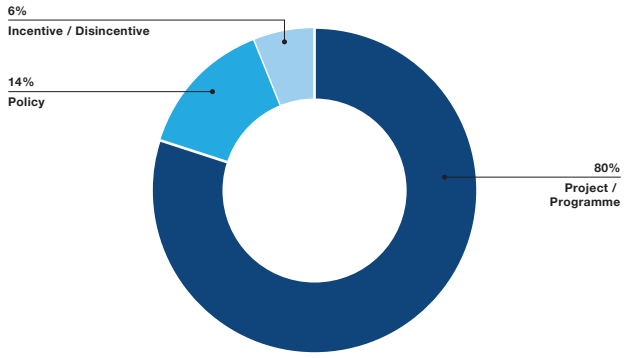
Figure 6.2 shows the number of cities that have undertaken at least one action under the four categories of 'initiative' in the Outdoor Lighting section of the survey.

FIG 6.2 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN OUTDOOR LIGHTING?



Twenty C40 cities participating in this study are replacing street lighting with LED (Light-Emitting Diodes) and/or CFL (Compact Fluorescent Lighting), with 18 reporting at least one action in smart lighting. Outdoor lighting is clearly a top priority for C40 cities, reflecting both the powers they have over roads, street and traffic lights as well as the significant energy saving potential from street lighting.

FIG 6.3 BREAKDOWN OF LEVERS USED IN IMPLEMENTING ACTION: OUTDOOR LIGHTING



As figure 6.4 indicates, action to reduce emissions from outdoor lighting has focused on programmes to switch to LED bulbs (19 actions), reflecting the roll-out of a Clinton Climate Initiative/C40 programme from 2009 onwards, and timed lighting (13 actions). Sixteen and 11 of these actions for LEDs and timed lighting respectively are listed as significant or transformative, which suggests that a number of cities are now convinced of the benefits of these technologies and are rolling them out on a city-wide basis.

6.4.1 Findings in focus

6.4.1.1 LED street lighting

LED lighting refers to the technology of Light Emitting Diodes. This technology is becoming increasingly prevalent on the international market, particularly following regulatory changes, for example the European Union prohibited the manufacture and sale of traditional tungsten bulbs from 2010.

LED bulbs are generally accepted as highly reliable, with a long service life and relative low energy consumption that can bring 50% or more energy savings compared with conventional lighting[1].

Most of the 20 cities which reported action on LED/CFL graded them as transformative, although a significant number of pilots were also noted. The lever which mayors tend to use for LED/CFL is through projects/ programmes, rather than policies or financial initiatives reflecting the strong degree of average mayoral power in this area.

In Los Angeles, the mayor-controlled Bureau of Street Lighting owns and operates over 209,000 public street and roadway lights, the vast majority of those in the city of Los Angeles. Through the mayor's LED Street Lighting Energy Efficiency Program, 140,000 street lights in Los Angeles will be converted to LED over a 5 year process. With around over 40,000 LEDs installed as of April 2011, LA has already achieved 58% in energy savings, and is saving the city over $1.4 Million USD annually. Los Angeles is also on track to convert 100% of their traffic lights to LED by July 2011.

This activity has helped to spread action to other parts of the world; in Rio de Janeiro where the mayor owns the traffic lights, half of the traffic lights on city streets will be converted to LED with the help of the Clinton Climate Initiative. Other cities are also taking notice and action: Seoul has committed to convert 100% of their streetlights to LED by 2020 and Rome is replacing 100,000 lights with LED by 2020 as well. Bogota, where the mayor also owns public lighting, is undertaking a preliminary analysis to retrofit 130,000 lights to energy efficient Ceramic Metal Halide technology.

[1] *LED for livable cities: Bringing the city to life with the power of light, Philips, 2010*

FIG 6.4 ACTIONS, SCALE AND LEVERS: OUTDOOR LIGHTING

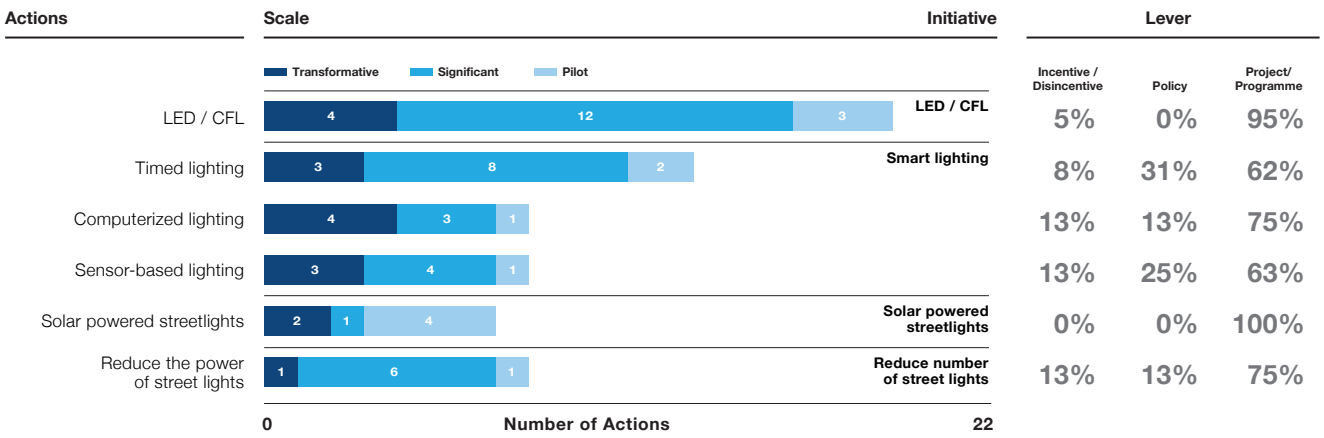


Figure 6.4 breaks these initiatives down by scale and type. The scale at which action has been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is an indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

6.4.1.2 Smart lighting

Smart lighting refers to lighting management systems that reduce the use of electricity. In the survey these come under three categories:

- Timed lighting
- Computerised lighting
- Sensor-based lighting

Actions grouped under smart lighting recorded the highest number of actions in the outdoor lighting section, most of which are project/ programme based. Timed lighting is the most popular measure, implemented by 18 cities, with most action reported as significant.

It is likely that the majority of these actions are associated with municipally owned buildings, as all of the cities that have started timed lighting projects have strong control over municipal buildings (generally ownership).

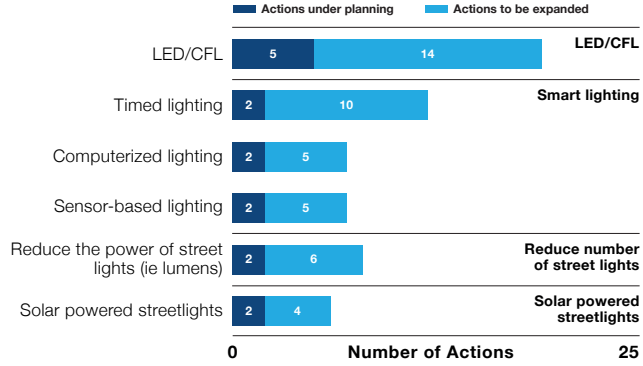
Most pilots are happening in solar powered street lighting, with the majority of pilots being carried out as projects.

6.5 FUTURE EXPANSION

Figure 6.5 shows the actions that cities are planning to either expand if they are already implementing them, or new actions cities are considering for implementation. The pattern is the same as for actions already delivered: 14 cities have plans to expand LED street lighting, and 5 cities are considering deploying LED bulbs for the first time. This suggests strong opportunity for collaboration within the C40 network to develop the existing LED lighting programme.

Ten cities plan to expand timed lighting systems, with a further two considering investing in this technology for the first time.

FIG 6.5 CURRENT AND FUTURE PLANS: OUTDOOR LIGHTING



07.

PLANNING AND URBAN LAND USE

7.1 INTRODUCTION

How cities use land within their boundaries and apply their strategic planning powers are two of the most important functions a mayor has in combating carbon emissions. As figure 7.1 illustrates, while measures to retrofit buildings, construct new energy supply systems, and change transportation, are comparatively easier to deliver in the short to medium term, decisions taken today about urban land use can have an impact over many decades.

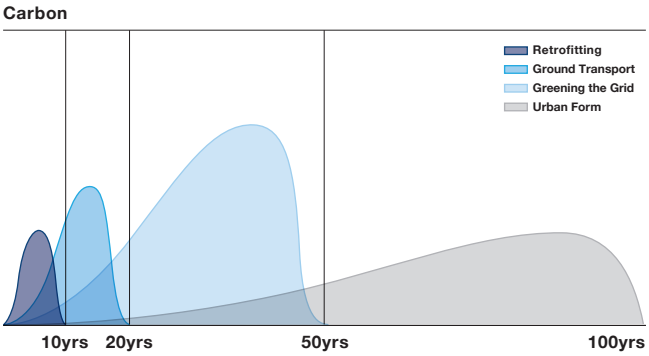
For example, planning and urban land use powers can be used by mayors to:

- increase density and create a 'compact city', shifting transportation norms from private cars (high emissions) to public transport, walking and cycling (low emissions)
- accommodate rural population growth
- institute low carbon standards for new buildings and developments
- protect and enhance green space

Planning and urban land use and planning powers are also critical tools for mayors to use to adapt their cities to the inevitable and potential impacts of climate change. For example, increasing tree cover and protecting green space not only improves quality of life in a city and absorbs carbon emissions, but also helps to reduce urban heat island effects and can be used to provide natural flood protection.

The Planning and Urban Land Use sector has been split into three main categories for the purpose of this report:

FIG 7.1 LONG-TERM IMPACT OF DIFFERENT GREENING MEASURES

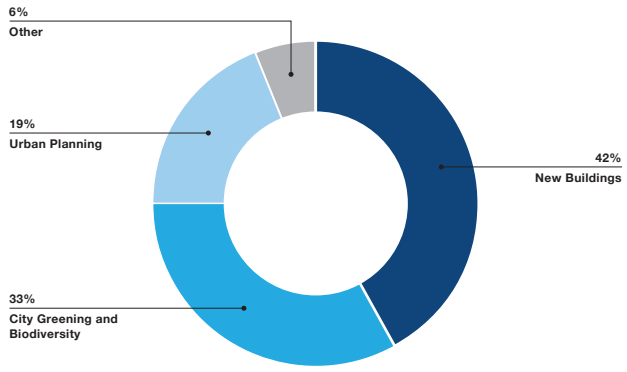


- **Urban Planning** which includes initiatives and actions undertaken by cities to promote density, restrict parking, encourage transit-oriented development, and promote brownfield redevelopment
- **City Greening and Biodiversity** which includes initiatives and actions undertaken by cities to protect green space, encourage gardens and green roofs, and enhance biodiversity
- **New Buildings** which includes initiatives and actions undertaken by cities relating to standards for new buildings and new developments and changes in use

Figure 7.2 shows the breakdown of planned and implemented actions across C40 cities by category of analysis.

7.2 OVERVIEW

FIG 7.2 PLANNING AND URBAN LAND USE: BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED BY C40 CITIES



Compared to five years ago, 20 cities reported total area of green space has increased in their cities, compared to only 5 which reported total area has reduced and 3 which reported no change. Over 28 cities have identified over 2,142 million km^2 of green space to-date.

Furthermore, 20 cities reported that they have a green space target (out of a sample size of 22). Some of the specific green space targets reported include:

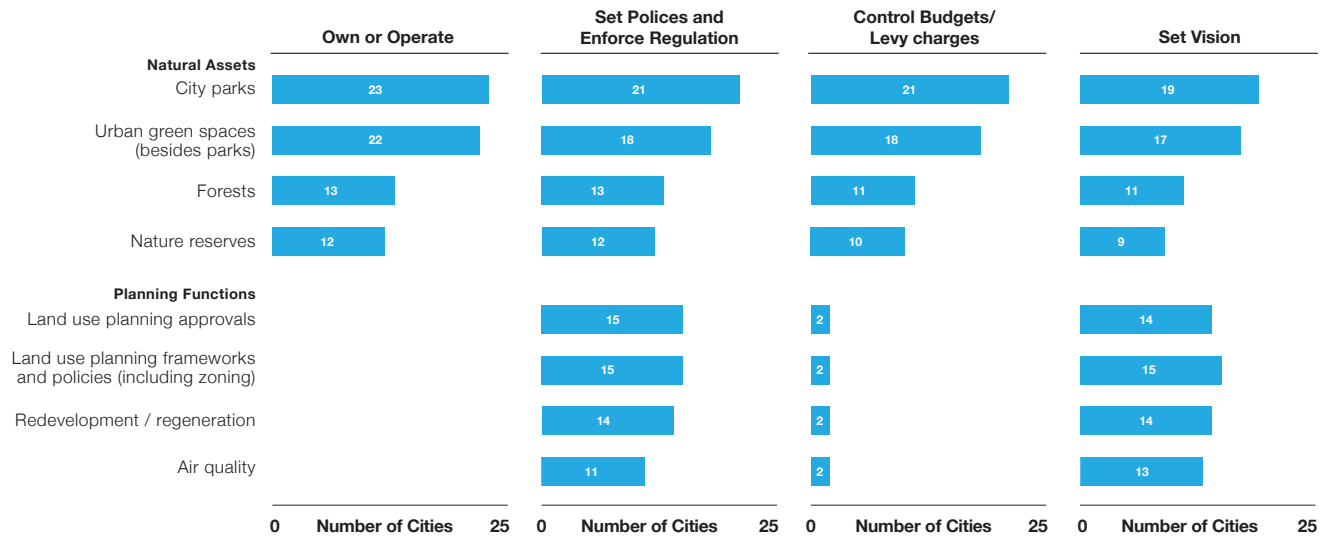
- Addis Ababa: 40% of the city as green space;
- Berlin: all residential neighbourhoods to have access to public parks and city squares via linkage and creation of such spaces;
- Bogota: 35,000 sq m of new gardens and maintain 105,000 sq m of existing gardens;
- Buenos Aires: 33 ha of green space;
- London: increase green infrastructure in central London by 5% by 2030, and increase tree canopy cover across London by 5% by 2025;
- Los Angeles: create 35 new parks by 2010;
- Mexico City: 9m^2 of green space per person;
- New York: all New Yorkers live within a 10-minute walk of a park and create over 800 acres of upgraded parkland and open space;
- Shanghai: 35% green cover and 30% forest cover within the city by 2020;
- Sydney: every resident will be within 250m walk of continuous green links that connect to the Harbour Foreshore, Harbour Parklands, Moore or Centennial or Sydney Parks;
- Toronto: double the existing tree canopy to 34% of the city area by 2020.

7.3 POWERS

Overall, powers in the Planning & Urban Land Use sector are strong among the C40 cities, both over assets related to city greening and biodiversity and over the function of urban planning.

More than half of the C40 surveyed cities reported ownership or operation powers over city parks and other green urban spaces – 23 reported these powers over city parks and 22 over other green urban spaces. Along with ownership or operational powers, cities also enjoy strong powers to set policies and enforce regulations, and control budgets / levy charges.

FIG 7.3 C40 MAYORS' POWERS: PLANNING AND URBAN LAND USE



On land use planning frameworks/policies (including zoning) and land use planning approvals 15 city governments reported the ability to set policies and enforce regulation, with 25 cities reporting these powers specifically over new municipal buildings.

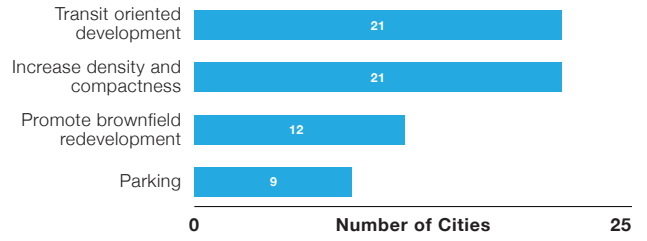
7.4 URBAN PLANNING

Figure 7.4 shows the number of cities that have undertaken at least one action under the categories of 'initiatives' implemented in the Urban Planning section of the survey.

