

The future of cities

Tech solutions to five urban challenges

With cities set to drive 85% of global growth in the next decade...

...technology will play a key role in tackling pollution, congestion, crime, housing and service provision

Funding remains a challenge, but the bond market has a role to play



Executive Summary

Doing cities, smarter

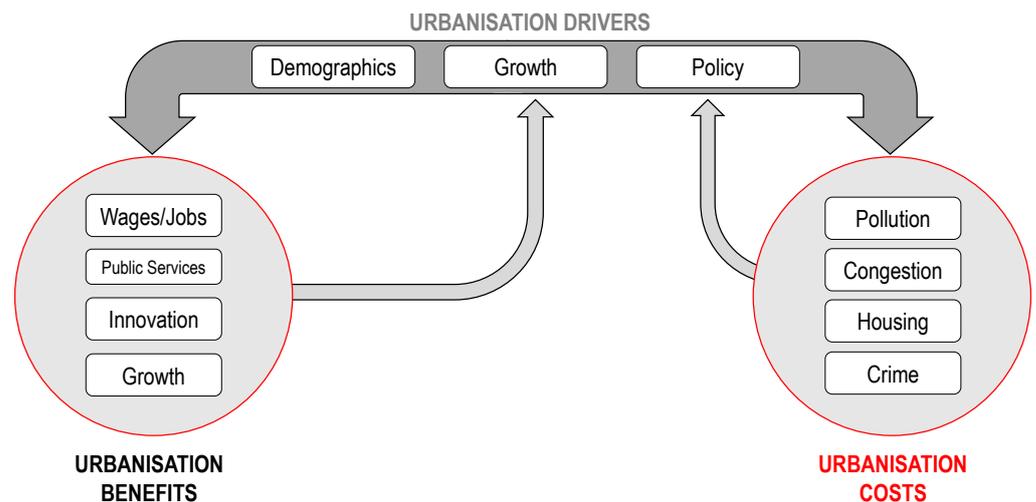
Cities are crucial for global growth

Cities are the lifeblood of the global economy. Today, roughly 4.2bn people live in cities across the world, and this is set to rise to 5.2bn by 2030 and 6.7bn by 2050 according to the UN. We believe that if the potential can be maximised, roughly 85% of global growth could be generated in urban areas over the next decade.

Many opportunities come from urban areas

Cities bring opportunities: finding the right job, having access to better education or healthcare or even just finding the perfect business partner. But there has always been a cost. Anyone who lives in an urban area can easily describe the issues facing their city when it comes to pollution, congestion, crime, or basic sanitation such as rubbish bin collections.

1. Urbanisation can support growth, but there are challenges



Source: HSBC.

Many challenges to tackle

As more people across the world move into urban areas, tackling these challenges becomes more important. New technologies can help governments here. We're heading into a new era of 'smart cities', where the connectedness of people, vehicles and infrastructure will allow cities to become cleaner, more efficient and safer places to live. The rapid roll-out of the smartphone across the world coupled with the internet of things and potentially game-changing technologies such as autonomous vehicles are making this possible.

EM and DM cities both need to invest in infrastructure

This is both a developed and emerging market issue. Developed market cities need to ensure they remain attractive places to live; as demographics and remote working may lead to peak urbanisation. In the emerging world, as millions of people urbanise over the coming decades many cities will be building infrastructure for the first time and have a chance to maximise the economic benefits that cities can bring by using smart city technologies.

Simply, there are many policy options that cities can use to make the most of their growth potential by improving productivity and efficiency, and new technologies provide a number of ways to do this. In this report, we outline policies that could be implemented and how cities can fund them.

What is a smart city?

Smart cities have a broad definition

Smart cities can mean many things – with a number of different definitions being used. The UK Department for Business, Innovation and Skills considers smart cities a process that increases citizen engagement, hard infrastructure, social capital and digital technologies and make cities more liveable, resilient and better able to respond to challenges. IBM defines a smart city as “one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimise the use of limited resources”.

We would go for something simpler: “**A smart city uses technology to maximise efficiency and improve the quality of life for its citizens**”. This follows on from our definition of climate smart city, which we define as one that: *safeguards and enhances the quality of life of citizens through economic growth and environmental protection, by investing in infrastructure, services and new technologies that ensure clean, safe and reliable transport, energy, housing, health and public sector services.*



A smart city is one that uses technology to maximise its efficiency and improve the quality of life for its citizens

In this report we look at five key areas in which governments can make this happen:

- ▶ **Pollution**
How can cities cut emissions and improve air quality?
- ▶ **Congestion**
How can cities cut traffic and provide transport alternatives?
- ▶ **Housing**
How can technology help to provide adequate housing?
- ▶ **Crime**
Can smart technologies help to cut crime in cities?
- ▶ **Service Provision**
How can cities provide basic services more effectively?

Social and economic benefits to cities

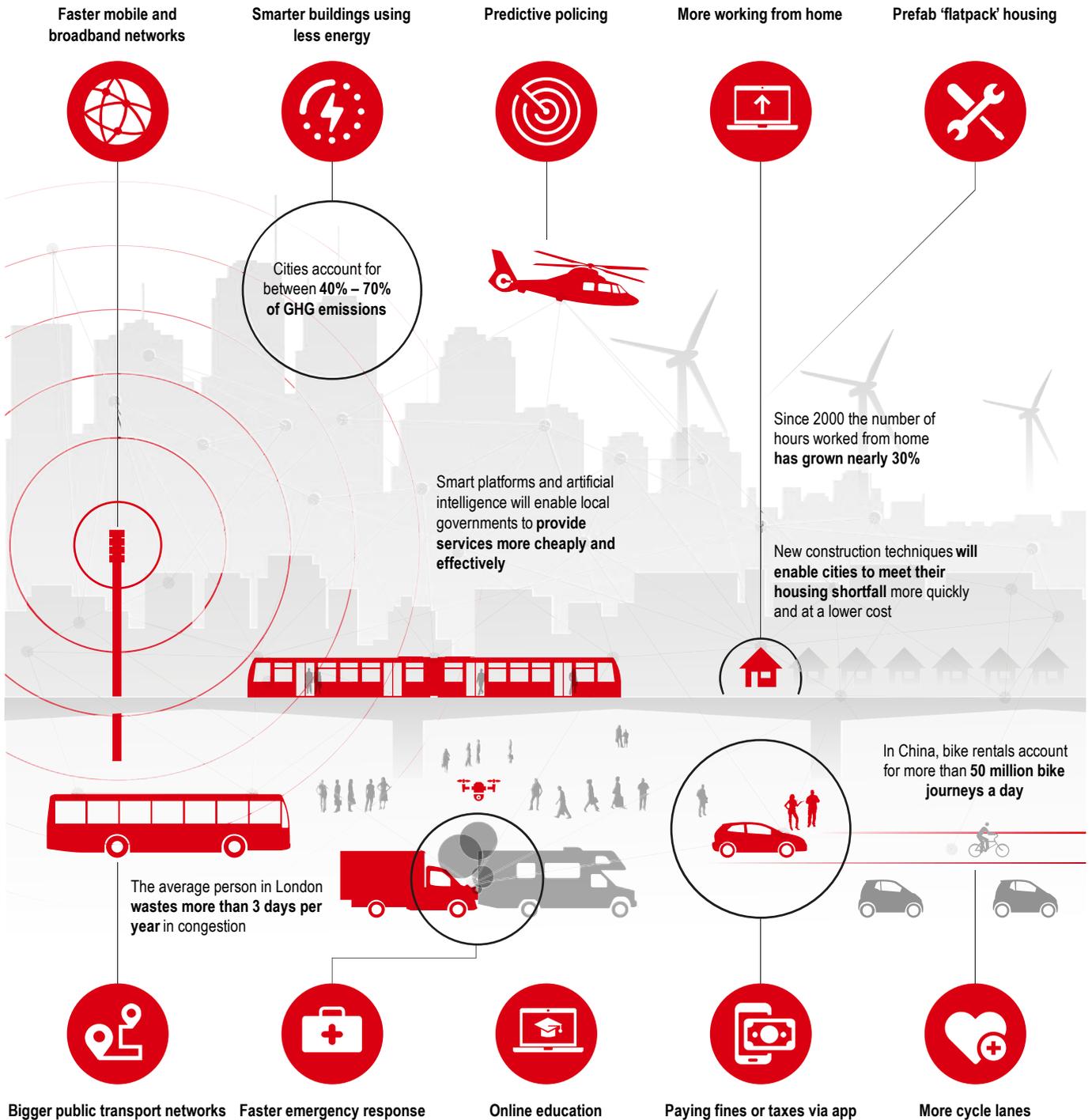
All of these developments can bring social as well as economic benefits. Cutting congestion can save time and enhance productivity, having better housing availability can attract the best labour to cities and cutting pollution can give both better health implying fewer sick days and a longer working life. While the benefits will depend on the starting point of cities and the rate at which these new technologies are adopted, using anything that maximises the productive potential of the world’s urban population can only be good news.

Funding challenges are clear for local governments

While there are many policy options available to tackle these challenges, funding them is not so easy. Given that many local governments face a lack of available capital and suffer with short-term thinking with regards to investment in new projects, the roll-out of these technologies is currently slow. Unlocking financing, via public-private partnerships is one option. But the growth of smart cities also creates a platform for the Green Bond market to grow: the City of Vancouver has published a green bond framework document which prepares the way for issuing a green bond. We discuss this key funding option for cities on page 24.

2. Policy options for making cities more efficient

How cities can be smarter



Urban population worldwide



Finance and urban areas

85%
of global growth will be generated in urban areas over the next decade

USD140-180bn
expected supply of green, social and sustainability bonds this year. A growing proportion to fund projects in urban areas

Source: HSBC, UN population division

Contents

A new type of city	5
Which are the 'best' cities today?	6
The smart city stars	8
Climate change and pollution	9
Cities and climate change	9
The urban impacts of climate change	10
Congestion: Get moving	13
Stuck in a jam	13
1. Better traffic schemes	13
2. Fewer cars	14
3. Making fewer journeys	16
4. Autonomous vehicles	17
Housing	18
Housing crisis?	18
Crime and safety	20
Public services	22
Better quality of life	22
Who pays for smart cities?	24
Funding smart city development	24
Green bonds and the city	26
City/regional green, social and sustainability bonds	32
Private sector property green, social and sustainability bonds	32
Mitigating credit risk	33
Disclosure appendix	35
Disclaimer	36

A new type of city

- ▶ Cities can drive growth, but they bring challenges...
- ▶ ...that technology can help to overcome...
- ▶ ...and allow cities to flourish

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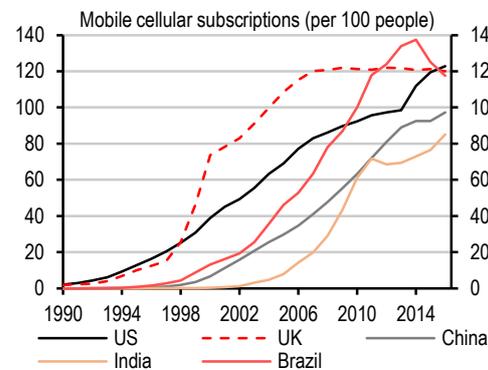
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Technology: The platform for change

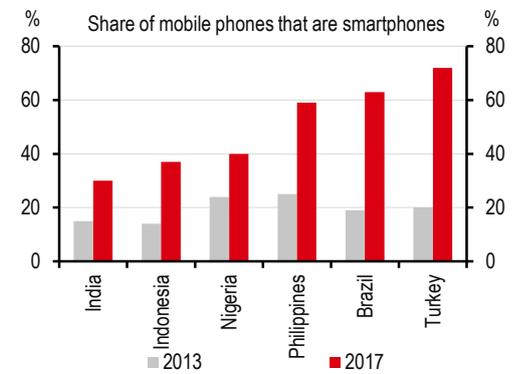
As urbanisation accelerates at an unprecedented rate, we need to think about how local governments make their cities work better. How can cities minimise the costs and maximise the benefits from mass urbanisation? One of the ways in which this has started to happen is through 'smart city' technologies, which allow governments to utilise the spread of smartphones across the world – firstly the developed world and now across the emerging world.