More than half of the C40 surveyed cities reported action on transit orientated development and increasing density / compactness in the Urban Planning section of the report – 21 cities reported at least one action in these initiatives. This is followed by action to promote brownfield redevelopment, which was reported on by 12 cities.

7.4.1 Findings in focus

FIG 7.4 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN URBAN PLANNING?



7.4.1.1 Transit oriented development

The cost of developing new major transit infrastructure can be overwhelming, yet the need for mass transit is clearly preferred for urban mobility over private vehicles and taxis. Another way to address this issue is to develop the city in areas where transit access already exists. Transit oriented development is a strategic way of reducing overall cost, but improving the efficiency of new development and urban mobility.

Sixteen cities reported action on requiring new development to be in transit strong areas, with 10 of these being reported as transformative and 75% being delivered through a policy lever. This reflects the strong powers city governments reported on both planning frameworks and land use planning approvals.

Fifteen cities reported on expanding transit to support current development, 13 of which were reported as transformative. In contrast to requiring new developments to be in transit strong areas, expanding transit to support new development was mainly achieved through an almost even split between policy and project/programmes.

In Buenos Aires, systems of green spaces and expansion of urbanised areas are centred around existing major mass transit infrastructure, to enable better mobility of residents of new developments. New York is using rezonings as opportunities to direct development and growth towards areas with existing strong transit access, while Hong Kong has prioritised expansion to areas where local railways exist.

FIG 7.5 ACTIONS, SCALE AND LEVERS: URBAN PLANNING

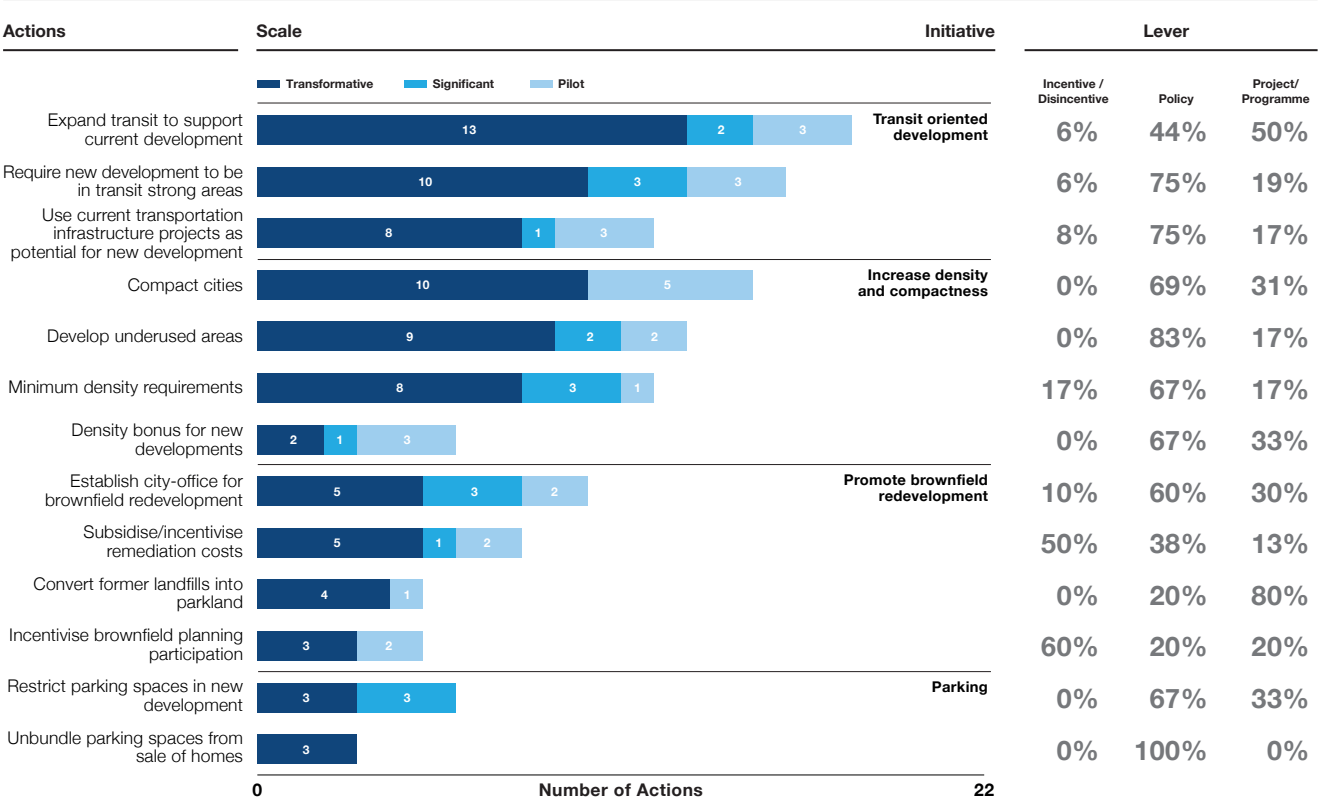


Figure 7.5 lists all actions recorded in the Urban Planning section of the survey. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is an indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or projects / programmes.

7.4.1.2 Increase density and compactness

High density living enables reduced land needed for building space, opportunities for decentralised energy systems and improved access to potential green and public space nearby. The idea of compact cities has emerged as a trend amongst C40 cities in a variety of mechanisms.

The actions under this category include: 15 actions on compact cities; 11 actions on develop underused areas; 12 actions on minimum density requirements and 6 actions on density bonus for new developments. Across all four actions, most actions are reported as transformative and the lever most used to take action is policy.

São Paulo is fostering compact city development and focusing growth along existing infrastructure. The mayor has set the vision for the municipal planning department as this being one of the major strategic objectives. Los Angeles and Toronto are utilizing development standards as a mechanism for bringing the concept of compact cities forward.

7.5 CITY GREENING AND BIODIVERSITY

Figure 7.7 shows the number of cities that have undertaken at least one action under the categories of 'initiative' in the City Greening and Biodiversity section of this chapter. Twenty seven cities reported at least one action on preservation and bio-diversity and 20 cities reported at least one action to protect green and open spaces from development. This corresponds to strong powers more than half of the C40 cities reported over city parks and other green urban spaces, as well as the number of cities (20) which reported targets related to preserving or increasing urban green space.

FIG 7.7 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN CITY GREENING AND BIODIVERSITY?

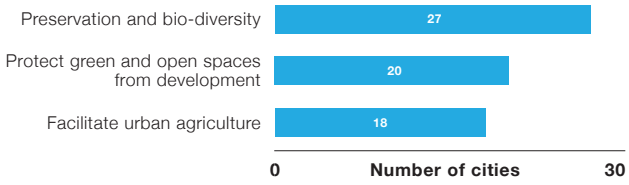


FIG 7.6 ACTIONS, SCALE AND LEVERS: CITY GREENING AND BIODIVERSITY

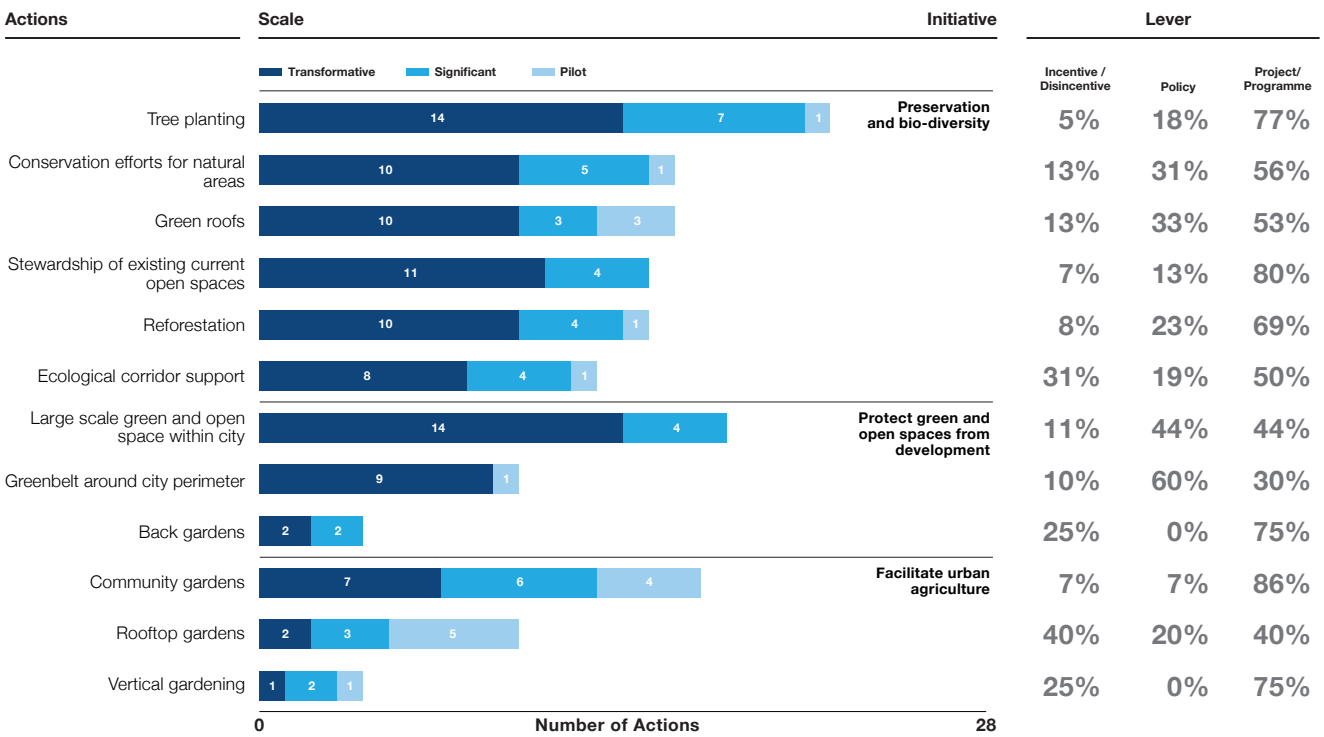


Figure 7.6 lists all actions recorded in the City Greening and Biodiversity section of this chapter. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is a indication of the type of initiative: whether they are primarily – incentives / disincentives; policies; or projects /programmes.

7.5.1 Findings in focus

7.5.1.1 Preservation and bio-diversity

The most popular action under this initiative is tree planting. 22 cities reported actions on tree planting, with 14 of those reporting the actions as transformative and 77% being delivered through projects/ programmes.

Hong Kong provides a good example of a comprehensive planting programme through its Greening Master Plans launched in 2004. The Plans aim to define an overall greening framework for the entire city by identifying suitable locations for planting with desirable themes and species, thus paving the way for continuous and consistent results in enhancing the green environment. Meanwhile, Jakarta has set the ambitious target for planting an additional 50,000 trees per year.

The second most popular action is conservation efforts for natural areas, with 16 cities reporting action, 10 of which are transformative and green roofs with 16 cities reporting action, 10 of which are also transformative.

Despite more than 20 cities reporting urban green space target, most action under preservation and bio-diversity were delivered through projects/ programmes rather than the policy lever.

Addis Ababa has allocated over 700 hectares of urban land for the Gullele Botanic Gardens, while mandating that every 150 m^2 of development must plant at least one tree. They have split the responsibility over preservation of a major forest with the national government as well. Addis Ababa as well as Caracas have identified issues with enforcement of policies already in place for preservation.

In Berlin, the identification of brownfields and lands with limited agricultural value are seen as opportunities for conversion into woodland, and then preservation.

Protect green and open spaces from development

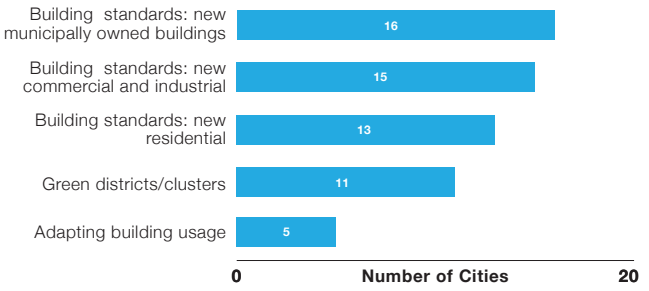
The most popular action under this initiative is on large scale green and open space within the city, with 14 cities reporting transformative action. This is followed by 9 cities who reported action on greenbelt around the city perimeter, all of which are transformative. Actions were mostly implemented through a comparable split between the policy and project/ programme lever.

One approach to do this is to limit urban sprawl. Seoul and Johannesburg have taken efforts to create a greenbelt around the city. New York aims to fulfil the potential of at least on major undeveloped park site in every borough, and has completed designs for seven of eight regional parks. They are also working to build and restore the greenways which line the city's waterfront. In Chicago, the city has adopted the Open Space Impact Fee Ordinance to address the need for additional public space and recreational facilities for residents and new residential developments.

7.6 NEW BUILDINGS

Figure 7.8 shows the number of cities that have undertaken at least one action under the categories of 'initiative' in the New Build: Residential, Municipal, Commercial and Industrial section of the survey.

FIG 7.8 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN NEW BUILDINGS?



In the new build section of this report, the most popular initiative implemented by cities is in building standards. Building standards or codes set out the minimum requirements new buildings must comply with, including requirements on environmental performance. The category of building standards includes four actions:

- Energy Performance Rating
- HVAC efficiency standards
- Environment impact assessment
- Lighting efficiency standards

In the new build municipal building sector, 16 cities are taking at least one of the actions above on building standards. This is lower than the number of cities who reported strong powers over new build municipal builds - 25 reported ownership and operational powers over new build municipal and 25 over setting policies or enforcing regulation. This indicates a potential to scale up activity on building standards in new municipal buildings.

Fifteen cities reported at least one action in buildings standard in new commercial buildings and 13 in new residential buildings. 11 cities reported at least one action on eco districts and 9 cities on green industry clusters.

FIG 7.9 ACTIONS, SCALE AND LEVERS: NEW BUILDINGS

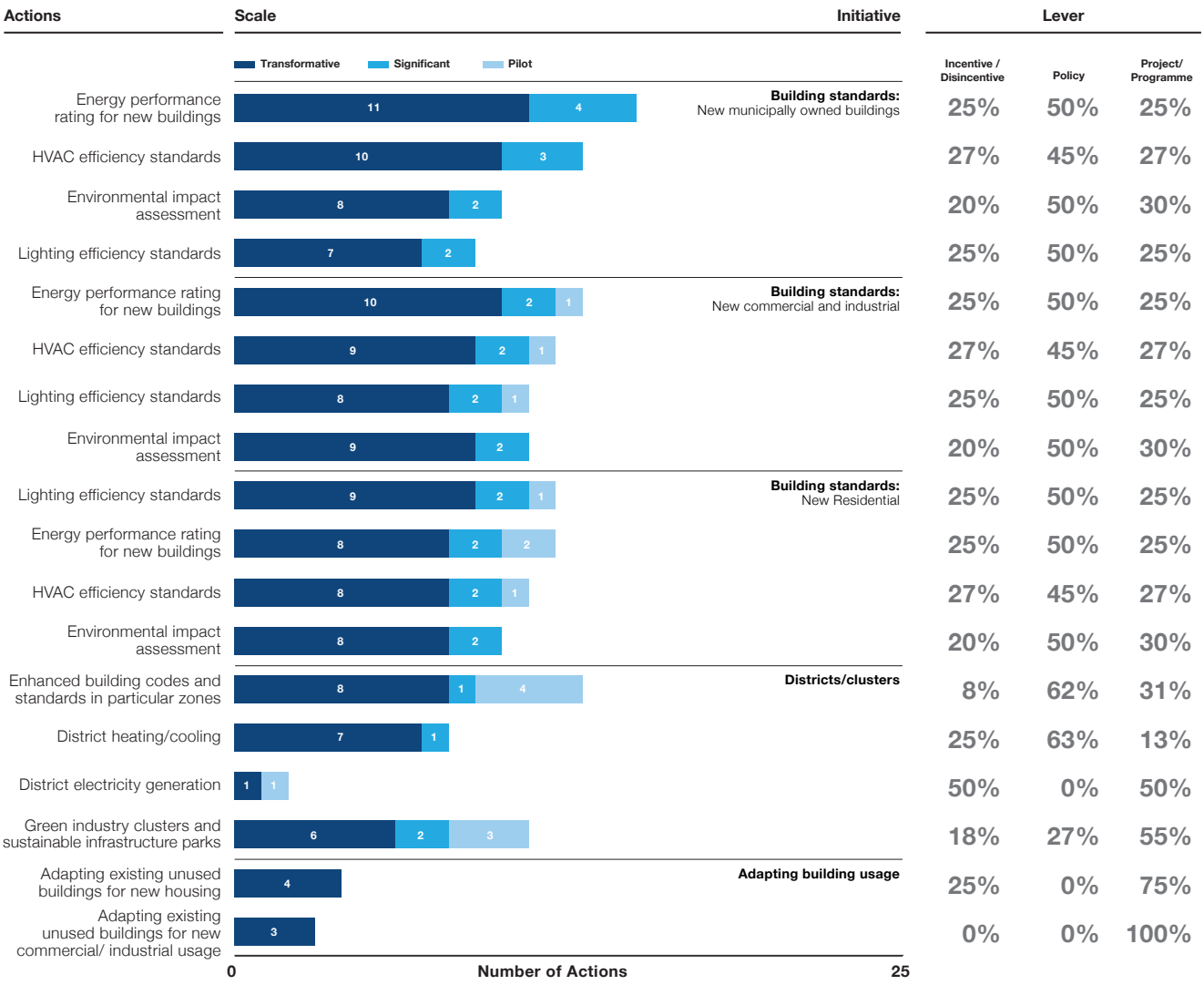


Figure 7.9 lists all actions recorded in the New Build: Residential, Municipal, Commercial and Industrial section of the survey. The scale at which actions have been delivered is recorded on the left of the figure in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the figure is an indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or programmes.

7.6.1 Key Findings

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and/or there is significant scope for scaling up activity.

7.6.2 Findings in focus

The majority of reported actions in the new build section of the report are in building standards across three categories of buildings: municipal, commercial and residential. Actions on building standards were mostly reported as transformative, with the main implementation mechanism being policy. Most pilots were reported in enhanced building codes and standards for particular zones, compact cities and green industrial parks.

Building Standards

Of the four actions under Building Standards reported on, Energy Performance Rating was the most popular action- as well as the most transformative – across all three categories of new buildings: municipal, commercial and housing. The delivery mechanisms used to implement Energy Performance Rating was policy in half of the actions reported, with the other half evenly split between incentives and programmes. Cities have reported on a variety of ‘green building standards’ that the cities’ building authorities (under the mayor) use as a guide.

A good example of a city talking action on building standards is Tokyo. All newly constructed large scale buildings in are subject to the Tokyo Green Building Programme, requiring rating of building environmental performance and disclosure of the resulting Building

Environmental Plans. Under this programme, which began in 2002, more than 1,300 buildings have been covered, at the rate of roughly 200 buildings per year.

Jakarta's Building Supervisory Agency, is to benchmark and rate new buildings against the Greenship rating system. Similarly, Chicago's powers enable them to utilize their Green Permit Program and develop incentives for commercial projects with LEED certification, in an expedited way. In New York, the strong powers held by the mayor over building standards have enabled the creation of the Greener Greater Buildings Plan, which covers mostly existing buildings, but also mandates upgrades to meet the mayor's NYC Energy Conservation Code for any renovation or alteration project.

Conversely, São Paulo's relatively limited building regulatory authority have led them to contemplate developing sets of incentives with the private sector to encourage the adoption of energy efficiency standards in new buildings. Rome has followed European directives to enforce building standards, which are relatively out of their power for developing effective action here.

7.6.2.1 Eco districts

Ecodistrict development involves a set of policies, incentives, and projects, which encourage specific districts of cities to have less carbon emissions than others. These policies include the setting of higher buildings standards in particular zones, development of district heat generation and district electricity generation, with cleaner power (eg combined heat and power) and incentives for development in these zones to meet these standards.

On eco districts, 9 cities are setting higher building standards in particular zones, with 6 of these reporting the measure as transformative.

3 cities are taking transformative action on district electricity generation in eco districts utilizing incentives and projects due to differences in powers, while 5 of the cities which are taking action on district heating and cooling, reporting both transformative and policy driven measures.

7.7 FUTURE PLANS

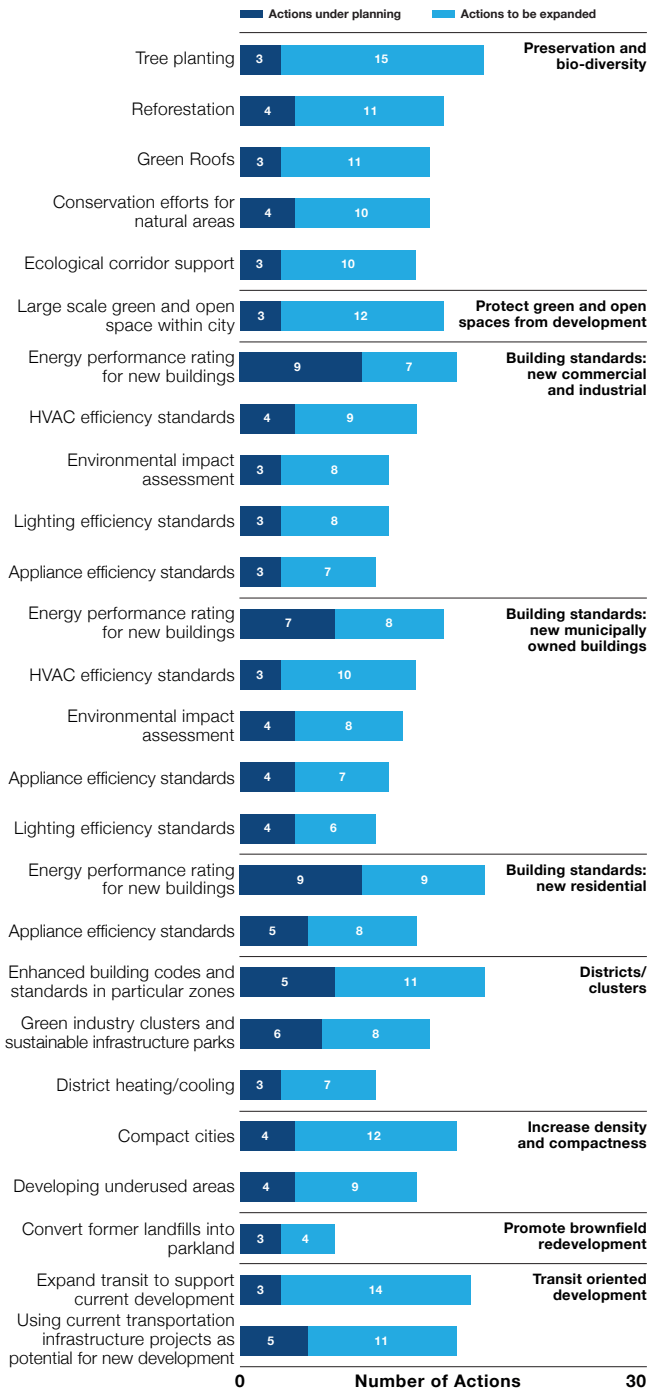
Figure 7.10 shows the actions cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation.

In urban planning, most future plans revolve around expanding current actions. In terms of new future plans, using current transport infrastructure projects as potential for new development is the most popular action.

In city greening and biodiversity, most plans for the future revolve around expanding existing action, reflecting the high level of action already taking place on tree planting and other greening initiatives.

In new buildings, energy performance rating for new buildings in all three categories – residential, municipal and commercial – is most popular action planned for the future by C40 cities.

FIG 7.10 WHAT PLANNING AND URBAN LAND USE ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?



08.

FOOD AND URBAN AGRICULTURE

8.1 INTRODUCTION

Globally, agricultural production accounts for 14% of greenhouse gas emissions. The largest contributors towards agricultural emissions are from deforestation to make way for farm land, fossil fuels consumed in modern farming (both pesticides and fuel used in farm machinery), along with methane production from livestock. 'Food miles' are commonly associated with increasing carbon emissions. The average food product in North American supermarkets has travelled 2,100km to get from source to shelf.

Only a limited amount of agricultural production takes places in cities. However, city populations, which now represent over half of the global population, consume the majority of the world's agricultural production.

Food security is a growing issue for a number of cities, particularly in those regions where climate change threatens to disrupt local or regional agricultural production. Some C40 cities have, therefore, started to develop plans for urban agriculture mostly by strategically increasing the rate of small scale farming within the city boundaries into economic drivers. Others have policies to encourage the consumption of food which is has been produced as locally as possible to the city, thus reducing food-miles. Sometimes this can take the form of encouraging 'farmers markets', where local farmers can sell their fresh produce in competition with supermarkets and larger food retailers.

8.2 OVERVIEW

Seven cities have set a target for reducing food miles, or encouraging local food production, two of whom (Shanghai and Toronto) also have a resilience or self-sufficiency target for food.

Figure 8.1 shows the breakdown of planned and implemented actions by category of analysis.

[1] International Energy Agency estimates – need report date, source
[2] *International Association of Public Transport (UITP): http://www.slideshare.net/jaaaspal/increasing-capacity-on-existing-infrastructure-in-delhi*

FIG 8.1 BREAKDOWN OF LEVERS USED IN IMPLEMENTING ACTION: FOOD AND AGRICULTURE

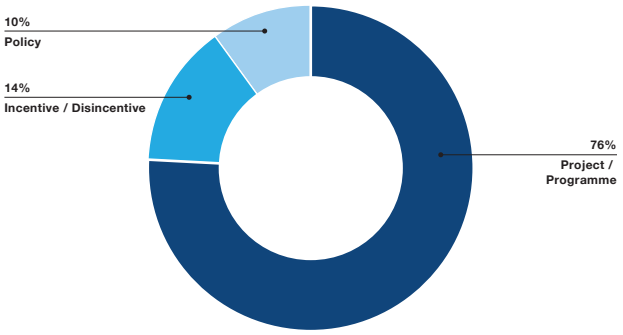


FIG 8.2 HOW MANY CITIES HAVE TAKEN CO_2 ACTIONS IN THE FOOD AND AGRICULTURE SECTOR?

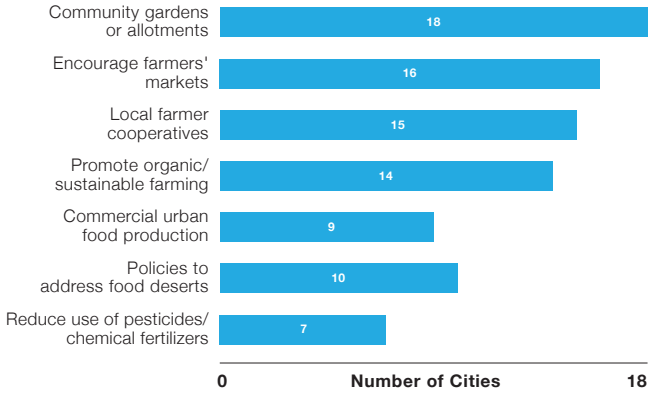
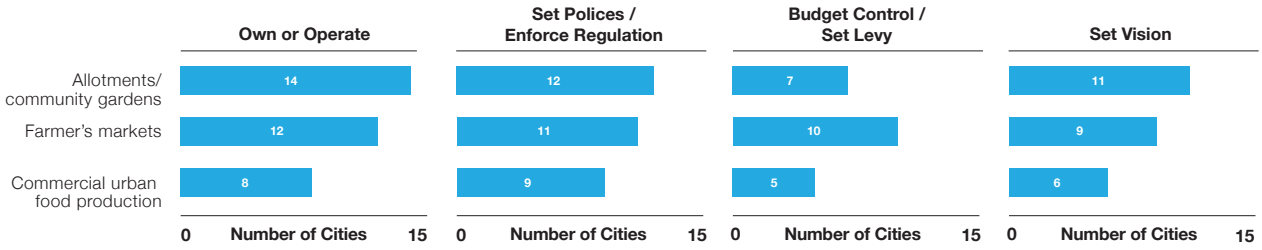


FIG 8.3 C40 MAYORS' POWERS: FOOD AND AGRICULTURE



8.3 POWERS

Mayoral powers for urban agriculture and food have been categorised in relation to food production and distribution. Fourteen city governments own or operate allotments and community gardens, while 12 have these powers for farmers markets. These powers are consistent with setting policies and vision for urban food and agriculture.

8.4 INITIATIVES AND ACTIONS

Figure 8.4 shows the number of cities that have implemented policies, incentives or programmes across of a range of action categories in the Food and Urban Agriculture sector.

C40 cities are beginning to think of innovative ways to support urban agriculture. A qualitative analysis of write-in responses from the survey showed that cities are starting small with land assessments and community gardens allocations, then moving on to help foster commercial-scale business growth in food production. In-total 18 cities are taking action to support community gardens or allotments and a further 9 have begun to back commercial urban food production and associated economies.

There are over 600 community gardens in New York where the mayor's administration recently announced support measures including increasing the total number of registered gardens by 25 each year, reducing impediments to agriculture in city codes and incentives, and expanding support for community gardens into new underserved neighbourhoods.

Farmers' markets were reported in 16 cities, with farmers cooperatives in 15 cities. Chicago has 29 farmers markets and through their City Farm programme, sell locally grown organic produce to major Chicago restaurants, the public, and subscription members. City Farm has employed 70 youth from local housing projects and trained them in urban farming and small business management, in addition to the hundreds of adults served.

The majority of actions taken in this sector (73%) are projects or programmes, with only 13% being policies. This indicates a drive by cities to implement action on the ground; however it also highlights a potential area of opportunity for C40 mayors to increase the range of policies on urban agriculture and food production within cities.

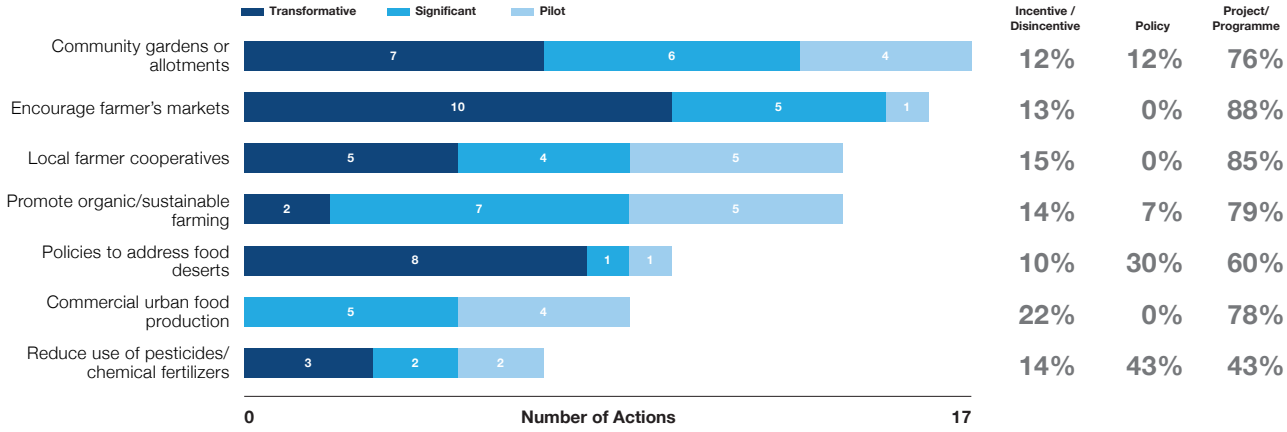
A quarter of the actions taken are pilots, with only 40% classified as transformative. This is a lower proportion of transformative actions than other sectors, highlighting the relative infancy of this area as a priority to city mayors.

The increasing importance of food security within a city has led to city governments taking action to integrate food and urban agriculture into a range of other policy areas such as reducing poverty.

A Technical Working Group on Food Security and Climate Change has been operational in Lima since 2008.