3. Mobile phone ownership is soaring in EM...



Source: World Bank WDI

4. ...and more of them are smartphones



Source: PEW Research Centre

Smartphones make a big difference

The smartphone is useful as it allows better sharing of information in both directions. City-dwellers can find live transport timetables, pay bills or find the opening times for local amenities easily, while governments can get a clearer sense of how busy transport networks are and provide services to citizens more cheaply and effectively.

Autonomous vehicles, 5G and AI could take things further

However, this is just the first stage. When we couple this with the rapidly advancing technologies in terms of autonomous vehicles, the internet of things and artificial intelligence, the impact that technology can have on how cities function could be dramatic. And all of this could be made possible from the roll-out of 5G technology. A fully functional smart city becomes much more feasible with the interconnectedness of people and devices, allowing the gigabits-per-second speeds needed¹.

¹ <https://www.verizon.com/about/news/why-5g-crucial-smart-city-tomorrow>

Which are the ‘best’ cities today?

Many cities are doing well

A good place to start is with the cities that are considered to be doing the right thing today. There are many ways of looking at this – with city rankings that you may have seen varying in the methodology used. But typically, there are two broad approaches to city ranking: liveability and economic success, and we highlight the latest rankings from some of the key providers in table 5 below.

5. City rankings value different things

Rank	Liveability studies		Economic success		Enjoyment
	Mercer	The Economist IU	MMF	Best Cities	Time Out
1	Vienna	Vienna	London	London	Chicago
2	Zürich	Melbourne	New York	New York	Porto
3	Auckland	Osaka	Tokyo	Paris	New York
3	Munich	Calgary	Paris	Moscow	Melbourne
5	Vancouver	Sydney	Singapore	Tokyo	London
6	Düsseldorf	Vancouver	Seoul	Singapore	Madrid
7	Frankfurt	Toronto	Amsterdam	Dubai	Manchester
8	Geneva	Tokyo	Berlin	Barcelona	Lisbon
9	Copenhagen	Copenhagen	Hong Kong	San Francisco	Philadelphia
10	Basel	Adelaide	Sydney	Chicago	Barcelona

Source: Mercer, Economist Intelligence Unit, MMF, BestCities.org, Time Out

Big cities often struggle to provide a high quality of life

What stands out is how only Sydney and Tokyo appear in the top 10 for both liveability and economic success, suggesting that currently cities have a trade-off between the two sides of the coin. Those who do well in terms of creating job opportunities and entertainment availability often suffer when it comes to quality of life – due to issues such as congestion, high house prices, crime or pollution.

That’s where smart city technologies come in. These new technologies that allow governments to bridge that gap (possibly literally) could allow cities to thrive economically as well as providing a high quality of life for their citizens. Firstly, we can look at who is doing well today.

Which are the ‘smartest’ cities?

Some cities are the trailblazers of the smart cities world: Copenhagen, Singapore and Stockholm for example. There are many ways of defining the smartest cities, and we highlight a few rankings in table 6 below, but one of the most comprehensive studies is from the easypark group, who don’t focus on attributes (such as the number of museums) that favour large cities as other studies do.

Their approach gives each city a score based on transport, sustainability, governance, innovation and digitalisation. This approach puts Copenhagen atop the list by some distance, with the top 20 cities in the index shown overleaf with the breakdown of scores.

Cities are hard to rank in terms of how ‘smart’ they are

6. Rankings of cities by ‘smartness’

Rank	EasyPark (see overleaf for details)	IESE Smart city index	Juniper research
1	Copenhagen	New York	Singapore
2	Singapore	London	London
3	Stockholm	Paris	New York
4	Zurich	Tokyo	San Francisco
5	Boston	Reykjavik	Chicago
6	Tokyo	Singapore	Seoul
7	San Francisco	Seoul	Berlin
8	Amsterdam	Toronto	Tokyo
9	Geneva	Hong Kong	Barcelona
10	Melbourne	Amsterdam	Melbourne

Source: EasyPark, Juniper, IESE. These rankings use a number of factors, as broken down within the easypark study, but also some ‘non-smart’ indicators such as GDP & unemployment rates.

The top scorers are small cities and in the developed world, but they give an idea of what other cities can do better, particularly emerging market cities as they continue to grow. Over the coming pages we break these options down to see what policy options are out there and what the impact could be.

7. Smart City Rankings

Rank	City	Country	Transport				Sustainability				Governance			Innovation	Digitalisation				Living Standards	Expert Perception	Overall	
			Smart Parking	Car Sharing	Traffic	Public Transport	Clean Energy	Smart Buildings	Waste Disposal	Environmental protection	Citizen Participation	Digital Government	Urban Planning	Education	Business ecosystem	4G	Internet Speeds	Wifi Hotspots	Smartphone Penetration	Living Standards		Expert Perception
1	Copenhagen	Denmark	9.8	8.6	8.2	6.8	7.9	9.8	8.2	6.1	9.4	8.5	7.1	5.9	9.1	8.6	7.7	4.1	9.7	8.7	9.1	8.2
2	Singapore	Singapore	7.3	6.6	4.2	10.0	2.3	8.4	7.6	7.2	10.0	5.5	7.8	5.1	8.6	8.7	7.8	6.6	7.6	8.2	9.3	7.8
3	Stockholm	Sweden	7.5	5.9	6.7	6.5	8.4	6.9	8.9	8.8	9.3	10.0	7.6	7.7	9.6	8.4	9.2	6.3	8.7	7.3	8.2	7.8
4	Zurich	Switzerland	7.8	7.8	5.0	9.8	8.6	10.0	10.0	8.7	2.1	8.1	9.0	9.0	9.7	4.7	4.4	5.6	7.6	10.0	9.0	7.8
5	Boston	United States	8.0	8.7	7.7	7.2	3.6	5.2	4.3	6.6	5.3	7.0	5.1	10.0	10.0	6.1	9.4	6.8	9.2	8.2	9.3	7.7
6	Tokyo	Japan	9.6	7.1	7.7	8.8	3.9	8.4	8.2	4.3	6.6	6.3	3.6	7.7	7.2	6.4	6.5	9.6	8.6	7.2	8.6	7.6
7	San Francisco	United States	9.1	9.1	5.1	3.4	3.6	5.2	4.3	6.4	6.2	6.6	5.4	5.7	9.9	7.9	10.0	9.1	9.2	9.0	9.1	7.6
8	Amsterdam	Netherlands	8.0	7.1	8.4	7.1	2.5	7.3	7.8	3.9	9.0	9.8	5.9	7.8	8.8	8.4	6.6	5.3	6.9	9.0	8.2	7.5
9	Geneva	Switzerland	8.1	5.0	6.1	7.0	8.6	10.0	10.0	9.1	1.8	8.4	8.6	9.1	9.0	8.1	8.8	3.9	7.6	9.8	8.1	7.5
10	Melbourne	Australia	8.0	7.1	4.6	8.7	2.9	6.3	5.2	2.9	9.8	5.4	9.2	9.3	6.0	10.0	7.8	6.7	9.3	8.0	7.3	7.5
11	Vancouver	Canada	9.7	10.0	3.1	9.0	9.1	2.6	3.3	3.0	4.8	7.7	9.4	8.4	8.4	9.2	8.3	7.5	7.9	8.2	7.1	7.5
12	Sydney	Australia	7.2	8.8	3.1	7.5	2.9	4.3	5.2	2.5	9.6	4.1	9.0	9.1	6.6	9.8	7.6	7.2	9.3	8.1	8.2	7.4
13	Berlin	Germany	6.9	9.7	4.4	7.8	6.9	7.3	9.8	3.3	7.3	5.9	6.1	8.0	8.9	2.7	3.2	8.9	5.0	8.9	7.9	7.4
14	Hamburg	Germany	6.0	8.1	4.2	9.1	6.9	9.0	9.8	3.4	5.9	5.4	5.4	7.3	7.3	4.1	5.1	4.3	5.0	9.6	9.1	7.4
15	Gothenburg	Sweden	6.9	6.2	8.8	2.0	8.4	6.9	8.9	9.4	8.6	9.7	8.2	7.6	7.5	7.7	8.5	2.6	8.7	7.6	8.5	7.2
16	Montreal	Canada	9.8	7.8	6.1	9.0	9.1	5.6	3.3	2.3	3.7	7.3	4.4	8.6	7.8	7.9	6.7	6.1	7.9	8.4	7.9	7.2
17	London	United Kingdom	8.5	9.5	2.7	7.7	5.2	8.1	6.1	6.1	4.7	3.0	5.9	7.9	9.1	4.3	5.2	9.8	6.7	7.6	8.2	7.2
18	Tel Aviv	Israel	9.0	7.0	3.1	6.9	1.2	9.4	7.9	5.9	6.4	7.9	6.7	7.0	8.8	5.0	6.6	7.1	9.0	6.9	8.1	7.2
19	Paris	France	7.2	9.0	3.3	5.8	4.5	7.1	6.4	6.5	4.9	8.9	4.4	7.3	8.2	7.3	8.2	9.5	8.1	7.8	7.3	7.1
20	Toronto	Canada	9.4	7.0	5.4	9.7	9.1	2.6	3.3	1.9	5.5	3.1	6.5	8.9	8.0	9.5	8.7	8.5	5.9	7.2	7.2	7.1

Source: <https://easyparkgroup.com/smart-cities-index/>. Note: Red shows a low score, Dark grey is a top score.

Copenhagen scores well on environmental and transport issues

The smart city stars

Copenhagen: A trailblazer

Copenhagen scores very well on many measures we would want to judge a smart city by. It has a high level of digital proficiency and access, with 100% 4G coverage and businesses using online sales and invoicing far more than the EU average. Copenhagen is engaged in a public/private collaboration with Hitachi to overlay the various 'movement' datasets for people across the city to enable better transport provisions and responses.