Mayors are also taking actions to try and change consumer-eating habits, with 16 cities now promoting farmers' markets, and further 15 supporting local farmer co-operatives.

FIG 8.4 ACTIONS, SCALE AND LEVERS: FOOD AND URBAN AGRICULTURE



8.5 FUTURE PLANS

Figure 8.5 shows the actions cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation.
The relatively high proportion of actions being expanded or planned by cities again highlights the increasing interest of C40 cities.

Cities are also considering a number of additional actions such as policies for: reducing loss of foodlands to urban sprawl; re-zoning of city owned land for agriculture; promoting adaptive new production methods for sustainable food production; and encouraging the growth of the industry and market opportunities for new businesses and farmers.

FIG 8.5 WHAT FOOD ACTIONS ARE BEING EXPANDED OR BEING PLANNED BY CITIES?

09.

INFORMATION + COMMUNICATION TECHNOLOGY

9.1 INTRODUCTION

As cities continue to grow, so do the challenges of balancing economic success, liveability, resource demands and climate change mitigation. Information and Communications Technology (ICT) has the potential to transform these energy-hungry urban centres into low-carbon 'smart cities' of the future.

Cities can be viewed as collections of interconnected systems, each tasked with providing municipal services such as waste, energy, water and transport. These systems are greatly dependent on ICT infrastructure to manage aspects such as monitoring, analysis and automation.

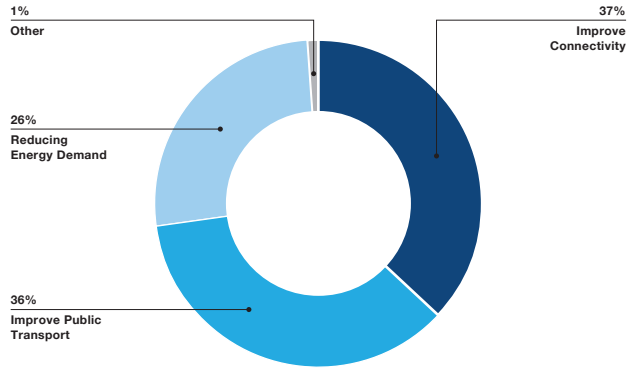
In the context of greenhouse gas emissions, ICT has a significant, and rapidly growing footprint which will need to be mitigated. At the same time, cities have the potential to leverage the power of ICT to provide substantial greenhouse gas reductions in a range of ways:

- Improved visibility over real-time performance;
- Sensor and analysis-driven optimisation systems, designed to maximise operational efficiency;
- Improved public empowerment and engagement;
- Improved information sharing and collaboration between systems and stakeholders.

While all cities have engaged in ICT projects at a departmental level, these are often designed to address a specific and immediate needs. While there will always be a place for such projects, leading cities are beginning to invest in more integrated, strategic and city-wide (smart) approaches to leveraging ICT.

Figure 9.1 shows the breakdown of planned and implemented actions by category of analysis used in this report. The breakdown of actions planned or implemented in ICT is spread relatively equally around the areas of connectivity, energy demand and transport. While ICT innovations around other sectors are beginning to emerge, this chart reflects the fact that ICT is particularly well interwoven into the energy and transport sectors.

FIG 9.1 WHAT IS THE BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED FOR ICT?



9.2 OVERVIEW

9.2.1 Wireless connectivity

Nineteen out of twenty-five cities surveyed provide wireless connectivity in public places. Almost all cities that have not reported wireless connectivity in public places are associated with a corresponding low per capita GDP level, and are located in the South-east Asia region. Six cities have explicitly defined targets for implementing wireless connectivity.

9.2.2 ICT Infrastructure emissions

As the demand for ICT infrastructure and associated energy requirements continues to grow at a rapid pace, so too do the greenhouse gas emissions associated with ICT electricity consumption. To date no C40 cities are addressing this issue through specific carbon reduction targets for ICT.

9.2.3 Digital divide

As change in the ICT sector continues rapidly, so too does the potential risk of excluding parts of society, in particular, those without access to technology as a result of socio-economic circumstance. Cities that are mindful of the issues of the 'digital divide' and social inclusion while developing their ICT strategies can benefit from greater adoption and engagement. Only 4 cities have explicitly stated goals of decreasing the digital divide. Therefore, opportunities remain for other cities to address this issue, and in doing so to increase the effectiveness of their services.

FIG 9.2 C40 MAYORS' POWERS: ICT

9.3 POWERS

In the context of this study, ICT initiatives can be described in two broad categories:

- Initiatives directly related to the infrastructure and delivery of communications and technology(ie. Connectivity); and
- Initiatives dependent on ICT infrastructure (ie. Transport, Energy Supply, Energy Demand etc.)

ICT is deeply embedded into all other sectors. It is therefore apparent that the potential to leverage the benefits of ICT across those sectors requires the associated sectoral powers and/or engagement with stakeholders in those sectors.

Figure 9.2 and 9.3 consider a range mayoral powers over assets where the use of ICT could improve the efficiency of service delivery. As information technology has been considered as a cross-cutting theme for the purposes of this report, most of the assets illustrated here replicate information provided in other chapters. For example, cities wishing to replicate C40 affiliate city, San Francisco, and its car parking sensor scheme are likely to need to have ownership of city roads (transport chapter) – thus the number of cities with powers over that asset are reproduced in this chapter.

The survey result indicates that not many of the C40 cities have powers over communications infrastructure directly. This reflects the reality that most ICT infrastructure is owned and operated by the private sector and governed by national and international standards.

Many cities do however, have powers over other relevant assets – for example, 26 cities own city roads.

Strong ownership and operational powers on city roads, buses, bus stops, underground and other intra-city rail systems are critical as they enable mayors to deliver actions on real-time transport displays, smart card ticketing and automatic enforcement capabilities.

As outlined in the existing buildings section, more than half of C40 mayors own municipal buildings, and are able to set and enforce building regulations. These powers enable the cities to implement actions on smart meter and smart building controls.

9.4 ICT IMPLEMENTED ACTIONS

Figure 9.3 shows that connectivity related actions have been implemented most frequently with 35 actions in total, 5 of which are transformative, 26, significant and 4 pilot. The 26 significant actions have been implemented across a broad spectrum of GDP levels. Few actions are in pilot phase as the technologies behind these actions are mature and most likely already operating in some capacity within the city.

Transport related ICT actions such as smart card ticketing and real-time transport displays (informatics) rank a close second, with a total count of 34 actions, 9 of which are transformative, 17 significant and 8 pilots.

FIG 9.3 ACTIONS, SCALE AND LEVERS: ICT

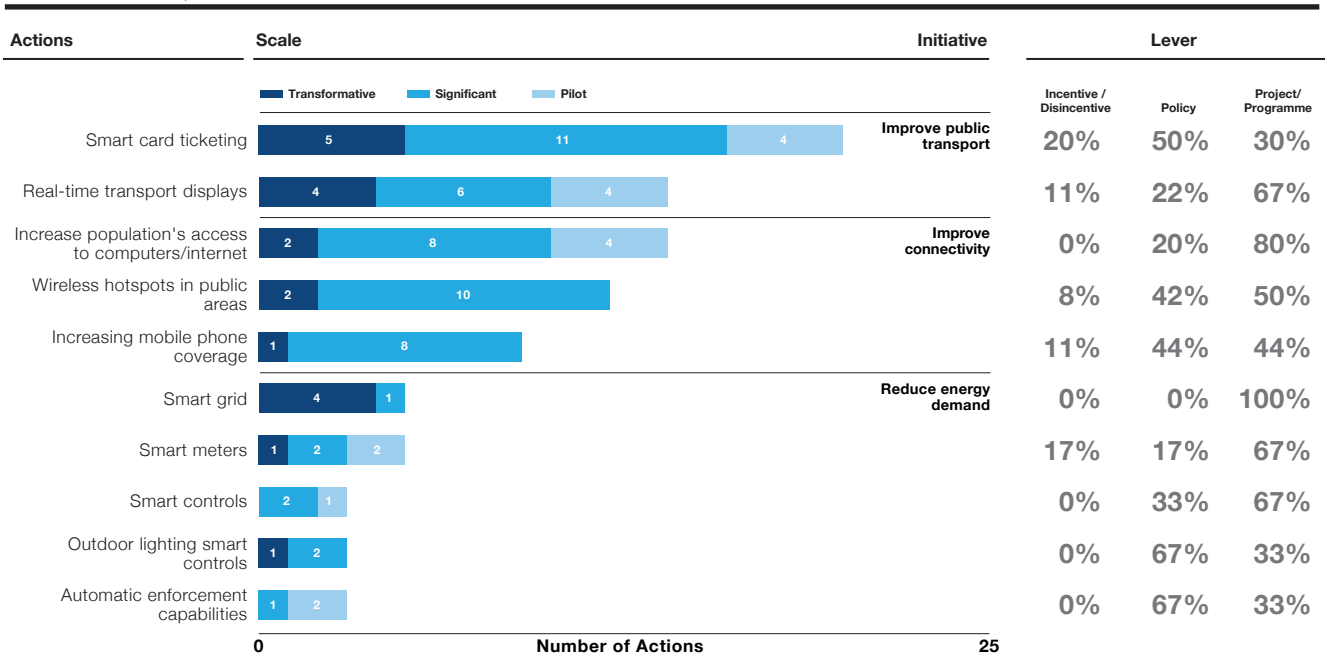


Figure 9.3 lists all the actions implemented for ICT and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives / disincentives, policies, projects / programmes.

Energy related actions rank lowest with a total of 19 actions, only 6 of which are transformative, 8 significant and 5 pilots. Technologies related to energy demand management actions are still emerging relative to those related to Connectivity. For example, Smart Grids, which have the potential to deliver significant energy efficiencies at the city scale, have only been partially implemented in five cities.

All transformative ICT actions relate to middle and higher cities in higher GDP bands. This is a reflection of the capital intensity related to implementing city-wide ICT projects.

Across all segments, the vast majority of implemented actions are Project/Programme. On average, 5% are incentives, 33% are policy levers and 62% are projects.

9.4.1 Findings in focus:

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and/or there is significant scope for scaling up activity.

9.4.1.1 Improve Connectivity

Apart from Tokyo, all mobile phone expansion projects being implemented are being undertaken in the middle to lower GDP level cities, with 1 transformative action and 8 significant actions.

Wireless hotspots in public areas have 2 transformative actions and 10 significant actions. Seoul has implemented wireless connectivity at a transformative level. For example, all visitors to government buildings are granted free PC and wireless internet connectivity. Chicago also has taken action to improve access to computers and the internet at a transformative level. It is worth noting that these actions are in direct alignment with Chicago and Seoul's commitment to reducing the digital divide.

9.4.1.2 Improve Public Transport

In addition to its critical operational functions, ICT can be been used to improve the efficiency and convenience of public transport services. These improvements have the ability to increase public adoption of public transport by way of improving the commuting experience through way-finding, reduced waiting times and more convenient and faster payment processing at ticket gates.

One action that is currently implemented in 14 cities is the use of real-time transport displays. There are 4 transformative, 6 significant and 4 pilot actions. Chicago, identified as undertaking transformative action has implemented a CTA Bus Tracker which uses Global Positioning Systems (GPS) to report bus locations in near-real time and provide accurate estimates of arrival time on an online map or by SMS (mobile phone) text. This system has the potential to be implemented in other cities.

Smart card ticketing is the action with the highest implementation rate amongst all ICT actions with 5 transformative, 11 significant and 4 pilot actions implemented. Details are located in Transport section.

9.4.1.3 Reducing Energy Demand

ICT can be used to drive reductions in energy consumption through solutions with varying levels of sophistication. Some actions studied here include:

- The use of smart metering which can collect real time energy consumption data which can be analysed and linked to reports, incentive/behavioural change schemes as well as sophisticated buildings/industrial control systems. Smart metering has been implemented in 5 cities, 1 transformative action, 2 significant and 2 pilot. Some noteworthy smart metering projects includes the metering of 50,000 homes in Sydney as well as a program of remotely tracking energy consumption and controlling non-essential appliances in 15,000 smart homes.
- Smart Grids are an emerging technology, only 5 partial smart grid actions implemented so far. Four of these are identified as transformative and one significant. Details about these smart grid actions are located in the energy supply section.

9.5 FUTURE PLANS

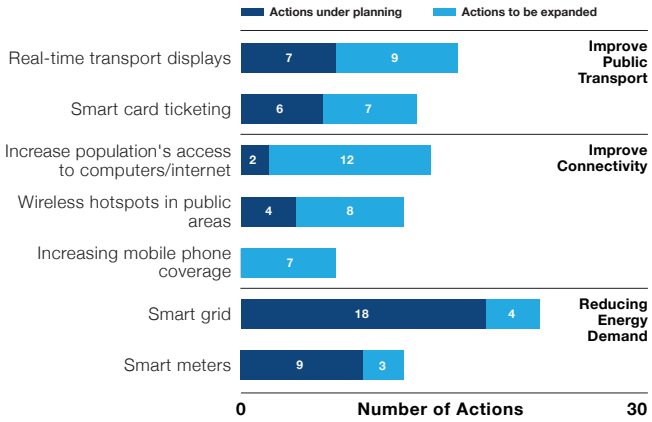
Figure 9.4 shows the actions cities are planning to either expand if they are already implementing them, or actions cities are considering for implementation.

Plans for the implementation and expansion of ICT initiatives are in place across all three major categories used for analysis in this report. It is worth noting that the bulk of new implementations are planned for the emerging and innovative Transport and Energy related actions. Smart Grids, as mentioned in the energy supply section, are a clearly dominant action planned for future implementation. With 4 existing implementations flagged for expansion and 18 new implementations planned for the future.

Three smart meter actions are flagged for expansion and 9 planned for the future.

Nine real time transport display actions are flagged for expansion and 7 planned for the future. Seven smart ticketing actions are flagged for expansion and 6 planned for the future.

FIG 9.4 WHAT ICT ACTIONS ARE BEING EXPANDED OR PLANNED BY CITIES?



10.

FINANCE AND ECONOMY

10.1 INTRODUCTION

Addressing the challenges of climate change – both mitigation and adaption – places a huge financial burden on city governments, many of whom are already burdened by the global economic crisis and struggling to provide basic services like health care and education to their residents.

The UN Framework Convention on Climate Change (UNFCCC) has estimated that the additional investment and financial flows needed in 2030 to return global greenhouse gas emissions to their current levels is about $200 billion, while the estimated additional funds needed for adaptation in 2030 are between $38-$160 billion[1]. Cities will have to bear a huge proportion of these costs, given that they are home to over half of the world's population. This financial burden is even greater on cities in low income economies, as they are proportionally more affected by the impact of climate change. Accessing finance from a variety of sources, such as carbon markets, multilateral banks, infrastructure funds and the private sector, will be essential to meeting this challenge.

While mitigating and adapting to climate change creates an enormous financial burden for governments, it also presents an opportunity for cities to increase resource efficiency, renew aging assets, embrace new technologies, spur growth of low carbon enterprises and create new jobs. This chapter on finance and economy discusses actions both to attract finance for climate change mitigation and adaptation, and support growth of the low carbon economy.