On an environmental front, there are very high levels of taxes on waste to incentivise recycling, with more than 60% of waste now recycled, while the city has rolled out extensive bike lanes throughout to make it easier to cycle to work. Copenhagen has one of the lowest car usage rates of cities in Europe as a result.

It has also made many attempts to revisit home spaces, with start-ups engaged in creating more shared living spaces to make the most of land in the city and to provide adequate housing.

Singapore is very connected

Singapore: Smart technology everywhere

Singapore has taken a number of initiatives to use technology to make the city state work better. In a city where internet speeds are the fastest in the world and fibre optic connections are being introduced to every home, technology is being used for social good too. For example, sensors in the homes of elderly residents learn their daily habits and if these patterns are disrupted an alert can be sent to neighbours or family. The city utilises crowd sourced citizen information to identify problems such as faulty infrastructure, damage and pests. All local issues can be raised by citizens via an app and feedback will then be directed towards the correct municipal agency.

The city has also taken a smarter approach to planning: urban areas are modelled before building application is granted to ensure that building alignment and parks facilitate air flow. This improves air quality and reduces the need for air conditioning which can be a notoriously heavy energy user.

On the transport front, dynamic congestion charging is being used. Car sensors and other traffic flow data judge the congestion levels and set prices accordingly, discouraging the use of roads in busy areas during peak hours.

Beijing is making strides as an EM city

Beijing: An EM example - some key innovations

Beijing is one of the top-performing large EM cities within the easypark index, but is still ranked 81st (Moscow 77th, Sao Paulo 80th). The city is home to some clever uses of smart city technologies- most notably with regards to transport. Mobike and Ofo are both providing dockless bike services to make it easier for residents to have access to bikes and to cut car usage. Equally, the city announced plans in 2017 to replace all (nearly 70,000) fossil fueled taxis with electric cars, as well undertaking a range of studies into the feasibility of using autonomous vehicles.

Also on the environmental side, a recycling incentive scheme has been established whereby citizens earn reward points for correctly recycling their waste. These points can then be exchanged for household items, basic groceries or toiletries.

These cities give a flavour for what other cities can do, and we explore the policy options in more detail in the coming pages.

Climate change and pollution

- ▶ Enterprise and endeavour in cities carry environmental downsides
- ▶ Cities are major sources of GHG emissions (up to 70% of the total) and face climate impacts – floods, droughts, heatwaves, health risks
- ▶ Localised air pollution resulting from industrial activity and energy use is a serious global health risk, causing up to 3m deaths pa

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The activities which occur within cities, functions that act as *raison d'être* for cities in the first place, are the direct cause of environmental risks. These have the potential to damage local economies and imperil human populations. To address climate change, cities must both lower emissions *and* be resilient to impacts from warmer temperatures. Additionally, cities face concentrated air pollution risks. Despite these challenges, we think city authorities are well placed to act, as they can move quicker in implementing climate change policies and measures, given: potential for faster decision-making; local governance meaning greater accountability to the electorate for local decisions; and control over specific budgets to prioritise important outlays for meeting local policy ambition.

Cities and climate change

Low-carbon and energy efficiency to meet emission reduction targets

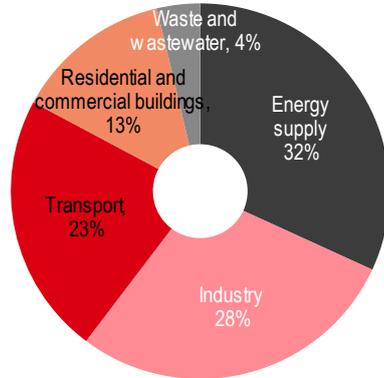
To achieve the goal of limiting temperature rises to 2°C in 2100, crystallised in the 2015 Paris Agreement, *all* parts of the economy – including cities and other non-state actors – will need to reduce emissions. This can be done by moving to lower carbon technologies. It can also be done by achieving greater energy efficiency, which is impactful given cities account for around two thirds of global energy consumption.

The Intergovernmental Panel on Climate Change (IPCC) estimates that cities are responsible for between 40% and 70% of GHGs. GHG emissions from cities are difficult to characterise and can be measured on a production *and* consumption basis. Production-based emissions are those generated by activities that take place within urban areas – for instance, cars and buildings burning fossil fuels (Scope 1 emissions). Consumption-based emissions include production emissions *and* those attributable to consuming products where the generation of emissions occurred outside the city – for instance, electricity generated by coal-fired power generation and transmitted in cables into the city (Scope 2) and those from consumption of food and manufactured products (Scope 3), transported from outside urban geographies.

Transport, buildings and power generation

We expect a continued increase in city plans that prioritise meeting local climate ambitions as cities move towards becoming 'climate-smart'. And this is already happening – to date, over 2,900 cities have submitted climate plans to a UN portal tracking non-state climate action (NAZCA), up from c2,500 in June 2017. Climate-smart cities can reduce their emissions through cleaner transport and green buildings, which may be the easiest options open to metropolitan leaders from a jurisdictional standpoint. Clean power and decentralised heat, technologically more cost-efficient, will also be an increasing area of focus. Chart 8 shows where urban emissions come from.

8. City emissions by sector



Source: UN-HABITAT, Global report on human settlements 2011

Here's our definition of a 'climate-smart' city:

Climate-smart cities safeguard and enhance the quality of life of citizens through economic growth and environmental protection, by investing in infrastructure, services and new technologies that ensure clean, safe and reliable transport, energy, housing, health and public sector services.

Short-term and long-term ambition

And indeed, a number of cities are becoming climate-smart. Some have pledged *short-term* action (offering further encouragement given the manifold benefits of acting sooner on climate change, not least on cost). Strong 2020 emissions reduction plans include Vancouver (33% cut on 2007 levels), Berlin (40% on 1990) and Melbourne, which has pledged carbon neutrality. Furthermore, cities around the world are showing strong low-carbon ambition in the *long* term, with pledges for carbon neutrality in 2050 from cities around the world, including London, Paris, Montreal, Johannesburg, Sydney, Tokyo and Lagos. Other cities have focussed plans on certain sectors, for instance in the US some large cities such as San Francisco and Chicago have pledged to procure 100% renewable power (by 2030 and 2035, respectively).

The urban impacts of climate change

Cities are exposed to the resultant impacts of the warming world: rising sea levels, floods, droughts, higher average temperatures and short-term heatwaves. In turn, these give rise to social impacts, such as livelihood destruction, loss of life and health risks.

“ People who have lost livelihoods and essential services may be forced to move to urban areas to find sustenance, shelter and new employment opportunities

22.5 million people have, on average, been displaced each year between 2008-15 by climate or weather related disasters. Climate change increases the likelihood of extreme weather events – droughts, storms and floods – and can increase their severity. People who have lost livelihoods and basic essential services may find themselves forced to move to urban areas where they expect to find some level of support structure – sustenance and shelter – and an economy offering new employment opportunities. We think that climate is likely to be a driver of rural-to-

urban migration, which can be rapid. As the impacts of climate change play out, we believe this will continue. Heavy rainfall in Kerala in August 2018, and resultant floods and landslides, saw 1m people displaced and 32% of road infrastructure damaged.

Building resilience

Climate-smart cities are thus also *resilient* to impacts associated with extreme events and high temperatures, protecting their people, environment, economy and physical assets in a changing world. This can include physical measures, such as advanced drainage systems, buildings which efficiently address extremes of heat and cold, coastal defences, protection of transport infrastructure, watershed resilience, drought-resistant power supply, and human health investments, as well as factors such as financial instruments and advanced risk modelling. We believe climate-resilient cities are less likely to experience net migration *out* of cities.

22.5 million

Annual displacement of people due to extreme weather, 2008-15

Air pollution

As urban populations grow and affluence increases, a key health risk is air pollution. Air pollution is caused by the release into the atmosphere of sulfur oxide (SO_x), nitrogen oxide (NO_x) and particulate matter through fossil fuel use – vehicle exhaust emissions, oil use in residential cooking and heating, coal-fired power generation and industrial activities such as petrochemicals and metal-making. It is also caused by airborne dust particles from drying wetlands, deforestation and land erosion.

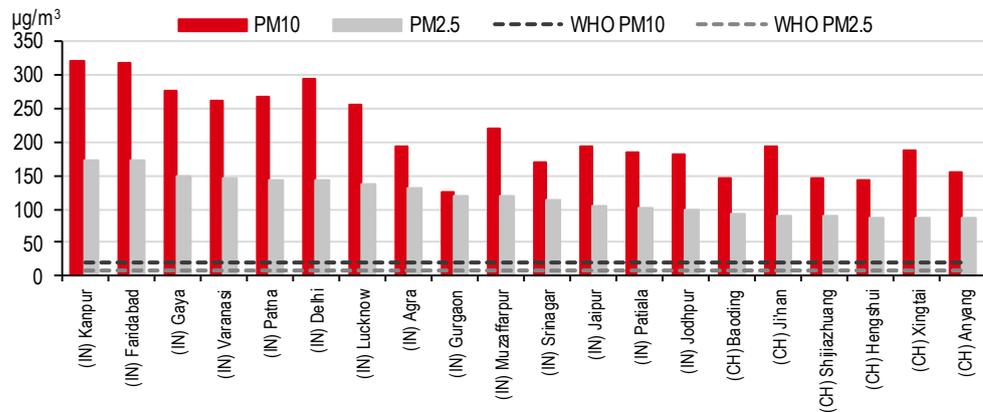
Air pollution and climate change are linked

Air pollution is a *local* environmental risk and should be understood, and addressed, as distinct to global climate change. However, it is causally also closely coupled with climate change. On the one hand, air pollution can contribute to climate change – ozone and nitrogen oxide (NO_x) are both emitted in high levels in some areas, by road transport, industry and coal-fired power generation, and both are short-lived warming pollutants as well as localised air pollutants. Reciprocally, climate change can also exacerbate air pollution, whereby higher temperatures increase local levels of such air pollutants such as ozone and particulates, and so exacerbating cardiovascular and respiratory disease levels. Air pollution causes many deaths through respiratory and heart complications, and can lead to lung cancer. In addition, dust storms associated with drought conditions contribute to degraded air quality due to higher airborne particulate counts and have also been associated with increased incidence of coccidioidomycosis (Valley fever), a serious disease caused by a fungal pathogen.

PM_{2.5} refers to atmospheric particulate matter (PM) that have a diameter of less than 2.5 micrometres

In total, air pollution is responsible for 3 million premature deaths a year globally, according to the World Health Organisation, a figure which is expected to rise to c9 million by 2060, according to the OECD, of which 95% is linked to high concentrations of PM_{2.5}, which are smaller particulates.

9. Top 20 most polluted cities in G20 countries (based on PM_{2.5} levels)



Source: Ambient Air Pollution Database, WHO, June 2018. Note: IN= India; CH= China. Classification based on PM_{2.5} levels. PM_{2.5} is especially dangerous because it can get lodged in the lungs and cause long-term health problems like asthma and chronic lung disease.

Air pollution can also act as an economic disruptor as people heed health warnings by staying at home or become ill and unable to work. Lost working days due to illnesses linked with air pollution are expected to rise from c1.2bn in 2015 to 3.7bn in 2060. EM cities typically have the highest pollution levels, with extreme levels recorded in many Indian cities in particular (Chart 9). Premature deaths from exposure to outdoor air pollution in India are expected by the OECD to rise from c0.61m in 2010 to c3.4m in 2060), while associated costs due to welfare costs are estimated to rise from cUSD 0.22trn in 2015 to cUSD 3.4-7.3trn in 2060.

3 million

Deaths pa attributable globally to air pollution (WHO)

A problem in EM and DM

We expect cities to prioritise tackling air pollution from industrial activities, particularly where these can be relocated, and from transport congestion, typically via replacement of diesel and support for public transport and congestion-easing measures and cycling. Additionally, as more data becomes available and is widely distributed on social media, we think this will drive popular support for preventative measures. However, it's not only a problem on the agendas of EM policymakers. Levels of PM_{2.5} – smaller and more dangerous particulate matter particles - are higher than WHO guidelines in many DM cities – for instance in Paris (by 75%), London (50%), Stuttgart (50%) and Chicago (20% above). The problem is even more acute in terms of NO₂ and NO_x, with levels in Paris, London and Stuttgart twice the long-term (annual mean) limit value set by the EU-WHO 2013 guidelines. It is thus unsurprising, in our view, that cities including Paris, London and Stuttgart have taken measures to phase out diesel cars. Meanwhile, cities including London are implementing measures designed to catalyse uptake of electric vehicles.

Tackling these challenges clearly requires investment, in using more sustainable power, transport infrastructure and more efficient buildings. In many cases, this is where the Green Bond market is useful, as discussed on page 26.

Congestion: Get moving

- ▶ Congestion is one of the biggest economic drags for cities...
- ▶ ...with many full days a year spend sat in traffic...
- ▶ ...and new technologies can alleviate the drags

Stuck in a jam

Congestion makes cities less efficient

Congestion is one of the biggest drags on productivity across cities the world over. Estimates from INRIX suggest that in Los Angeles, the average person wastes 4.25 days a year queuing in traffic. In London, where cars are less prevalent, it is still more than 3 days per year.

10. Congestion wastes a lot of time

	Hours spent in congestion in 2017	Minutes spent in congestion per day
Los Angeles	102	16.77
Moscow	91	14.96
New York City	91	14.96
Sao Paulo	86	14.14
San Francisco	79	12.99
Bogota	75	12.33
London	74	12.16
Atlanta	70	11.51
Paris	69	11.34
Miami	64	10.52
Bangkok	64	10.52
Jakarta	63	10.36

Source: INRIX. Note: On average, per person.

Estimates from McKinsey² suggest that smart city technologies could cut this by 15-20%, allowing cities to make more of their people, creating mobility of labour and improve skills matching. The time saved could reap productivity gains for workers all over the world. So what are the options?

1. Better traffic schemes

We can use data to manage traffic better

Cities can make a difference to their existing traffic problems by analysing traffic data to cut congestion. A great example has been Moscow, where the traffic is famously incredibly gridlocked. The city now uses data from traffic cameras, road detectors and traffic lights to manage traffic flow in real time and be able to react to accidents and traffic disruptions more easily. According to Moscow Mayor's office, traffic speeds have improved by 34% on average as a result of the system³.

² <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future>

³ <https://www.mos.ru/en/news/item/16556073/>

In a similar vein, in Barcelona, “superblocks” have been designated as a way of stopping through traffic and streamlining the roads that are in place. Nine blocks are cordoned off where traffic through the area is one-way only and allows authorities to funnel vehicles onto roads that are better equipped to deal with large traffic volumes.

These issues are simple and use either new technologies or new designs, but don’t overhaul a city’s transport system.

2. Fewer cars

Cars can be banned...

There are many ways to reduce car usage in cities, but most focus on the provision of alternatives rather than blanket bans. However, bans are still popular: Madrid has an ambitious plan to ban all non-local cars within the city by 2020, while central Oslo is going even further aiming to ban all cars from the city centre by 2019⁴, with a nationwide ban of petrol cars in Norway due by 2025.

Sharing is not always caring

...or shared

Ride-hailing may not be a typical smart city technology because the benefits are yet to be fully realised. While companies such as Uber may help to cut down car ownership, research conducted by Alejandro Henao at the University of Colorado⁵ finds that more ride hailing users substituted away from public transport (22.2%) than away from private driving (19%). 11.9% of passengers would have walked/cycled otherwise. On top of this, ride hailing results in more miles on the road than a ‘self-driven’ car journey – often providing two thirds more traffic to the road for completing the same trip – as the driver must collect the passenger.

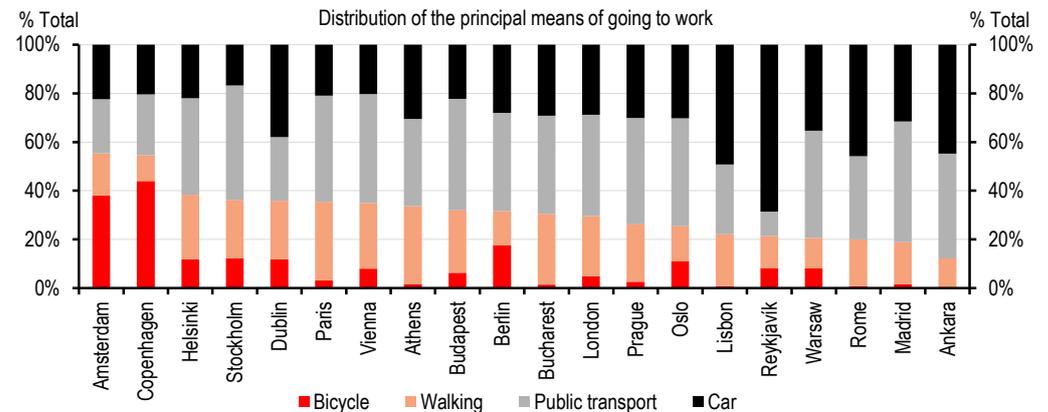
On your bike

Encouraging bike travel is key

However, many cities are using a carrot, rather than a stick, approach, and providing alternatives to car travel.

Copenhagen’s vast cycle lane network means that nearly half of the population primarily cycles to work, while in Hamburg, local planners are aiming to build out an interconnected space that is off-limits to cars, aiming to cover 40% of the city by 2035.

11. In Europe, cycling to work is common in Amsterdam and Copenhagen



Source: Eurostat. Note: Ranked by sum of bicycle and walking. Respondents were given the option to mention more than one means of transport for going to work so re-based to sum to 100%. London, Paris and Lisbon are greater city.

⁴ <http://www.businessinsider.com/cities-going-car-free-ban-2017-8?IR=T>

⁵ Henao, Alexander, 2017. Impacts of ridesourcing – Lyft and Uber – on transportation including VMT, mode replacement, parking, and travel behaviour, Doctorate Thesis at the University of Colorado.

It's not just about the infrastructure: across the world, provision of bikes through sharing schemes is proving more popular. In China, Ofo and Mobike provide easy access bike rentals (with no docks), and now provide more than 50 million bike journeys a day. These sorts of schemes are rapidly spreading to other countries, made possible by having a connected city due to smartphone ownership. Of course, these schemes do face challenges around keeping the bikes well looked after and not dumped around the city.

Staying in China, the city of Chengdu is building a suburb, known as the "Great City" to accommodate 80,000 people, being designed in such a way that it is quicker to walk than drive from one point to another, with public transport to take people out from the city and cars only being allowed on half of the roads⁶.

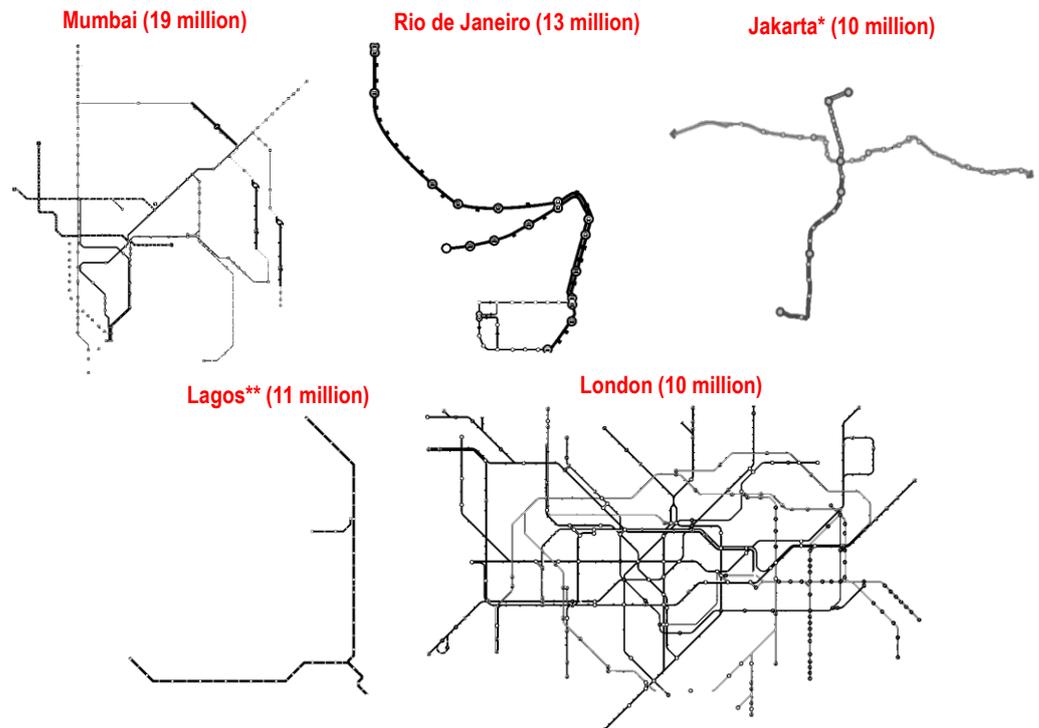
Public transport

Public transport is poor in many cities

Walking and cycling is not for everyone: it can either be too time-consuming or dangerous (67% of non-cyclists in the UK do not cycle because they feel it is too dangerous⁷). So cities need to provide better public transport provisions to enable a switch away from cars.

Many large cities lack adequate public transport infrastructure. Many large emerging market cities rely heavily on crowded bus routes on overcrowded roads, and the roll-out of metro systems can go a long way to alleviate congestion.