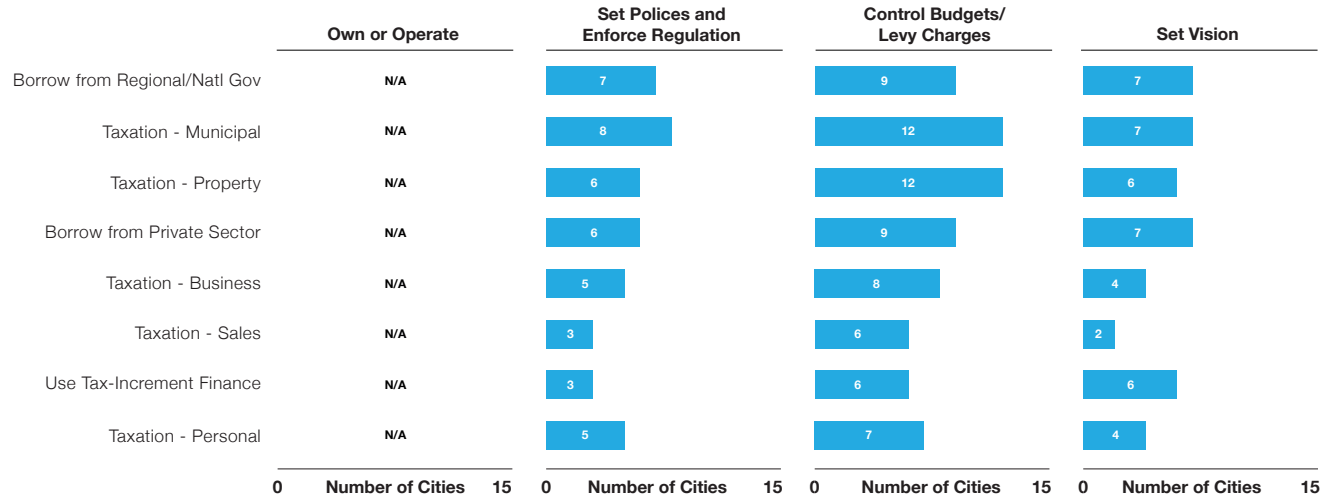
10.2 OVERVIEW

C40 cities have responded to the pressing need for carbon reduction by tapping into a wide range of alternative financing mechanisms – from the Clean Development Mechanism (CDM)/Joint Implementation (JI) vehicles under the Kyoto Protocol, to seeking private finance via energy performance contracts, to establish revolving funds for investments in energy efficiency and renewable energy.

While innovative finance solutions can be crafted by cities to spur investment in energy efficiency and renewable energy, meeting the massive cost of adapting infrastructure is a cost cities cannot bear alone. For some cities in particular, raising finance can be difficult or impossible due to borrowing constraints placed by central governments. Only about half of surveyed cities for example have their own credit rating. Undertaking these large scale projects to adapt infrastructure to climate change will require a collaborative approach with regional or central governments.

[1] *Investment and Financial Flows to Address Climate Change, United Nations Framework Convention on Climate Change, 2007*

FIG 10.1 C40 MAYORS' POWERS: FINANCE



10.3 POWERS

Figure 10.1 presents the number of cities that have strong powers across different financing mechanisms. About one-fourth of cities appear to have stronger powers over municipal and property taxes, and about a third are able to borrow funds from central/regional government or from the private sector.

10.4 FINANCE AND ECONOMY

Figure 10.2 shows the number of cities that have undertaken at least one action under the 4 categories of initiatives in Finance and Economy. The most popular initiatives undertaken by cities are energy efficiency finance and carbon finance. Closer review of the data reveals that there are a number of cities implementing actions across most these initiatives. These cities are true leaders in the climate finance field, and have much in the way of innovative programmes to share with the rest of the C40 network.

FIG 10.2 HOW MANY CITIES HAVE TAKEN INITIATIVES IN FINANCE AND ECONOMY

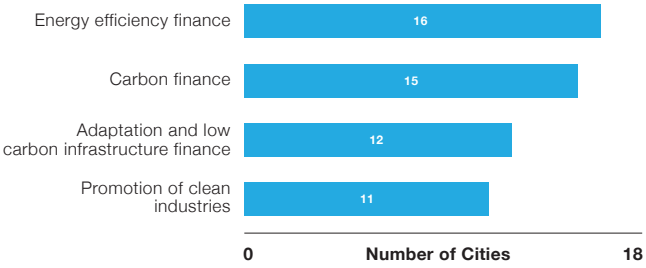
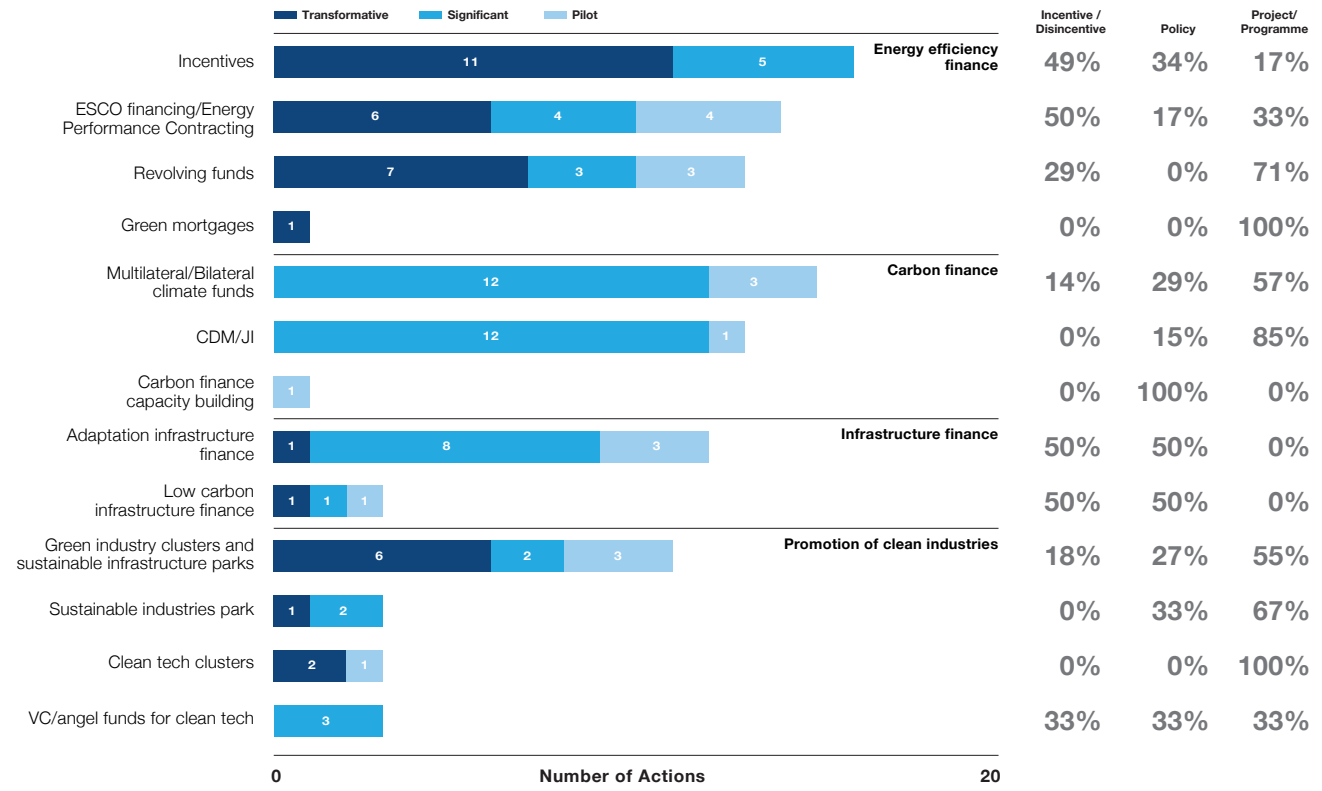


Figure 10.3 lists all the categories of 'Initiative' recorded in finance and economy and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives/disincentives, policies, programmes. The overall results indicate that while cities have actively pursued different financing mechanisms for carbon mitigation and adaptation, there is ample room to scale up efforts to attract private finance, develop innovating funding schemes and partnerships, and harness the power of carbon markets.

In the area of energy efficiency, cities have used sector-wide incentives to encourage investment, have tapped into private sector knowledge and finance via ESCOs and energy performance contracts and have established revolving funds to enable ongoing investments in energy efficiency. Over a third of responding cities have sought carbon financing for projects via climate funds and CDM/JI. While one quarter of responding cities have sought financing for projects to adapt infrastructure, only three indicated they raised finance to invest in large scale low carbon infrastructure projects. Almost a dozen C40 cities have developed green industry clusters, but far less have focused specifically on developing and supporting clean tech industry. Almost half of the actions undertaken by cities have been classified as projects/programmes.

The next section highlights in more detail innovative actions undertaken by C40 cities in the area of climate finance and energy efficiency.

FIG 10.3 ACTIONS, SCALE AND LEVERS: FINANCE AND ECONOMY



10.4.2 Carbon and Energy Finance

A number of cities are taking innovative approaches to catalyse investment in energy efficiency and tap into private sector finance. Examples of these include:

- Philadelphia established the Greenworks Loan and Rebate Fund in partnership with the Philadelphia Industrial Development Corporation and The Reinvestment Fund to help businesses finance energy-efficient building practices, materials, and equipment for major renovations and new construction projects.
- The Toronto Atmospheric Fund has been used for over 20 years to help the City invest in measures that improve energy efficiency and create green, healthier communities. The revolving fund started with a small endowment from a sale of surplus lands owned by the City and has invested more than USD$50 million. Projects have included deep lake water cooling, home energy retrofit incentives, conversion of traffic signals to LEDs, energy efficient streetlighting, and solar water heating for pools and buildings.
- The London Green Fund (LGF) is a USD$160 million revolving fund launched in 2009 by the Mayor of London and the European Commissioner for Regional Policy to invest in energy efficiency and waste schemes to cut London's carbon emissions. The fund includes EU, regional and local funding sources. It will be invested via two different investment vehicles managed by private fund managers, who are also securing private capital.
- In Mexico, a specially created fund has been established to provide loans and mortgages for low income families to purchase energy efficient homes. These green mortgages give home buyers stronger buying power and enables them to enjoy the benefit of energy savings.

11.

CLIMATE ADAPTATION

11.1 INTRODUCTION

C40 cities are focused on both types of climate action: reducing their own greenhouse gas emission (climate change mitigation) and making their cities more resilient to the degree of global warming that is now inevitable (climate change adaptation).

Climate change is having very different effects across C40 cities, however the following impacts are notable:

- **Risk of flooding from sea level rise**
  Fifteen of the cities in this survey have coastal regions. The Intergovernmental Panel on Climate Change predicts that global sea levels will rise anywhere between 0.18 to 0.59 metres above 1980-1990 levels by the end of the 21st century[1]. Sea level rise has occurred fastest in the central Pacific region away from the Equator (Hong Kong, Jakarta, Tokyo), the northeast Indian Ocean (Mumbai) and in the North Atlantic along the coast of the USA (New York, Philadelphia).
- **Tropical cyclones**
  With the exception of the South Pacific Ocean, all tropical cyclone basins show increases in wind speed, wind strength and storm duration, with the greatest increases in the North Atlantic and northern Indian Oceans[2].
- **Heavy rainfall events**
  According to the UN 'on average, observations indicate that heavy one-day and heavy multi-day precipitation events have increased globally throughout the 20th century and these trends are very likely to continue throughout the 21st century[3].' In the Tropics, eastern North America (New York, Philadelphia), Northern Europe (London, Paris, Berlin, Warsaw, Moscow), and Northern and Central Asia, rainfall increases have been documented in summer and winter.
- **Drought**
  The flip-side of increased heavy rainfall is that some parts of the world are experiencing more intense drought periods due to climate change. Impacts on C40 cities are widespread, from the world's existing arid and semi-arid areas in Brazil, northern Mexico, and Ethiopia, through to European cities.
- **Flooding**
  The frequency and severity of flooding has generally increased during the last decade (compared with 1950-80), along with the frequency of floods that exceed levels that only typically occur once every 100 years. It

[1] *'Climate Change 2007:Synthesis Report, IPCC, (2007b), p.28*
[2] *'Global Report on Human Settlements 2011: Cities and Climate Change', UNHabitat, 2011, p.67*
[3] *Ibid, UNHabitat 2011, p.67*

is generally accepted that these trends will continue in Asia (Delhi NCT, Karachi, Dhaka, Mumbai), Africa (Addis Ababa, Cairo, Johannesburg, Lagos), and Latin America (Buenos Aires, Caracas, Lima, Rio de Janeiro, São Paulo).

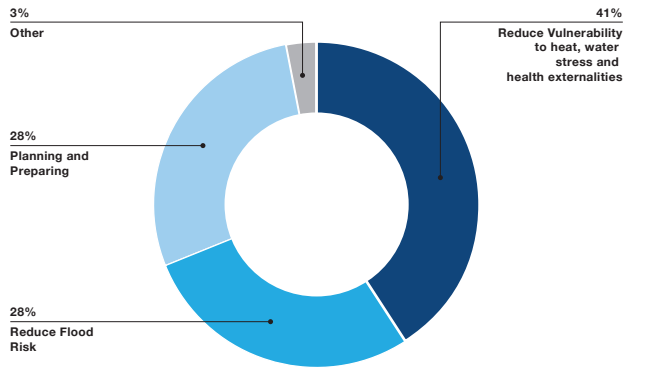
- **Landslides**
  The risk from landslides is likely to increase with extreme rainfall events, especially in cities where there has been informal (and formal) development on marginal and dangerous lands. This is typical of many informal communities, particularly in Latin America. For example, there have been devastating landslides in Caracas and near Rio in recent years.
- **Extreme heat events**
  As a result of climate change, heat-waves are predicted to become more frequent, intense and longer lasting over most land areas, especially in North America and Europe. Both Paris and London, for example, suffered considerably in the 2003 heat-wave. Changes in average temperature also affect the one sixth of the world's population which are dependent on glacial run-off, especially in Latin America, China and Pakistan. C40 cities likely to be affected include Lima and Bogota.[4]
- **Urban Heat Island**
  Densely populated, built-up cities often experience a phenomenon known as the 'urban heat island' effect, whereby temperatures in the city can be many degrees higher than the surrounding countryside. This is often particularly true at night and can cause ill-health and reduced productivity, especially in cities where buildings and other infrastructure have not previously needed to cope with consistently high temperatures, but are now having to adapt due to climate change.

Adaptation & Resilience has been split into three main categories for the purpose of this report:

- **Crisis Planning and Preparation** - this includes actions undertaken by cities to assess vulnerabilities, and develop emergency and crisis response mechanisms to prepare for climate change.
- **Reducing Flood Risk** - this includes actions undertaken by cities to reduce the risk (probability and impact) of floods .
- **Reducing Vulnerability to Climate Stress** - this includes actions to reduce vulnerability to heat, water and health stressors produced by climate change.

Figure 11.1 shows the breakdown of planned and implemented actions.

FIG 11.1 WHAT IS THE BREAKDOWN OF ACTIONS PLANNED OR IMPLEMENTED FOR ADAPTATION?

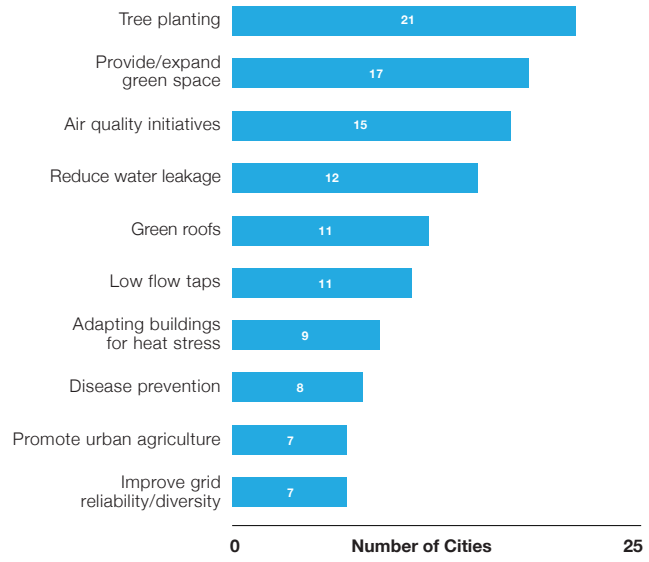


11.2 OVERVIEW

Adaptation to climate change is a fundamental issue for the C40 cities. Nineteen cities have allocated funding for adaptation measures all of whom are undertaking vulnerability and risk assessments of their city, of which 12 have sought external funding and co-financing and 14 have given responsibility for climate adaptation to a specific office of the city government. However, only 12 out of 21 responding cities have developed a climate change adaptation plan.