12. EM cities have inadequate subway networks for their large populations



Source: HSBC. Note: * First part of Jakarta line to open in March 2019, the second line in 2025. **Lagos to open in 2018, as of latest information is 95% complete. Populations in brackets. Maps show simple outlines of the city metro networks.

⁶ <http://www.wired.co.uk/article/china-great-city>

⁷ UK Department for transport, 2013 - British Social Attitudes Survey

There have been some promising steps in the past year or so. One of the most congested cities in the world, Jakarta, is on track to open its first metro line in 2019, passing the baton of the world's largest city without a metro line to Karachi, where a Google search for "Karachi subway" brings up results for the well-known sandwich chain rather than fast-moving trains.

And the quantity of network doesn't even tell us about how well they run. Although residents will complain about metro systems in New York or London, the challenges are nothing compared to the risks and problems with many metro lines in emerging markets. For example, according to the Government Railway Police in Mumbai, 3,014 commuters were killed on the tracks of the Mumbai suburban rail network in 2017⁸, with 654 of those as a result of falling from moving trains.

Many reasons to build infrastructure

Cities need to continue to invest in public infrastructure, and will be incentivised for political as well as economic reasons. In the Philippines, there is an investment programme which aims to spread the growth across the population. The plan is to build 75 projects over a decade, including six airports, nine railways and four seaports as well as a raft of roads, bridges and bus transits⁹ with the Manila metro one of the jewels in the ambitious crown. While such investment may need to be seen to be believed, the idea is that it will help to make urban areas more effective from an economic perspective as well as improving the quality of life for citizens.

Public transport data is very useful

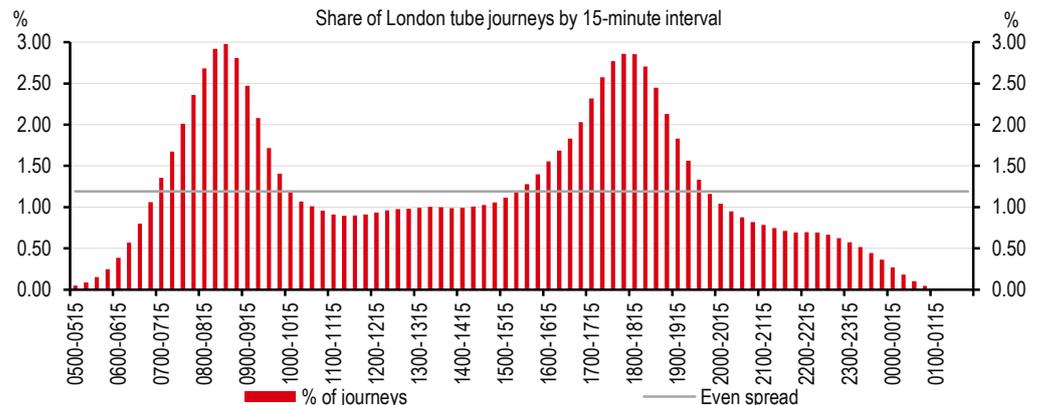
Cities can also use public transit data effectively: Transport for London (TfL) provide a wealth of open-source data from their network¹⁰, which allows businesses to see the flows of passengers at each station at a given time as well as live network data. This data can be used to help businesses with setting opening times, staffing levels and be used by app developers to provide information to consumers.

3. Making fewer journeys

Technology can help cities with congestion

While the first two 'solutions' to easing congestion are policy dependent, some smart city development will happen via the spread of technology, often not dependent on local decisions or investments. For example, creating opportunities to cut down congestion by changing travel patterns and plans. On top of providing useful information to businesses, the TfL data show how clearly travel is focused around 'rush-hour', putting greater strain on the network that is in place.

13. Rush hours put strains on transport networks



Source: <http://crowding.data.tfl.gov.uk/>, HSBC calculations. Note: We have used all flows within the Station Passenger Link Flows database

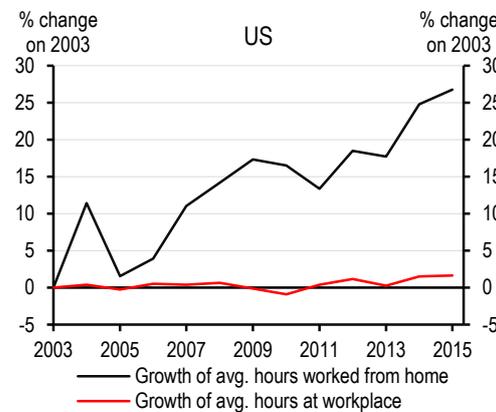
⁸ <https://indianexpress.com/article/cities/mumbai/3014-commuters-killed-on-mumbai-railway-tracks-in-2017-5040393/>
⁹ <https://www.forbes.com/sites/outofasia/2018/02/28/dutertes-ambitious-build-build-build-project-to-transform-the-philippines-could-become-his-legacy/#300497561a7f>
¹⁰ All of TfL's open data is available here: <https://tfl.gov.uk/info-for/open-data-users/our-open-data-including-the-data-used-for-chart-13>

More people are working from home

Better communications technologies allow workers to be ‘at their desk’ from anywhere in the world. In fact, much of this note was written from coffee shops, airport departure lounges and hotels. So, in theory, workers can either work from home, or travel to-and-from work at more flexible times to minimise the strains on the existing public transport network.

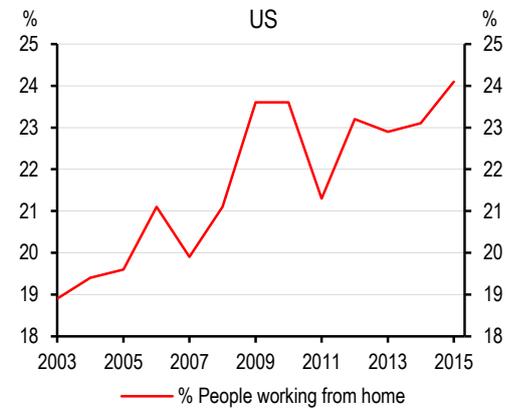
Given the shift in the type of work being done, away from physical labour to the knowledge economy, this becomes increasingly possible. Charts 14 and 15 below show that since the early 2000s, which is essentially the beginning of the connected age, the number of hours worked from home grew by nearly 30%, whereas the hours worked from the workplace has remained flat. This trend should only increase as technologies such as virtual reality and other decentralised communication tools increase in popularity over the coming decade.

14. Hours worked at home is growing faster than hours worked in the workplace



Source: BLS, HSBC

15. The proportion of people working from home in the US is also growing



Source: BLS

So, it is important for cities to improve communications technology in order to help their transport networks. If broadband speeds are too low or access is too limited, these alternatives cease to be options. But as the world becomes more connected, more flexible working can streamline cities.

Building connected cities is key

This is one of the biggest challenges for emerging market cities. As they continue to develop new infrastructure, the challenge is not just to build physical roads, railways and airports, but also to ensure a high degree of connectivity, and to allow residents to have internet access as much as possible. This could come from existing fixed broadband lines but more so across the emerging world it is coming from mobile communications – firstly 4G and eventually 5G as the technology spreads. Ensuring a connected city could have many advantages.

4. Autonomous vehicles

On top of the decision to travel less due to remote working, a future development that could transform how city transport networks look is that of autonomous vehicles. We may be some way from a broad roll-out despite the rapid improvement in the underlying technologies in recent years.

As Davey Jose’s note: ‘Transport shock’, 19 October 2016 suggests, we could see a sharp fall in the number of cars needed on the road and the costs of travel falling for households.

Cities could benefit from autonomous vehicles

Recent studies, such as one from the World Economic Forum¹¹, suggest a number of benefits to cities: the number of cars on the road in some cities could fall by 15% but miles travelled could rise by 16%. Travel times could improve by 4% on average but in parts of cities not connected to mass transit this could rise to a 12% improvement.

¹¹ <https://www.weforum.org/reports/reshaping-urban-mobility-with-autonomous-vehicles-lessons-from-the-city-of-boston>

Housing

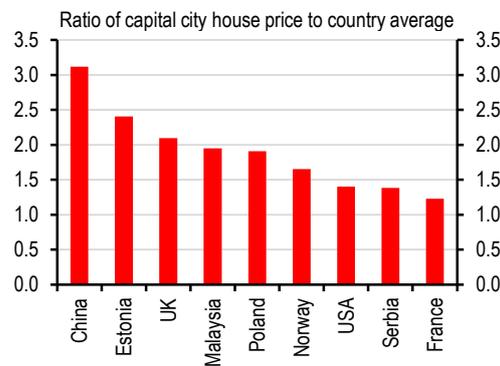
- ▶ Housing costs and availability are big challenges for governments
- ▶ New technologies can streamline the process...
- ▶ ...and allow housing stock to be built up more quickly

Housing crisis?

Many cities have a housing shortage

Cities are expensive places to live. In many cities, a shortage of housing relative to the rapid growth in urban populations is putting further upward pressure on prices and making housing unaffordable. McKinsey estimate that, globally, 330m urban households already live in substandard housing and this could rise by one third if trends are not reversed.

16. Cities are expensive places to buy...



Source: BIS, National sources, HSBC. Note: for countries where the data is provided as a local currency house price rather than an index

17. ...especially for first-time buyers



Source: Thomson Reuters Datastream, Nationwide

Build cheaper, build quicker

New technology can allow cheaper and faster builds

Technology can help correct this problem in a few ways. Firstly, new construction techniques can allow cities to meet their growing housing needs more quickly and at lower cost. Particularly in emerging markets, prefab housing which is produced in factories as components and then assembled on site, could be extremely useful in building the quantity of homes that are required at a speed, cost and scale that traditional building methods do not make possible. Might 3D printing of homes be the natural next step in the prefab trend? For example, the city of Eindhoven in Holland is set to create the first habitable homes made by a 3D printer. The company creating these structures said about 5% of homes could be made by a 3D printer within the next five years.¹² In cities where there is a shortage of housing, such techniques could allow housing supply to expand quickly and at a cost that makes them affordable to many.

¹² "Netherlands to build world's first habitable 3D printed houses", The Guardian, June 2018.

On a similar note, a collaboration between UN Habitat and Yale University has helped to develop ways of building quantities of sustainable housing – with a tiny 22 square metre home that sleeps four people and is entirely run by renewable energy¹³. The project aims to be able to provide cheap, easy to build and environmentally friendly homes to cities across the world.

Prefab housing can already make a difference in the developed world, where cities are already seeing the speed of construction as a key way to tackle housing shortages¹⁴ and enable young workers to live in cities – crucial for providing a skilled workforce to the service economy.

Lower cost to build out EM housing

But in EM, the real benefits could come from the lower cost. Even on more complicated design projects, costs could be 10-50% lower than site-built homes. The speed and the lower cost may mean that this form of housing goes a long way to providing housing solutions to cities with an existing shortfall in the housing stock.

Make the most of the space we have

Secondly, the spread of both technology and new transport options will allow a better use of the existing housing stock. On the transport side, bigger public transport networks or the eventual roll-out of completely game-changing technologies such as autonomous vehicles will play a role in “expanding” the size of cities and create more land that can be used for urban housing and/or increase the supply of homes, putting downward pressure on house prices.

Transport networks can expand the range of cities

In London, for example, the Crossrail project will mean that (once it opens) the journey time from West Drayton, on the very western edge of the city, to London Liverpool Street Station, in the heart of the City of London, will take 31 minutes compared to the 60 it does today. While that may not seem like much, the time saved opens up the areas around West Drayton to be much more commutable to central London and provides an alternative land-area for homes.

We could take this further, and following on from the rise of home-working (as discussed in the previous chapter), we could see workers de-urbanise and take some strain from city housing stock. Workers could either be willing (one day) to undertake longer commutes via autonomous vehicles or not need to physically commute at all. This could mean that instead of just expanding the ‘commuter belt’ for a city, it would be completely re-thought.

On top of this, home-sharing companies such as AirBnB could also allow the existing housing stock to be utilised in a more efficient manner, with fewer homes left idle. While this may not be a new technology as such, the spread of information could allow for a better usage of the available capital stock.

Better planning and process

Finally, technology can allow cities to undertake the planning process more effectively. We could see simple improvements in data management and land registry, possibly using blockchain technology, which could streamline the process and allow the housing stock to be built up more effectively. On top of this, better data management on housing occupancy and idle land could allow city authorities to make better use of the land and housing stock that is available.

Streamlining the approvals process

¹³ <https://www.weforum.org/agenda/2018/07/un-environment-and-yale-debut-stunning-sustainable-tiny-home-collaboration>

¹⁴ <https://www.theguardian.com/sustainable-business/2017/jan/26/prefab-homes-uk-housing-crisis-modular-offsite-construction-manchester-liverpool-energy-efficiency>

Crime and safety

- ▶ Cities are typically more dangerous places to live than rural areas
- ▶ Smart technologies can cut crime rates...
- ▶ ...and make cities safer places to live

New technologies can help to cut crime

Of course, how effective new innovations can be in cutting crime will depend on your start point. For example, it's much easier to think about cutting crime rates in Caracas where more than 0.1% of the population was murdered in 2017 (3,387 people), than in say, Reykjavik, where the crime rate is 100x lower. But nonetheless, smart technologies in cities can help to cut the rate of crime. Mortality rates can come down for a number of reasons: by making roads safer, predictive policing and optimising emerging responses.

18. Most of the most crime-ridden cities are in Latin America

City	Murders per 100,000
Los Cabos, Mexico	111.33
Caracas, Venezuela	111.19
Acapulco, Mexico	106.63
Natal, Brazil	102.56
Tijuana, Mexico	100.77
Highest in the US:	
St Louis	65.83
Maryland	55.48
New Orleans	40.10
Detroit	39.69

Source: World Atlas

Predictive policing is already in use

Predictive policing and the use of data are extremely powerful in helping to reduce crime rates in cities across the world. In Rio de Janeiro, where the crime rate is elevated, the local government has started mapping the locations and times of crimes, feeding into a mobile app¹⁵. This data is used to predict the probabilities of crime being committed in certain areas at certain periods of the day, allowing police presence to be managed efficiently and for locals to know where to avoid after dark.

It's not just an emerging market issue: A similar approach to predictive policing was taken in Santa Cruz, California, in 2011 where in the first year of adoption, burglaries dropped by 29%¹⁶.

Surveillance on the rise, which may meet opposition

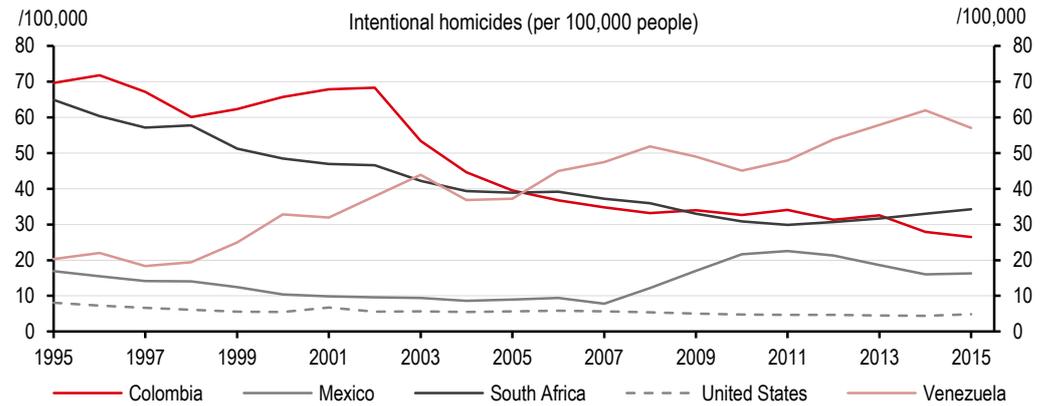
This fits in with the broader idea that increasing surveillance quality and quantity can help reduce criminal activity. Although not popular amongst many citizens, with the many sensors, cameras and monitoring systems being deemed an invasion of privacy, such data can be crucial in pre-empting criminal activity and ensuring safety. Cameras can recognise faces and vehicles, as well as weapons and unusual activity in different parts of the city.

¹⁵ <http://www.wired.co.uk/article/crimeradar-rio-app-predict-crime>

¹⁶ <http://www.stellenboschheritage.co.za/wp-content/uploads/The-Responsive-City.pdf>

Across the world, various other approaches have been used to cut down crime rates, from smart street lighting to gunshot detection technology. Although more street lighting may not actually have a dramatic impact on a given crime, it may make people feel safer and more comfortable, a key part of any local government’s aim.

19. Countries with high crime rates could see a greater return from smart cities



Source: World Bank WDI

More resistant buildings

Smarter buildings for safety

Building technologies are advancing in ways that help to protect residents too. Defensive architecture which is designed to protect against terror attacks, fire or other damage can help to minimise injuries. Technologies such as “blast walls” that protect against explosions or better fire-proofing can help to minimise damage.

Quicker moves from emergency services

A faster emergency response

One of the side effects of better surveillance and connectivity is a faster emergency services response. While predictive policing and better building techniques can mean fewer fatalities, once an incident has occurred, getting an emergency response out more quickly is key. Fire brigades may be notified automatically by smoke sensors within buildings – cutting down delays due to the time it takes to report an incident.

Of course, this doesn’t mitigate the other cost challenges that cities face. Providing enough firefighters and police officers will still be a cost challenge – and one that can’t be solved with new technology quite yet.

Citizens being more engaged or able to report incidents will also help. Apps that allow quick and easy reporting of crimes, fires or injuries will enable both emergency services and other citizens to help quickly. In Singapore, for example, the app ‘MyResponder’ allows citizens to report cardiac arrests, sending a notification to any trained responders who could be nearby.

Public services

- ▶ Technology can also help roll out basic services...
- ▶ ...saving time and money for governments...
- ▶ ...and improve the lives of city residents

Better quality of life

Many technologies aren't constrained to cities

One of the main jobs of local governments is to provide adequate public service provision to their inhabitants. This can be bigger expenses such as education and healthcare, or smaller items such as refuse collection. Not all of these are city-specific, but they provide a platform to rethink how urban land can be used in the coming years.

Education

Education can move online

New technologies can help to improve educational attainment in all walks of life, and play a big role in how cities design educational programmes. Schools are able to use apps on students' smartphones to track attendance via locations and to scan in and out of school sites, helping to cut down an administrative burden.

Data can also be used to develop more customised educational programmes for students – allowing tests and homework to be analysed and finding areas for improvement. As Steve Case suggested in his book, *"The Third Wave"*, we don't use educational data properly, and by doing so we could raise educational attainment.

Access to degree courses for all

The biggest gains will come in emerging markets, where technology is making quality education accessible for most. Although the share of young people regularly going to school is on the rise in most emerging nations, technology is pushing this even further. Projects such as The University of the People¹⁷, which allows anyone, anywhere in the world to undertake a bachelor's degree in Business Administration, Computer Science or Health Science for an USD80 processing fee (and there are scholarships available for this fee too). In 2016, the top 10 countries of applicants were the US, Nigeria, Canada, Ghana, South Africa, the UK, Zimbabwe, Kenya, Brazil and Cameroon – showcasing how it is mainly emerging market residents who gain from these resources.

This sort of programme is key when designing rapidly growing cities across the emerging world. School buildings themselves need to be smarter in order to make the most of online resources, but do we need as many physical schools as before? Will these new means of teaching change how cities use space for educational establishments? This could allow educational attainment to rise, money to be saved and space within cities to be used for alternative means.

Healthcare

A well designed city will naturally create more incentives for a healthier lifestyle: open spaces that facilitate and encourage walking, cycling and creating spaces for other outdoor pursuits.

But on top of this, modern technology allows us to know much more about our health through data collected by smartphones. If this data is used correctly, then medical professionals will be able to

¹⁷ <https://www.uopeople.edu/>

diagnose illnesses and design healthy-living programmes based on individuals' lifestyles. Water systems can be tracked continuously to check for disease and pH levels – key in the emerging world as water-borne disease can spread quickly, meaning that smart technologies can play a key role in pushing up life expectancy and cutting mortality rates across the emerging world.

Public services: Improving basic service provision

Streamlining the simple things

As well as the big-ticket items such as education and healthcare, smart technologies can be used to streamline how basic government services are provided more efficiently.

In Singapore, there has been an enormous investment in producing apps that allow citizens to solve issues in the city state. Some are more practical, such as *MyResponder* as already mentioned, as well as those which track healthy living. Some apps allow the reporting of minor issues such as loose animals or overflowing bins and one app allows payment for car parking. One of the (arguably) less economically useful apps allow locals to upload sightings of wildlife.

20. Singapore's government has released a stream of "useful" apps for citizens

Singapore's available smart apps

<p>Beeline Transport routes and tickets</p>	<p>Police@SG Accessible police information</p>	<p>HealthHub Health records on your phone</p>	<p>OneService An easy way to report municipal issues</p>
<p>MyResponder Helping first aiders' to help cardiac arrest victims</p>	<p>Customs@SG Pay taxes on overseas purchases</p>	<p>NLB Mobile Read on the move with access to library content</p>	<p>Moments of Life Information for parents and caregivers</p>
	<p>SingStat Access to key official statistics</p>		<p>SBBioAtlas Report sightings of wildlife and plants</p>

Source: <https://www.smartnation.sg/>

A narrower approach is adopted in Dubai, where the DubaiNow app allows you to pay bills and fees to the government but also plan travel, track posted packages and find a doctor or school. There are a host of other apps to help workers, pay utility bills and keeping on top of events happening in the city.

Easier deliveries

As well as this, basic services are being upgraded to utilise modern technology. Delivery, which requires vans to fill the streets of cities, may soon be (at least partially) eradicated due to drone deliveries or autonomous delivery vehicles. These can be more nimble and free up space on roads.