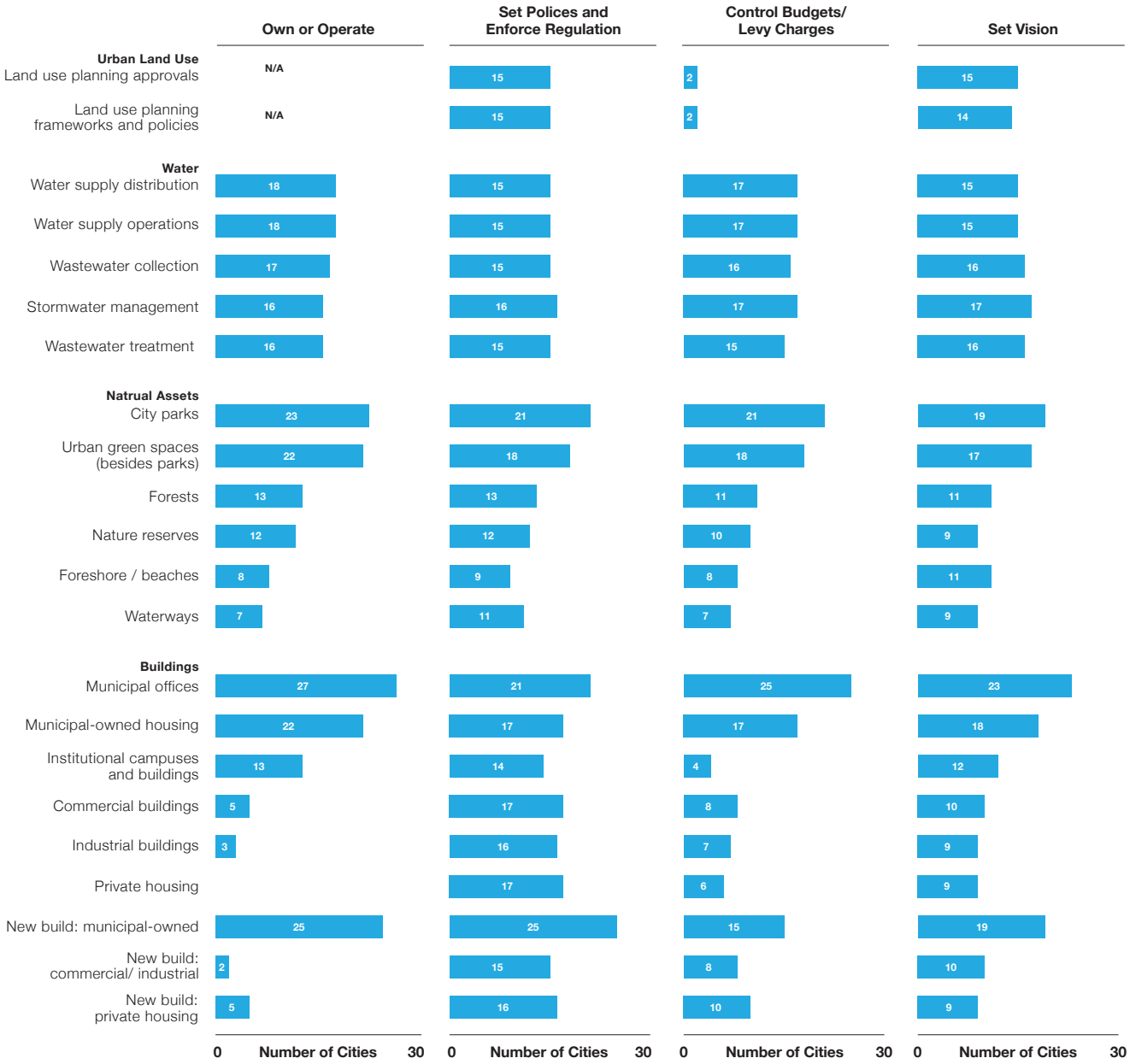
Figure 11.2 presents the number of cities that have undertaken studies to assess climate change impacts and risks related to heat stress, water stress, flood risk, extreme weather, and agriculture / habitat. C40 cities have been focused strongly on assessing flood risks, which is not surprising given that 90% of C40 cities are located by rivers and lakes or border the coast. Issues that appear to be clearly less understood are those relating to impacts on agriculture and habitat.

FIG 11.2 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES TO REDUCE VULNERABILITY TO CLIMATE STRESS?



[4] Ibid, UNHabitat 2011, p.67

FIG 11.3 C40 MAYORS' POWERS: ADAPTATION



11.3 POWERS

Climate change adaptation is a broad issue that cuts across a range of sectors and city functions, from water to buildings to planning and land use. The powers shown in figure 11.3 incorporate a broad range of city assets and functions, most of which have already been discussed elsewhere in this report. For the purposes of context and framing, they have been represented here again.

Across the different assets and functions that are relevant to adaptation, C40 cities have strongest powers across water, urban green assets, and municipal buildings. Over one-third of cities have the ability to set policies for land use, which is critical to ensuring new development and infrastructure considers climate change impacts and is 'future-proof'. A key challenge for C40 cities will be to achieve adaptation measures in existing buildings, given that powers over private buildings are limited.

11.4 CRISIS PLANNING AND PREPARATION

Figure 11.4 shows the number of cities implementing initiatives in Crisis Planning and Preparation. It is clear from the data that cities are actively undertaking measures to assess risks and develop appropriate response mechanisms to address potential crisis situations. The area which shows the lowest positive response is targeting adaptation investments to the most vulnerable populations.

The survey indicates that about half of C40 cities have implemented most of the identified actions related to Crisis Planning and Preparation, and most of these have been transformative in scale. While the results are positive, this indicates more effort needs to be taken by cities to prepare themselves adequately for the potential impacts of climate change. Actions taken by cities have been classified as mostly projects and programmes.

Bangkok is highly threatened by climate change, including from increase extreme weather and heat-waves – impacts that are already being felt. The city has in place plans for:

- Improving the local public health infrastructure;
- Creating early warning systems for severe weather and pollution;
- Implementing stricter zoning and building codes to minimise storm damage;
- Improving disease surveillance and prevention programmes;
- Educating local health professionals and the general public about the health risks associated with climate change;
- Changing both water infrastructure and management to prevent contamination of potable supplies; and
- Providing emergency shelters for the most vulnerable citizens during times of extreme heat.

Bogota has in-place 'SIRE' which is a municipal information system for risk management and attention to emergencies. Components of SIRE include: evaluation of emergency and contingency plans; information centre; damage evaluation; risk maps; reports, monitoring; resettlement of displaces families, and crowd management (public events), etc.

New York has put in place systematic plans to prepare for the impact of climate change, particularly increased flood risk and the urban heat island effect. Efforts are coordinated through the Climate Change Adaptation Task Force and the New York City Panel on Climate Change, emerging out of 'PlaNYC' (the Mayor's long-term sustainability plan). The Task Force includes City and State agencies, authorities and private companies that operate, maintain, or control critical infrastructure in New York City. Advising the task force is a panel of experts from academic institutions and the legal, engineering, and insurance industries.

FIG 11.4 HOW MANY CITIES HAVE IMPLEMENTED INITIATIVES IN CRISIS PLANNING AND PREPARATION?

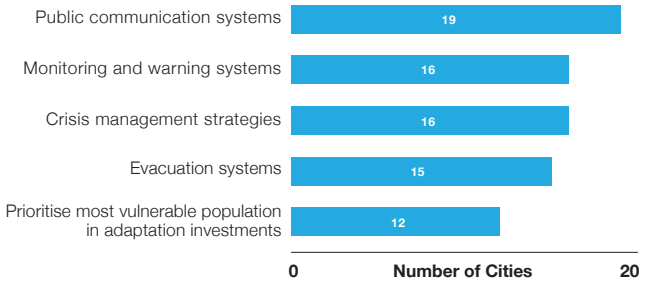


FIG 11.5 ACTIONS, SCALE AND LEVERS: CRISIS IS PLANNING AND PREPARATION

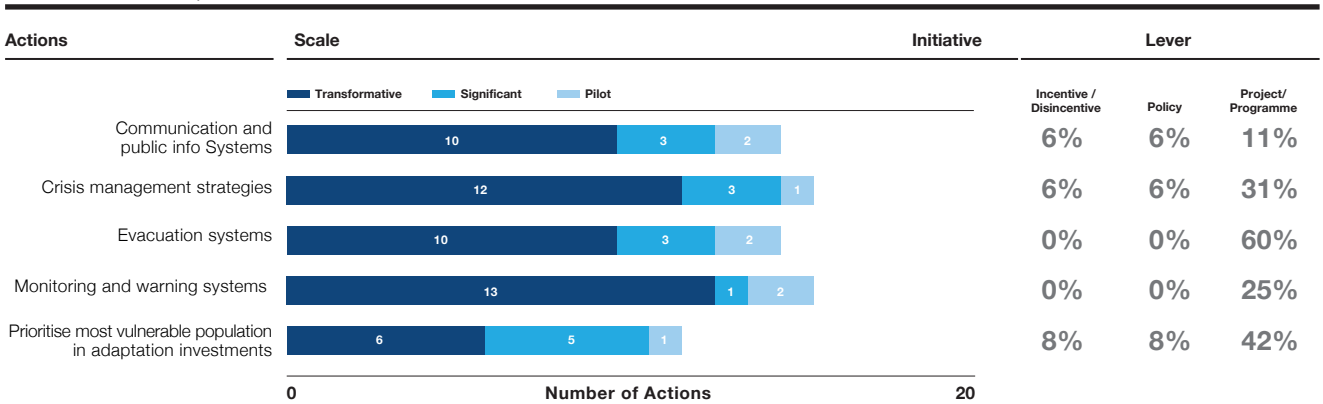


Figure 11.5 lists all Crisis Planning and Preparation initiatives and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives / disincentives, policies, or projects / programmes.

11.5 REDUCING FLOOD RISK

Figure 11.6 shows the number of cities that have implemented initiatives to reduce flood risk. Twenty seven C40 cities are located near major water bodies, yet less than half the cities surveyed have taken action, indicating either that few face flood risk (which is highly unlikely) or low levels of preparedness for the increased flood risk which climate change will pose. The area where cities have taken the least action is in helping buildings to be more resilient to the risk of floods.

Most actions undertaken by cities have been transformative in nature, a positive sign that they have been implemented across cities. The top actions implemented clearly reflect that cities have stronger powers in land use and stormwater management. Actions implemented have also been mostly projects/programmes, with the exception of sustainable urban drainage.

FIG 11.6 HOW MANY CITIES HAVE IMPLEMENTED INITIATIVES TO REDUCE FLOOD RISK?

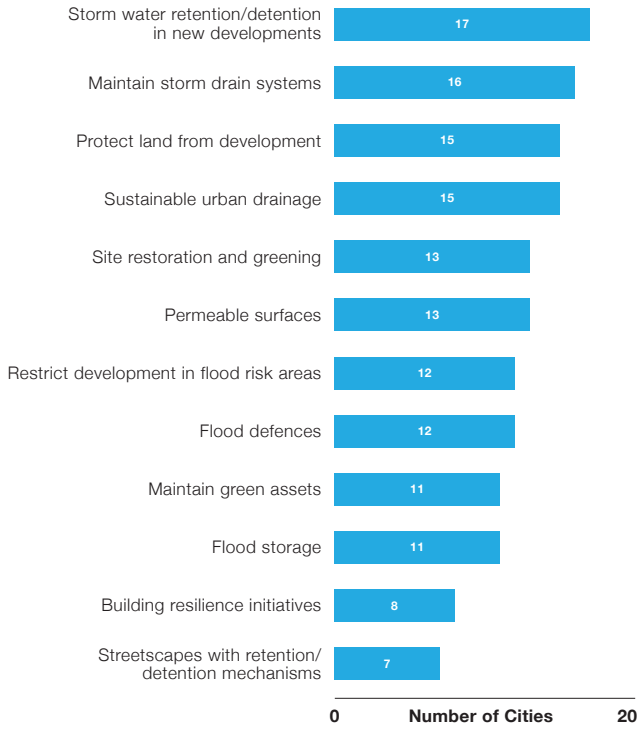
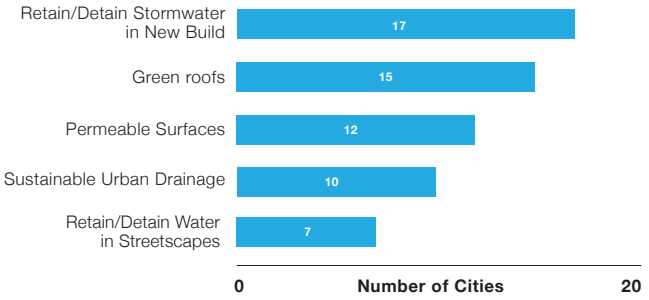


Figure 11.6 lists all the actions undertaken to reduce flood risk and sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of initiative they are – incentives/disincentives, policies, programmes.

11.5.1 Dealing with stormwater

A key issue for many cities in relation to reducing flood risk is to manage stormwater. Figure 11.7 shows the number of cities that have undertaken at least one action under the five categories of initiatives within the Stormwater Treatment section of the survey (the powers relating to this type of action are referred to in Chapter 4 – Water Supply).

FIG 11.7 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES IN STORMWATER TREATMENT?



The two areas where cities are undertaking the most actions is in retaining or detaining stormwater in new developments and green roofs - this corresponds to the strong powers cities have over planning for new buildings. Interestingly, despite many cities having power over roads and green assets, few have implemented actions related to sustainable urban drainage and stormwater retention / detention in streetscapes.

The results show most actions have been taken in stormwater retention/detention in new developments, and they were primarily policies or projects/programmes that are transformative in scale. Twelve cities, including early leaders such as London, New York, and Tokyo, have developed comprehensive climate adaptation strategies, which have been used to set requirements for stormwater management.

FIG 11.8 ACTIONS, SCALE AND LEVERS: FLOOD RISK REDUCTION

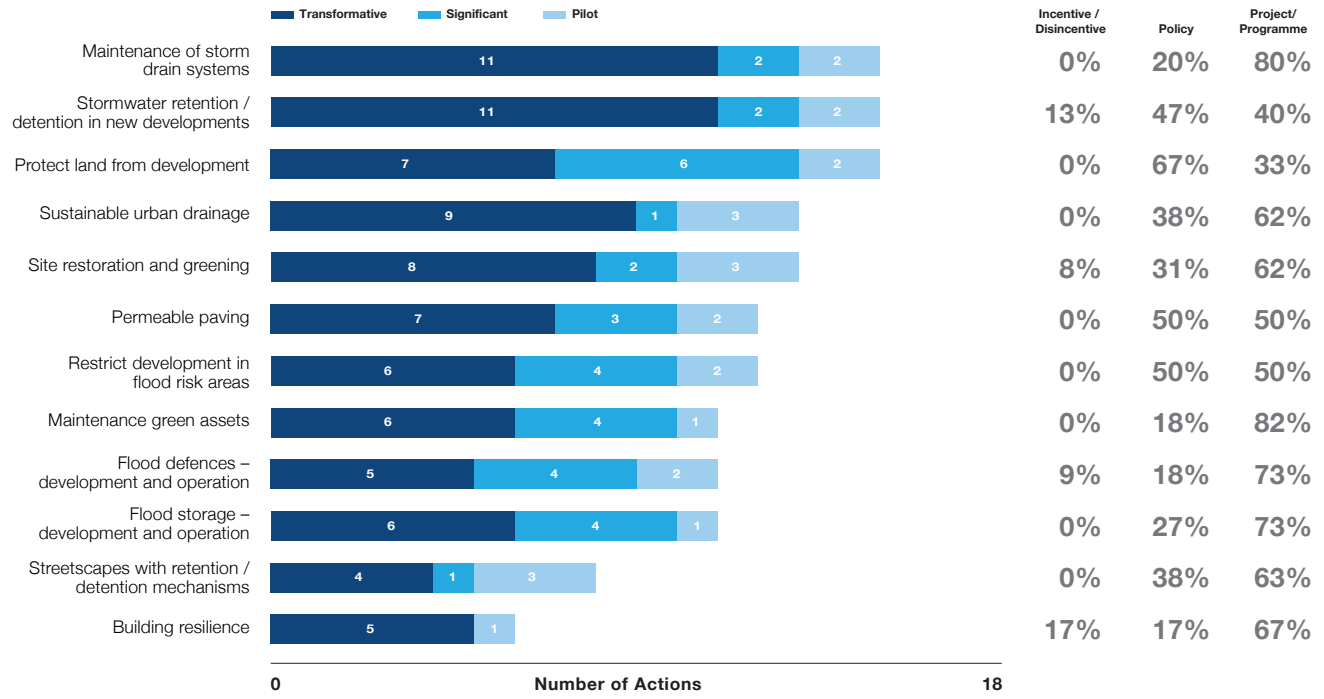


Figure 11.8 sets out (on the left) the scale of activity for each – how many are pilots, significant, or comprehensive – and (on the right) what kind of action they are – incentives / disincentives, policies, projects / programmes.

FIG 11.9 ACTIONS, SCALE AND LEVERS: STORMWATER MANAGEMENT

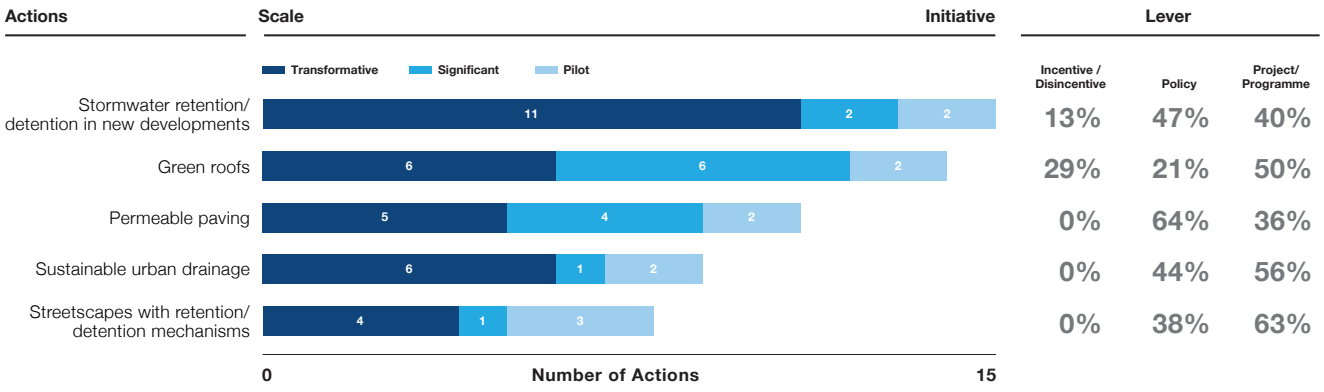


Figure 11.9 present the actions implemented in Stormwater Management. The scale at which actions have been delivered is recorded on the left of the graph in three categories: whether the initiatives are broadly pilots, significant in scope, or comprehensive/transformative. On the right of the graph is an indication of the type of initiative: whether they are primarily – incentives/disincentives; policies; or projects / programmes.

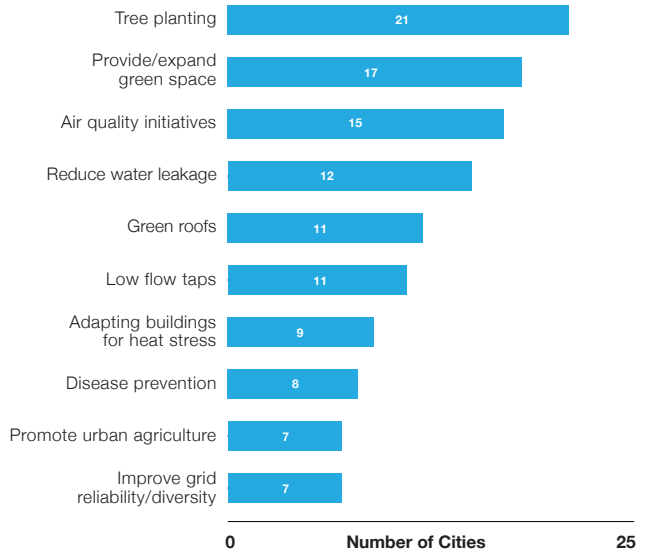
11.6 REDUCE VULNERABILITY TO CLIMATE CHANGE STRESS

Figure 11.10 shows the number of cities that have undertaken initiatives to reduce vulnerability to climate stress, including heat, water and health stress. The two top initiatives are tree planting and green space expansion, actions typically under city control.

Twenty one cities are implementing policies to plant more trees. This includes cities in every continent. Possibly the most ambitious programme is taking place in Addis Ababa (Ethiopia) where the Mayor is mid-way through a programme to plant 3 million new trees and create a massive new nature reserve containing at least one specimen of every plant and tree native to Ethiopia. In doing so, Addis is taking advantage of advice from London's Kew Garden botanists.

The growing trend in cities is to integrate adaption actions with infrastructure development. In Jakarta, a low-lying city, based on the Flood Control Policy, measures consist of the rehabilitation and development of infrastructure to reduce flood caused by sea level rise and Heavy Rain, such as polder system development, sea defence, and rivers dredging, including a retention basin, and water capture. Other innovative actions include developing bio-pore holes and absorption wells, which are structural measures to capture water underground. These are now part of Jakarta's building regulations.

FIG 11.10 HOW MANY CITIES ARE IMPLEMENTING INITIATIVES TO REDUCE VULNERABILITY TO HEAT, WATER STRESS AND HEALTH EXTERNALITIES?



In New York, a review of planning efforts already underway for opportunities to integrate climate adaptation, ensures cost-effective risk reduction. The first major milestone of this initiative was in September 2010, when New York City released the NYC Green Infrastructure Plan which presents an alternative approach to improving water quality that integrates “green infrastructure,” such as swales and green roofs, with investments to optimise the existing system and to build targeted, “grey” or traditional infrastructure.

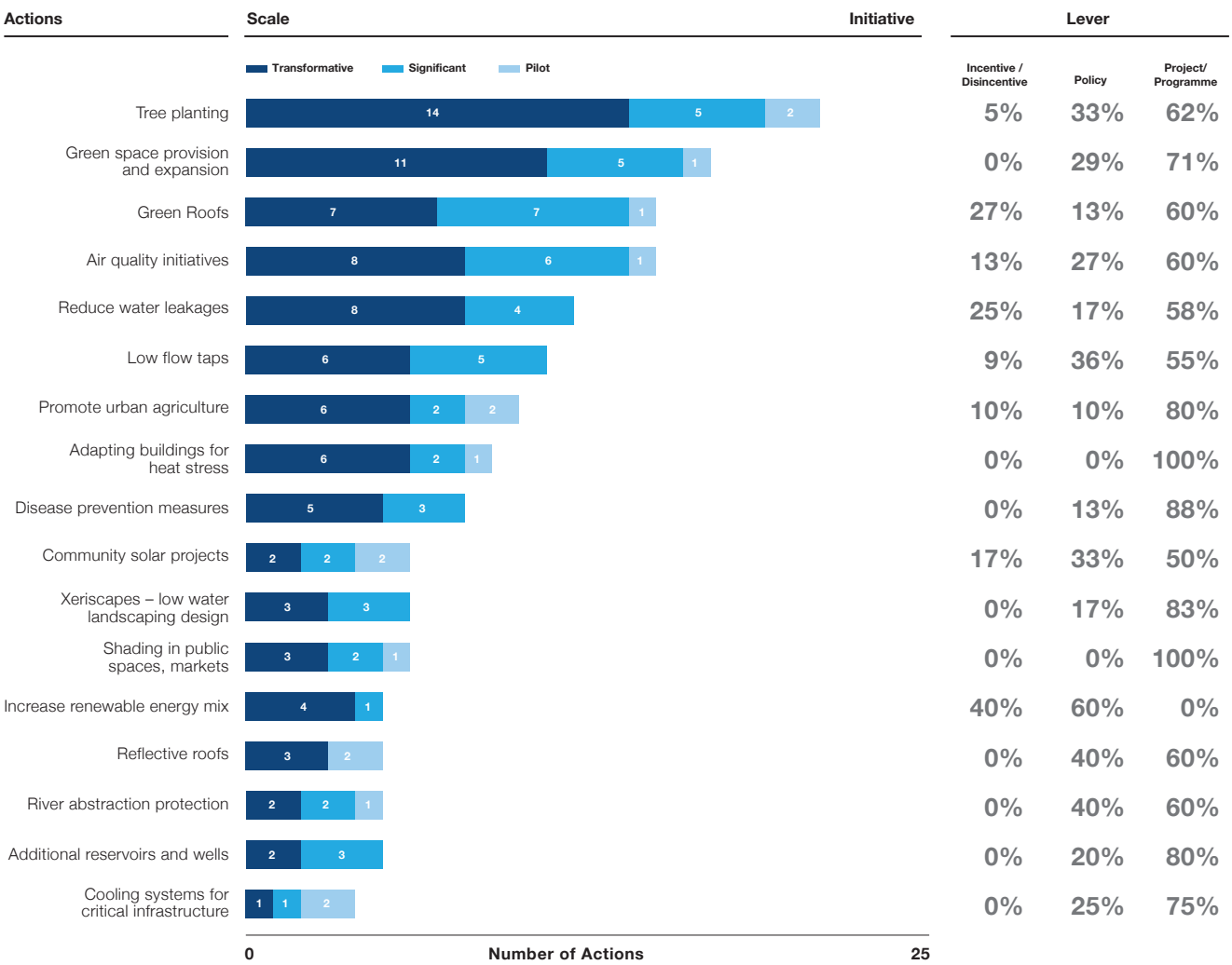
Figure 11.11 lists all the adaptation actions to reduce vulnerability to climate stress. It includes a range of actions that help cities to manage the impact of climate change through reducing urban heat islands, conserving water, adapting buildings for heat stress, disease prevention, and improving resilience in energy, food and water supply.

Over two-thirds of all actions undertaken by cities have been projects and programmes, and it is encouraging that nearly 60% of all actions have been transformative in scale. However, the results indicate cities overall have not taken strong enough measures to reduce their vulnerability to climate stress. For example, few have taken measures to adapt buildings for heat stress, a critical issue which involves broad stakeholder engagement and significant capital investment.

11.6.1 Findings in focus

The sections below highlight in more detail initiatives or actions where C40 cities are either already taking notable action and / or there is significant scope for scaling up activity.

FIG 11.11 ACTIONS, SCALE AND LEVERS: REDUCING VULNERABILITY TO CLIMATE STRESS



11.6.2 Green Roofs

Fourteen cities are taking action to create ‘green roofs’, where vegetation is planted on the top of buildings. This approach can fulfil a number of purposes from improving insulation, to capturing storm-water. While they are still unusual in some cities, it is a sign of their acceptance in some marketplaces that actions are significant and transformative, rather than pilots.

In Buenos Aires, the city has utilized powers of ownership over public schools to develop a transformative green roof programs. This trend has continued in New York and Chicago where mayors are incentivising green roof development through tax abatements and grants.

11.6.3 Reducing health impacts

Many cities are taking informal and formal action to reduce vulnerability of their populations to the adverse affects of climate change. These include the increased possibility of transmitting diseases through infecting organisms who can survive in the warmer climates associated with climate change. They also include preparing populations for heat waves and ensuring that water systems are not toxic.

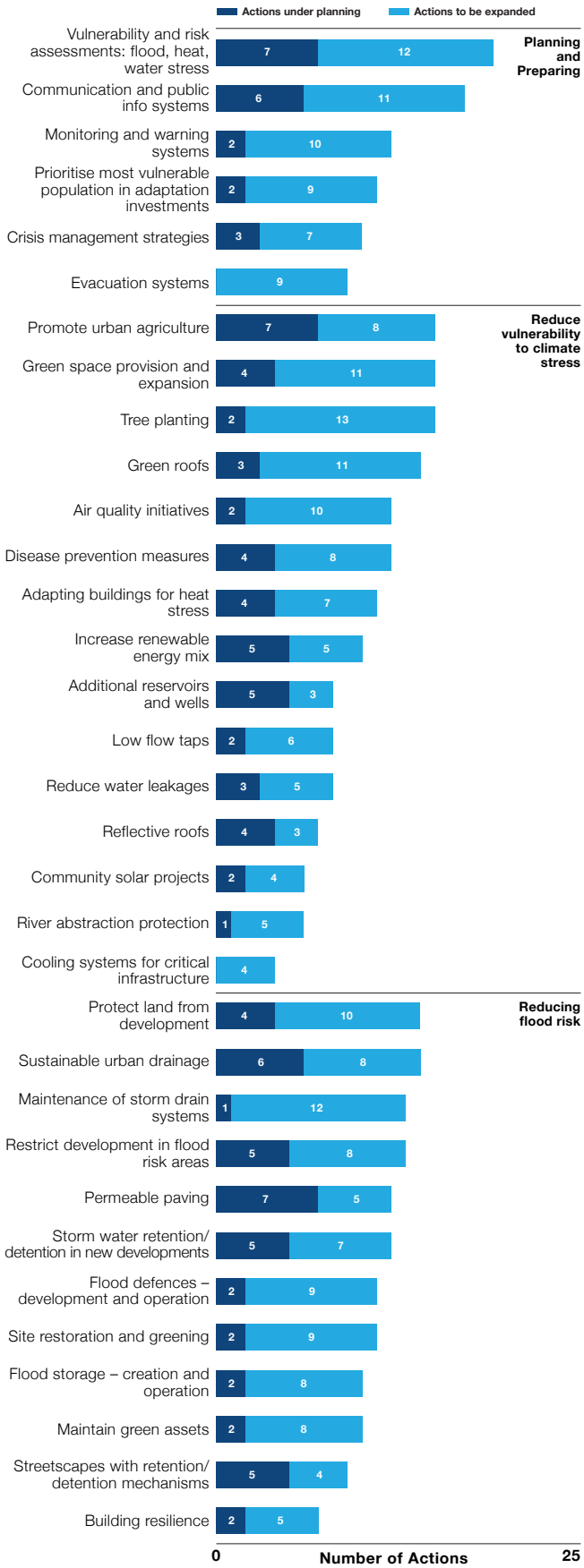
In Mexico City, the mayor has helped to create conferences to address mothers of children who have increased exposure to disease, due to a generally warmer climate and increased vector transmission. These conferences address the need to take care of children affected by dehydration and diarrhoea. Mexico City has also developed a virtual centre of information for climate change, as a resource for the community to understand their potential vulnerabilities.

Buenos Aires has also identified high vulnerability, high risk for the health of segments of their population. They have taken action to evaluate and strengthen health services, including infectious disease surveillance and training the health department. They have also taken to promote health education programmes and develop information campaigns to allow residents to be preventive in how they live. Finally, Buenos Aires has utilized their strong powers over water to provide safe drinking water to low-income houses.

11.7 PLANS FOR THE FUTURE

Figure 11.12 shows adaptation actions cities are currently considering or actions already under implementation which they are going to expand. A number of cities have indicated they will be undertaking significant action in adaptation in the future. Areas where cities are taking the most action include crisis planning and preparation, urban heat island reduction and reducing flood risk.

FIG 11.12 CURRENT AND FUTURE PLANS: ADAPTION



APPENDIX A DETAILED METHODOLOGY

1 RESPONSE RATE AND DATA QUALITY

Across all cities and sectors 40% of the possible data points have been completed. The breakdown for specific sections of the survey was as follows:

Overview section: 33%
Powers section: 65%
Actions section: 35%

The response rate was exceptionally high overall given the expanse and in-depth nature of the survey questionnaire. The range of powers that needed to be assessed for each city and the list of over 1,200 potential actions spanned across many city government departments and required the cooperation of many officials.

The first-run abbreviated data collection period was 5 weeks long. Due to the different dynamics of engaging with city governments for data collection processes data for thirty-six of the forty C40 participating cities were used for analysis in this report. At this time we were unable to capture the full verified data set necessary for Dhaka, Karachi, Athens, and Cairo. With Dhaka and Karachi, an extended follow-up effort is already underway to populate their survey responses. With Athens and Cairo, due to the current political state, we are reserving research efforts there until such time would be suitable to engage their mayors regarding powers and actions.
The report identifies the relevant sample size (n=) only for data presented in the overview section, as the sample size varies for each individual action and power discussed within a sector. It is acknowledged the findings presented in the report may not be representative of all C40 cities and may only reflect the data from cities submitting a response per the quality of their response.