Better bin collections?

Even simple things could be done better. In 2017, 417 of the 741 (56%) complaints to the city council in Newcastle, UK, were about bin collection¹⁸. Smart technologies in regards to smarter route mapping and traffic avoidance could help to speed up the work of refuse collectors and mean a more efficient provision of service. On a similar note, in Boston an app called 'street bump' allows users to report road hazards while driving as the accelerometer registers bumps in the roads and reports them.

While none of these sorts of technologies are economically life-changing, they can help to streamline the provision of public services and save governments' money, as well as improving the lives of citizens.

¹⁸ <https://www.chroniclive.co.uk/news/north-east-news/annual-newcastle-city-council-complaints-14872226>

Who pays for smart cities?

- ▶ While smart city technology can be rewarding, costs are high...
- ▶ ...meaning private-public partnerships are attractive...
- ▶ ...and Green Bonds will likely play a key role in funding

Funding smart city development

Many cities don't have funding or are too short-sighted

While the economic benefit is clear from investing in smart city technologies, many cities are finding it hard to stump up the initial cash. In Barcelona, investment in Internet of Things (IoT) systems generated 47,000 jobs and saved the city nearly EUR80m a year through water supply and smart parking options. Yet, according to a joint report by Philips and SmartCitiesWorld¹⁹, one in ten local authorities claim that they do not have the resources to look at implementing similar programmes. The same report exhibits some frustration with current short-termism in that cities are unwilling to invest in technologies that essentially pay for themselves in terms of savings over the years.

The financing challenge for local governments is clearly seen in the UK, where in February 2018 the Northamptonshire County Council went effectively bankrupt²⁰ following failed investments on consultants and rebranding. Funding investment is not easy.

For that reason, funding for smart city initiatives is likely to come from alternative sources:

1. National governments
2. Private-public partnerships
3. Private investment, via the growing Green Bond market.

Partnerships provide one solution

With 75% of respondents to a survey by Black & Veatch²¹ believing that the third option, public-private partnerships, is the most effective model, much of the attention on funding smart cities has focused on this front; but the other options are also playing a role.

National government

National governments may not fund smart city investment directly, but they may provide subsidies or grants that make it easier for local governments to fund this sort of project.

National subsidies can help funding

In Norway, the national government offers USD6,000-90,000 in grants to support start-ups in producing smart city services that can ease the burden on local governments. Across Scandinavia, there are similar schemes in Sweden and Denmark – where the aim is for local governments to focus solely on implementation and not the research and design. In a similar vein; in the US, the Department of Transportation ran a “Smart City Challenge”²², where the

¹⁹ Smart Cities: Understanding the challenges and opportunities, Philips and SmartCitiesWorld

²⁰ <https://www.theguardian.com/uk-news/2018/feb/11/northamptonshire-county-council-effective-bankruptcy-tories-cuts>

²¹ <https://hub.beesmart.city/strategy/paying-for-smart-cities-wheres-the-money#SOURCES>

²² <https://www.transportation.gov/briefing-room/us-department-transportation-announces-columbus-winner-unprecedented-40-million-smart>

winner (Columbus, Ohio) received USD40 million from the national government and USD10 million from a private partner to help implement a new transport system.

India has showcased a strong initiative at a national level. The Smart Cities Mission²³ has provided USD15bn to develop 100 smart cities and rejuvenate 500 other cities over the course of five years, with each city receiving roughly USD15m per year. According to this initiative, in order to win the funding, cities must showcase the feasibility and impact of any project and install a CEO of a new private company to oversee the implementation.

Private-public partnerships

Some cities have become engaged in comprehensive private-public partnerships that allow much of the technological implementation to be taken care of by private companies in exchange for contracts within the city. These examples are some of the more prominent but showcase what can be done.

Some partnerships are simple and effective

Sidewalk Labs²⁴ is an offshoot of Google and is working with the City of Toronto - with USD50m being co-funded by the company to roll out new technologies across the city. To facilitate the transition towards autonomous vehicles, Sidewalk Labs is using a completely flexible modular construction system, to allow current parking spaces to be easily and cheaply repurposed as liveable spaces once the autonomous transition is complete. Given Toronto's infamously inhospitable weather they have also looked at encouraging year round pedestrian and cycle flows by weatherproofing sidewalks with heavy duty awnings and underground heated paths to melt snow.

Some schemes are simpler, such as in New York City, where a partnership with the firm CityBridge has led to the many payphone boxes in the city being converted to provide wifi and charging points. In this partnership, the private firm provided USD200m for the conversion and takes advertising revenues from these new 'links'. From the revenues generated, the city receives whichever amount is higher between USD17.5m and half of the advertising revenues, creating a win-win partnership that upgrades the infrastructure in the city for the modern age.

Some cities have tried a different approach, by offering competitions to aspiring app designers – with Reykjavik in Iceland offering USD9,500 to the winner of a 2018 competition to make the city smarter. Similar schemes have been rolled out in Melbourne and Dublin on a more regular basis, to try to encourage fresh ideas.

The bond market may have to play a role

In addition to these, Green Bonds should serve as an increasingly important funding source for smart cities initiatives. The next few pages highlight how this is already happening and will continue to develop in coming years.

²³ <http://smartcities.gov.in/>

²⁴ <https://sidewalktoronto.ca>

Green bonds and the city

- ▶ Cities are increasingly a focus of climate mitigation and adaptation
- ▶ Green bond supply to fund urban greening is rising
- ▶ UN SDG-11 may further boost urban green & SDG bond supply

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Currently we are seeing rapid growth in the supply of green, social and sustainability bonds to fund green and social projects in urban areas. Not only is the supply of green, social and sustainability bonds growing rapidly, but a growing proportion of these bonds are issued to fund climate change mitigation and adaptation in urban areas.

Many different types of green bond fund urban projects including bank and US municipal green bonds. Nevertheless, in this report we focus on green bonds issued by i) cities and municipal regions and by ii) private real estate firms, as we think bonds from these issuer groups are the most focussed on urban green and social projects. City and region green bonds fund energy efficiency, public transit, social housing; private real estate green bonds fund green buildings. Bonds from these two groups made up 13.0% of all green, social and sustainability bonds issued in H1 2018, up from 12.6% in H1 2017 (figure 21).

21. Green, social and sustainability bond supply by regions/cities and real estate firms

	2018 H1 issuance (USDm)	Growth (% yoy)	Percentage of total H1 2018 iss. (%)	2017 H1 issuance (USDm)	Percentage of total H1 2017 iss. (%)
Regional/city	7,300	1.2	8.4	7,215	10.1
Private real estate	3,935	125.7	4.6	1,744	2.5
Total	11,235	25.4	13.0	8,958	12.6

Source: Dealogic, HSBC

Cities a focus for climate change adaptation projects

We are not surprised that more green projects are taking place in urban areas. As attention moves from decarbonising large thermal power plants (built in remote locations) to decarbonising transport, housing and heating, so the focus moves to cities.

Equally, as societies increasingly focus on climate change adaptation, so the focus moves to protecting urban areas from climate change impacts.

Of course, not all cities and regions issue green bonds. Some may prefer to raise taxes rather than borrow. And not all sub-sovereigns can borrow on the capital markets, even if they wanted to: some sovereigns prevent their cities and regions from borrowing in the capital markets. Nevertheless, in countries where sub-sovereigns can issue bonds, like Australia, Canada, France, South Africa and Sweden, many cities and regions are issuing green.

Cities also are ideally placed to favour sustainability bonds – bond funding both green and social projects – as local authorities often fund both green (renewable energy, efficient buildings) and social projects (social housing, public transit).

Figure 22 lists city and regional green, social and sustainability bonds (including ABS but excluding US muni green bonds). We include all bonds classified by Dealogic as 'government', but exclude actual sovereign bonds. Figure 23 lists private real estate and REIT green bonds.

22. City, regional issuers of green, social and sustainability bonds (including ABS but excluding US munis)

Name	Ticker	Rating	Country	Date of first green issuance*	Tranches issued	Amount out. (USDm)
Province of Jujuy	JUJUJA	-/B-	Argentina	13/09/2017	1	210
Province of La Rioja	PRIO	-/B+	Argentina	16/02/2017	2	300
Queensland Treasury Corp	QTC	Aa1/AA+	Australia	15/03/2017	1	567
Treasury Corp of Victoria	TCV	Aaa/AAA	Australia	19/07/2016	1	228
City of Ottawa	OTTAWA	Aaa/AA	Canada	02/11/2017	1	79
City of Toronto	TRNT	Aa1/AA	Canada	18/07/2018	1	228
Province of Ontario	ONT	Aa2/A+	Canada	02/10/2014	4	2,384
Province of Quebec	Q	Aa2/AA-	Canada	24/02/2017	3	1,151
Departement de l'Essonne	ESSONN	-/-	France	22/10/2014	1	51
Ile de France	IDF	Aa2/NR	France	14/04/2014	5	3,208
Paris	VDP	-/AA	France	10/11/2015	2	693
Region Limousin	LIMOUS	-/-	France	05/06/2014	2	27
North Rhine Westphalia	NRW	Aa1/AA-	Germany	04/03/2015	4	7,006
Tokyo Metropolitan Government	TOKYO	-/A+	Japan	20/10/2017	2	89
Mexico City	GDFMX	-/-	Mexico	07/12/2016	1	49
Auckland Council	AUCKCN	Aa2/AA	New Zealand	21/06/2018	1	138
Oslo	OSLO	-/AAA	Norway	04/12/2015	1	174
City of Cape Town	CAPTWN	-/-	South Africa	13/07/2017	1	74
City of Johannesburg	JOBURG	Baa3/-	South Africa	23/06/2014	1	137
Madrid	MADRID	-/BBB+	Spain	05/08/2016	3	2,027
Basque Country	BASQUE	A3e/-	Spain	05/06/2018	1	585
Barcelona	BARMUN	Baa1/A-	Spain	13/12/2017	1	41
City of Gothenburg	GOTA	NR/AA+	Sweden	26/09/2013	6	612
City of Malmo	MALMOK	-/-	Sweden	30/11/2017	2	156
City of Orebro	OREBRO	-/-	Sweden	13/10/2014	4	221
City of Vasteras	VASTER	-/-	Sweden	24/11/2016	2	81
City of Vellinge	VELLIN	-/-	Sweden	06/03/2018	3	53
Municipality of Lund	LUNDSK	-/-	Sweden	16/05/2017	1	85
Municipality of Nacka	NACKAN	-/-	Sweden	07/06/2018	1	57
Municipality of Norrkopings	NORKOM	-/-	Sweden	10/10/2016	1	70
Skane County	SKANE	-/-	Sweden	30/05/2018	2	112
Stockholms Lans Landsting	STOCKL	-/AA+	Sweden	15/05/2014	7	915
Vastra Gotalandsregionen	VASTRA	-/-	Sweden	28/05/2018	1	114
Canton of Geneva	GENEVA	-/AA-	Switzerland	09/11/2017	2	620