It should also be noted the actions discussed in this report are those currently in place or those being planned by the city government entities represented in the C40; however, some of these actions may reflect the leadership of the regional or central government, not necessarily only the actions of city government. If and where possible, we have utilized an analysis of powers and qualitative city feedback to understand where direct mayoral action has led to results.

Although a quality control review was undertaken to identify potential errors and omissions, the results presented in this report are largely those self-reported by cities and have not all been independently verified.

2 ASSESSING MAYORAL POWERS

The aim of the 'Powers' analysis is to determine which cities have strong powers to be able to deliver the initiatives and actions analysed in the report. With the following methodology we are able to summarise questionnaire responses to questions regarding mayoral powers, and minimise error. The methodology affords the reader an understanding of potential opportunity through the C40 and between its cities, and suggests the complexity of the underlying data set.

Within each of the sectors and cross-cutting themes covered in the report, the assets or functions over which Mayors could potentially hold power (eg. within transport, buses and city roads) were identified. The concept of power was further broken down into seven specific categories or areas where Mayors could potentially hold power.

Categories of Powers Possible:						
Own	**Operate**	**Set Policies and Regulation**	**Enforce Policy and Regulation**	**Control Budget**	**Levy Fees and Charges**	**Set Vision**

In each of the powers categories there are a series of options, where a city can choose one per category and asset:

Possible Power Response:						
Own	**Operate**	**Set Policies and Regulation**	**Enforce Policy and Regulation**	**Control Budget**	**Levy Fees and Charges**	**Set Vision**
Own all	Controls all	Unilaterally set policies and regulations	Leads enforcement	Sets	Sets	Set
Own some	Partial control (eg lease)	Sets policies and regulations but approval is required	Responsible for enforcement but it is carried out by another agency	Sets but approval required	Sets but approval required	Sets but approval required
Leases from	No control	Can influence	Can influence	Influence	Influence	Influence
Does not own any	N/A	No influence	No influence	No influence	No influence	No influence
N/A		N/A	N/A	N/A	N/A	N/A

The 7 categories of power above have been synthesized into 4 for the report. This enables us to most accurately represent 7 sets of powers in a format, which does not impact our analysis, yet affords the reader a greater degree of simplicity with understanding complex dataset. These four are:

- Own or Operate
- Set and/or enforce polices/regulations
- Control budget and/or levy fees or charges
- Set vision (not synthesized)

We were able to synthesize these categories because a majority of cities have the same power in both categories as defined below:

- Ownership and operational control (correlation = 66%)
- Power to set policies/regulation and enforce policies/ regulation (correlation = 76%)
- Ability to control the budget and levy fees or charges (correlation = 66%)

The table on the following page sets out which responses from cities were considered as denoting strong 'power' for the purposes of this report:

Own	Operate	Set Policies/ Regulation	Enforce policy/ regulation	Control Budget	Levy fees/ charges	Set Vision
Own all	Controls all	Unilaterally set policies and regulations	Leads enforcement	Sets	Sets	Set
Own some	Partial control (eg lease)	Sets policies and regulations but approval is required	Responsible for enforcement but it is carried out by another agency	Sets but approval required	Sets but approval required	Sets but approval required
Leases from	No control	Can influence	Can influence	Influence	Influence	Influence
Does not own any	N/A	No influence	No influence	No influence	No influence	No influence
N/A		N/A	N/A	N/A	N/A	N/A

With the goal of accurately representing the number of cities which have power over one of the four new categories (own/operate, set/enforce policies, control budget/levy fees, and set vision), an approach was devised to determine which category of power (eg, set or enforce policy) is most relevant and best represents an ability to take action with a particular asset. There are three ways the seven power categories can be synthesized into four:

1. OR: A city is counted as having power if it, for example, sets OR enforces policy. This leads to a possible misrepresentation of a high number of cities having power when applied to all assets and categories.
2. AND: A city is counted as having power if it, for example, sets AND enforces policy. This leads to possible misrepresentation of a low number of cities having power when applied to all assets and categories.
3. TAILORED APPROACH: An asset-specific approach, which could involve using OR, AND, or identifying if one category of power is particularly relevant. This approach means when the first two approaches misrepresent, we count the number of cities that hold only one chosen category of power. The relevant category is chosen based upon understanding the real drivers and determinants of power to act in a particular sector as well as the dynamics of that sector. For example, for assets that tend to be owned by the private sector (such as private vehicles), having the ability to levy fees or charges is more important than budgetary control, which is irrelevant. Conversely, for assets that tend to be in the hands of the public sector (such as municipal buildings) budgetary control is more important than levying fees or charges.

Because of the diversity and complexity of the dataset, a tailored approach (3) was utilised to assess power.

The matrix below shows the tailored approach used for each asset across all sectors. It identifies whether the categories of powers were combined through AND/OR or if a specific category of power was used to count whether a city has power over that particular asset. For example, under the asset of city parks, a city is counted as having power in each of the four synthesized categories of powers if:

- It owns OR operates city parks
- It sets OR enforces policies and regulations related to city parks
- It has budgetary control over city parks
- It sets the vision for city parks

Category	Asset	Own / Operate	Set policies / Enforcement	Budget control / Set levy	Set vision
Energy Demand Buildings	Commercial buildings	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	Energy procurement for municipal	OR	Set Policies	Budget Control	Set Vision
Energy Demand Buildings	Industrial buildings	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	Institutional campuses and buildings	OR	Set Policies	Budget Control	Set Vision
Energy Demand Buildings	Municipal offices	OR	Set Policies	Budget Control	Set Vision
Energy Demand Buildings	Municipally owned housing	OR	Set Policies	Budget Control	Set Vision
Energy Demand Buildings	New build: commercial/ industrial	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	New build: housing	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	New build: municipal-owned	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	Other municipal facilities	OR	Set Policies	Budget Control	Set Vision
Energy Demand Buildings	Private housing	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	Private primary and secondary schools	OR	OR	Set Levy	Set Vision
Energy Demand Buildings	Public primary and secondary schools	OR	Set Policies	Budget Control	Set Vision
Energy Supply	Centralised power generation (outside the city)	OR	Set Policies	Budget Control	Set Vision
Energy Supply	Distributed power generation (within the city)	OR	Set Policies	OR	Set Vision
Energy Supply	District heat generation	OR	Set Policies	OR	Set Vision
Energy Supply	District heating network	OR	Set Policies	OR	Set Vision
Energy Supply	High Voltage transmission grid	OR	Set Policies	OR	Set Vision
Energy Supply	Low Voltage distribution grid	OR	Set Policies	OR	Set Vision
Energy Supply	Natural gas / biogas distribution	OR	Set Policies	OR	Set Vision
Finance and Economy	Borrow from private sector	OR	Set Policies	OR	Set Vision
Finance and Economy	Borrow from regional/natl gov	OR	Set Policies	OR	Set Vision
Finance and Economy	Issue bonds	OR	Set Policies	OR	Set Vision
Finance and Economy	Taxation - business	OR	Set Policies	OR	Set Vision
Finance and Economy	Taxation - municipal	OR	Set Policies	OR	Set Vision
Finance and Economy	Taxation - personal	OR	Set Policies	OR	Set Vision
Finance and Economy	Taxation - property	OR	Set Policies	OR	Set Vision
Finance and Economy	Taxation - sales	OR	Set Policies	OR	Set Vision
Finance and Economy	Use tax-increment finance	OR	Set Policies	OR	Set Vision
Food and Agriculture	Allotments/ community gardens	OR	Set Policies	Budget Control	Set Vision
Food and Agriculture	Commercial urban food production	OR	Set Policies	Budget Control	Set Vision
Food and Agriculture	Farmer's markets	OR	Set Policies	Budget Control	Set Vision
ICT	Internet communications infrastructure	OR	Set Policies	OR	Set Vision
ICT	Wireless internet communication infrastructure	OR	Set Policies	OR	Set Vision
Outdoor Lighting	Streetlights on private land	OR	Set Policies	Budget Control	Set Vision
Outdoor Lighting	Streetlights on public land	OR	Set Policies	Budget Control	Set Vision
Outdoor Lighting	Traffic lights	OR	Set Policies	Budget Control	Set Vision
Transport	Airports	OR	OR	OR	Set Vision
Transport	Bicycles	OR	Set Policies	Set Levy	Set Vision
Transport	Bus stops	OR	AND	OR	Set Vision
Transport	Buses	OR	Set Policies	Budget Control	Set Vision
Transport	City Roads	OR	OR	OR	Set Vision
Transport	Freight marine vessels	OR	OR	OR	Set Vision
Transport	Highways	OR	OR	OR	Set Vision

Category	Asset	Own / Operate	Set policies / Enforcement	Budget control / Set levy	Set vision
Transport	Intercity-rail & freight systems	OR	OR	OR	Set Vision
Transport	Municipally owned fleet	OR	Set Policies	Budget Control	Set Vision
Transport	Off-street car parking	OR	AND	OR	Set Vision
Transport	On-street car parking	OR	AND	OR	Set Vision
Transport	On-street railway system	OR	Set Policies	Budget Control	Set Vision
Transport	Passenger ferries/ boats	OR	Set Policies	Budget Control	Set Vision
Transport	Pavements / sidewalks	OR	AND	OR	Set Vision
Transport	Ports piers	OR	OR	OR	Set Vision
Transport	Private Cars and Motorcycles	OR	OR	Set Levy	Set Vision
Transport	Rickshaws (non-motorised)	OR	OR	Set Levy	Set Vision
Transport	Taxis (including motorised rickshaws)	OR	OR	Set Levy	Set Vision
Transport	Trucks	OR	OR	Set Levy	Set Vision
Transport	Underground & other intra-city rail systems	OR	Set Policies	Budget Control	Set Vision
Urban Land Use	Foreshore / beaches	OR	OR	Budget Control	Set Vision
Urban Land Use	Waterways	OR	OR	Budget Control	Set Vision
Urban Land Use	Air quality	OR	Enforce	Set Levy	Set Vision
Urban Land Use	City parks	OR	OR	Budget Control	Set Vision
Urban Land Use	Environmental impact assessment	OR	Enforce	Set Levy	Set Vision
Urban Land Use	Forests	OR	OR	Budget Control	Set Vision
Urban Land Use	Land use planning approvals	OR	Set Policies	Set Levy	Set Vision
Urban Land Use	Land use planning frameworks and policies (including zoning)	OR	Set Policies	Set Levy	Set Vision
Urban Land Use	Nature reserves	OR	OR	Budget Control	Set Vision
Urban Land Use	Redevelopment / regeneration	OR	Set Policies	Set Levy	Set Vision
Urban Land Use	Strategic planning functions over land uses and development	OR	Set Policies	Set Levy	Set Vision
Urban Land Use	Urban green spaces (besides parks)	OR	Set Policies	Budget Control	Set Vision
Waste	Agricultural waste collection	OR	AND	OR	Set Vision
Waste	Commercial building collection	OR	AND	OR	Set Vision
Waste	Construction and demolition waste collection	OR	AND	OR	Set Vision
Waste	Food waste collection	OR	AND	OR	Set Vision
Waste	Industrial building collection	OR	AND	OR	Set Vision
Waste	Landfill sites	OR	AND	OR	Set Vision
Waste	Municipal-owned building collection	OR	AND	OR	Set Vision
Waste	Recycling facilities / centres	OR	AND	OR	Set Vision
Waste	Residential building collection	OR	AND	OR	Set Vision
Waste	Street sweeping / cleaning	OR	AND	OR	Set Vision
Waste	Waste processing facilities	OR	AND	OR	Set Vision
Waste	Waste to energy facilities	OR	AND	OR	Set Vision
Waste	Waste transfer stations	OR	AND	OR	Set Vision
Water	Stormwater management	OR	Set Policies	Budget Control	Set Vision
Water	Wastewater collection	OR	Set Policies	Budget Control	Set Vision
Water	Wastewater treatment	OR	Set Policies	Budget Control	Set Vision
Water	Water supply	OR	Set Policies	Budget Control	Set Vision
Water	Water supply distribution	OR	Set Policies	Budget Control	Set Vision
Water	Water supply operations	OR	Set Policies	Budget Control	Set Vision

3 'INITIATIVES' AND 'ACTIONS'

The survey has analysed a comprehensive range of methods by which city governments are tackling climate change. Climate change actions are classified in three ways – policies, projects/programmes, and incentives/ disincentives; whose scale is measured along three tiers: pilot, significant or transformative (i.e. city-wide). An example of a policy could be a broad policy vision or strategy, such as New York's PlaNYC, or a specific law or regulation enacted, such as New York's law mandating the benchmarking of energy efficiency. To the extent that policies transcend several sectors, they are "counted" as multiple actions. As an example of how these terms have been applied:

- A Project/Programme denotes delivery, for example Sao Paulo's landfill gas capture project, Paris' Velib bicycle rental scheme or Addis Ababa's urban agriculture programme;
- An Incentive/Disincentive represents the ability to influence constituent behaviour; an example could be the London Congestion Charge.
- A 'Policy/Regulation' could be a wide-ranging strategy document like New York's PlaNYC or the Green Beijing Action Plan; through to a policy statement for a particular sector, or sub-sector, like building codes;

Each sector contains 'Initiatives' for climate change mitigation or adaptation, which are further sub-divided into over categories of 'Actions' (there are over 1,000 potential categories of action across the survey as a whole). The example below is taken from the 'Waste' sector:

The study attributed four status levels to actions:

1. Considered and rejected
2. Actively being considered but final authorization is still required
3. Authorized but not yet in effect
4. In-effect

Only those actions that were determined as being 'in effect' have been considered whenever an action or initiative is referred to in the study as having been implemented or 'delivered' by a city. All of the counts of actions undertaken by cities are made on the same basis.

4 SCALE OF DELIVERY

Initiatives	**Actions**
Waste prevention	Pay as you throw
	Disincentives or bans on certain waste (eg, plastic bags)
	Outreach / informative programmes
	Reducing packaging
	Product reuse / repurposing
Integrated waste management	Re-use schemes
	Source separation policies
	Waste collection fees
Recycling and composting collections	Collection for Dry recyclables (glass, plastic, paper)
	Collection for Organic compostable waste
	Municipal recycling points or centres for residents
	Incentives / penalties for recycling
	Electronic waste recycling
Recycling and composting facilities	Composting in house
	Composting facilities
	Advanced material recovery facilities
Improve the CO_2 efficiency of waste collection vehicles	Biofuels
	EV
	CNG
Improve the fuel economy of waste collection trucks	Electric vehicles
	Hybrid vehicles
Optimize waste collection logistics	Automated (vacuum) waste collection
	Sectoral consolidated waste collection
	Geographical franchising (if private)
	Single waste stream collection

Each action is further analysed in terms of its scale, referring to whether they are

- Pilot
- Significant; or
- Comprehensive/transformative actions.

For the purposes of this report, comprehensive/ transformative actions are those that are sweeping, high impact, all-encompassing actions that have gone as far as they can reasonably go. By definition, comprehensive actions therefore cannot be significantly expanded as discussed in the next paragraph.

5 FUTURE PLANS

The survey also asked respondents about plans for future expansion of actions already under implementation. These actions, together with those marked by cities as being "Actively considered but final authorization is still required" or "Authorized but not yet in effect" (ie, status equal to 2 or 3) constitute what is described in the report as being future plans. This enables the analysis to make some consideration of where are the opportunities to scale-up delivery of low-carbon measures across the C40.

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40 cities
297 million residents
4,734 climate actions

C40 participating cities

Addis Ababa
Athens
Bangkok
Beijing
Berlin
Bogotá
Buenos Aires
Cairo
Caracas
Chicago
Delhi NCT
Dhaka
Hanoi
Houston
Hong Kong
Istanbul
Jakarta
Johannesburg
Karachi
Lagos
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