Source: Dealogic, Bloomberg, HSBC

* Pricing date

Defined as Dealogic General Industry Group "Government", excluding sovereign issuance

23. Private real estate and REIT green bond issuers (non-SEK)

Name	Ticker	Rating	Country	Date of first green issuance*	Tranches issued	Amt. Out. USDm)
ICPF Finance Pty Ltd	ICPFAU	-/A-	Australia	12/04/2017	1	75
Investa Listed Funds Management Ltd	IOFAU	-/BBB+ -	Australia	30/03/2017	1	115
Stockland Trust Management Ltd	SGPAU	-/A-	Australia	22/10/2014	1	383
Chongqing Longhu Development Co Ltd	LNGFOR	-/-	China	16/02/2017	3	588
Guangzhou Yuexiu Holdings Ltd	GZYPX	-/-	China	23/02/2018	1	315
Landsea Green Group Co Ltd	LSEAGN	B3/B-	China	20/04/2018	2	200
Modern Land (China) Co Ltd	MOLAND	B3/-	China	13/10/2016	4	850
Nanjing Fullshare Industrial Holding Group	NJFSHO	-/-	China	19/07/2017	2	373
Pingxiang Huifeng Investment Co Ltd	PXETMC	-/-	China	20/09/2017	1	304
Shaanxi Xixian New Area Fengxi New City	SXXXFX	-/-	China	22/08/2017	1	225
Shanghai Lingang Economic Development	SHLGED	-/-	China	15/03/2018	2	158
TusPark Co Ltd	THSCPA	-/-	China	18/08/2017	2	137
Yiwu State-owned Capital Operation	YWSOAO	-/-	China	11/07/2017	1	118
Zhenjiang Dantu District Construction	DANTU	-/-	China	03/11/2017	1	212
Fonciere des Regions	COVFP	-/BBB	France	09/05/2016	1	570
Fonciere INEA	INEAFP	-/-	France	21/02/2018	4	124
Icade SA	ICADFP	-/BBB+	France	04/09/2017	1	713
Rodamco Sverige AB	ULFP	-/A	France	23/05/2014	2	228
Unibail-Rodamco-Westfield	ULFP	-/A	France	19/02/2014	2	1,579
Hang Lung Properties Ltd	HLPPY	-/-	Hong Kong	12/07/2018	1	150
Link Finance	LINREI	A2/A	Hong Kong	14/07/2016	1	500
Mitsubishi Estate Co Ltd	MITEST	A2/A+	Japan	20/06/2018	1	182
Toda Corp	TODA	-/-	Japan	08/12/2017	1	89
Entra ASA	ENTRAN	-/-	Norway	16/09/2016	3	238
OBOS Forretningsbygg AS	OBOS	-/-	Norway	20/10/2017	1	54
Growthpoint Properties Ltd	GRTSJ	-/-	South Africa	09/03/2018	3	93
Alexandria Real Estate Equities Inc	ARE	Baa2/BBB	United States	12/06/2018	1	450
Digital Realty Trust LP	DLR	Baa2/BBB	United States	18/06/2015	1	500
Prologis International Funding II SA	PRIFII	A3/A-	United States	01/03/2018	1	366
Regency Centers LP	REG	Baa1/BBB+	United States	13/05/2014	1	250
Vornado Realty LP	VNO	WR/BBB	United States	09/06/2014	1	450

Source: Dealogic, Bloomberg, HSBC
* Pricing date

UN SDG-11 may stimulate city-focused green bonds

The UN Sustainable Development Goals (SDGs) may further galvanise urban climate change mitigation and adaptation efforts, given that SDG-11 targets ‘Sustainable Cities and Communities’. UN SDG-11 aims to make cities ‘inclusive, safe, resilient and sustainable’²⁵. The seventeen UN SDGs were published in 2015 and run to 2030 (Figure 24).

24. United Nations Sustainable Development Goals



Source: United Nations Department of Public Information

²⁵ <https://www.un.org/sustainabledevelopment/cities/>

Three SDG bonds all target sustainable cities

Indeed the creation of the UN SDGs already has stimulated some capital market innovation. Three institutions, namely HSBC, ANZ and the Autonomous Community of Madrid have issued SDG bonds²⁶.

The proceeds of an SDG bond go to fund one or more of the UNSDGs. Each of these bonds specifies between 7 and 9 SDGs that they intend to fund. All three of these SDG bonds intend to fund SDG-11 ‘Sustainable Cities’ as one of their use of proceed goals, probably as many different types of green and social projects can be undertaken in cities (Figure 25).

25. How use of proceeds will be put to work in three SDG bonds

	Goal	HSBC	Madrid	ANZ
SDG 1	No poverty		Y	
SDG 2	Zero hunger			
SDG 3	Good health and well being for people	Y	Y	Y
SDG 4	Quality education	Y	Y	Y
SDG 5	Gender equality		Y	
SDG 6	Clean water and sanitation	Y		Y
SDG 7	Affordable and clean energy	Y		Y
SDG 8	Decent work and economic growth			
SDG 9	Industry, innovation and infrastructure	Y	Y	Y
SDG 10	Reduced inequalities			Y
SDG 11	Sustainable cities and communities	Y	Y	Y
SDG 12	Responsible consumption and production			Y
SDG 13	Climate action	Y	Y	Y
SDG 14	Life below water			
SDG 15	Life on land			
SDG 16	Peace, justice and strong institution			
SDG 17	Partnerships for the goals			

Source: HSBC, individual bond prospectuses, Sustainalytics

If SDG bond supply were to take off, this could provoke more and more funding for smart cities, given that many different types of green and social projects that can be undertaken in urban areas.

The International Capital Markets Association (ICMA) seems to agree with us. ICMA previously stated that there are ten different forms of green projects and six forms of social project.²⁷ Now in a new document²⁸, ICMA specifies which green and social projects it thinks can be used to fund each of the seventeen UN SDGs. We are not surprised that ICMA thinks as many as eight (out of ten) green project categories could be used to fund SDG-11, and three out of the six social project categories (Figure 26).

²⁶ We regard SDG bonds as a sub-set of sustainability bonds.

²⁷ Respectively in ICMA's Green Bond Principles (2014) and Social Bond Principles (2017).

²⁸ 'Green and social bonds: a high-level mapping to the sustainable development goals', June 2018.

26. Matching the UN SDGs against GBP and SDG project categories

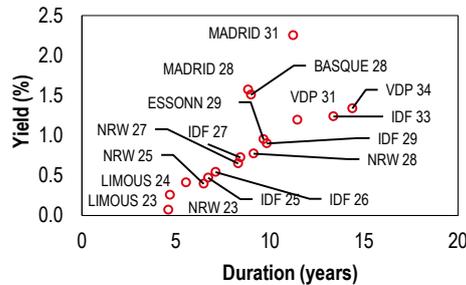
UN Sustainable Development Goals	Green Bond Principles	Social Bond Principles
<u>1 - No poverty</u>	<ul style="list-style-type: none"> ▶ Climate change adaptation 	<ul style="list-style-type: none"> ▶ Access to essential services ▶ Affordable housing ▶ Socio-economic advancement and empowerment
<u>2 - Zero hunger</u>	<ul style="list-style-type: none"> ▶ Climate change adaptation ▶ Environmentally sustainable management of living natural resources and land use ▶ Terrestrial and aquatic biodiversity conservation 	<ul style="list-style-type: none"> ▶ Access to essential services ▶ Affordable basic infrastructure ▶ Food security ▶ Socio-economic advancement and empowerment
<u>3 - Good health and well being</u>	<ul style="list-style-type: none"> ▶ Pollution prevention and control ▶ Renewable energy 	<ul style="list-style-type: none"> ▶ Access to essential services ▶ Affordable basic infrastructure
<u>4 - Quality education</u>		<ul style="list-style-type: none"> ▶ Access to essential services ▶ Socio-economic advancement and empowerment
<u>5 - Gender equality</u>		<ul style="list-style-type: none"> ▶ Access to essential services ▶ Socio-economic advancement and empowerment
<u>6 - Clean water and sanitation</u>	<ul style="list-style-type: none"> ▶ Sustainable water and waste water management ▶ Terrestrial and aquatic biodiversity conservation 	<ul style="list-style-type: none"> ▶ Affordable basic infrastructure
<u>7 - Affordable and clean energy</u>	<ul style="list-style-type: none"> ▶ Energy efficiency ▶ Renewable energy 	<ul style="list-style-type: none"> ▶ Affordable basic infrastructure
<u>8 - Decent work and economic growth</u>	<ul style="list-style-type: none"> ▶ Eco-efficient and/or circular economy adapted products, Production technologies & processes ▶ Energy efficiency ▶ Renewable energy 	<ul style="list-style-type: none"> ▶ Access to essential services ▶ Employment generation ▶ Socio-economic advancement and empowerment
<u>9 - Industry, innovation and Infrastructure</u>	<ul style="list-style-type: none"> ▶ Energy efficiency ▶ Renewable energy 	<ul style="list-style-type: none"> ▶ Access to essential services ▶ Affordable basic infrastructure ▶ Employment generation
<u>10 - Reduced inequalities</u>		<ul style="list-style-type: none"> ▶ Access to essential services ▶ Socio-economic advancement and empowerment
<u>11 - Sustainable cities and Communities</u>	<ul style="list-style-type: none"> ▶ Clean transport ▶ Eco-efficient and/or circular economy adapted products, Production technologies & processes ▶ Environmentally sustainable management of living natural resources and land use ▶ Green buildings ▶ Pollution prevention and control ▶ Renewable energy ▶ Sustainable water and waste water management ▶ Terrestrial and aquatic biodiversity conservation 	<ul style="list-style-type: none"> ▶ Affordable basic infrastructure ▶ Affordable housing ▶ Socio-economic advancement and empowerment
<u>12 - Responsible consumption & production</u>	<ul style="list-style-type: none"> ▶ Eco-efficient and/or circular economy adapted products, Production technologies & processes ▶ Environmentally sustainable management of living natural Resources and land use ▶ Pollution prevention and control ▶ Renewable energy ▶ Sustainable water and waste water management 	<ul style="list-style-type: none"> ▶ Food security
<u>13 - Climate action</u>	<ul style="list-style-type: none"> ▶ Climate change adaptation ▶ Climate change mitigation ▶ Renewable energy 	
<u>14 - Life below water</u>	<ul style="list-style-type: none"> ▶ Environmentally sustainable management of living natural resources and land use ▶ Terrestrial and aquatic biodiversity conservation 	<ul style="list-style-type: none"> ▶ Socio-economic advancement and empowerment
<u>15 - Life on land</u>	<ul style="list-style-type: none"> ▶ Environmentally sustainable management of living natural resources and land use ▶ Terrestrial and aquatic biodiversity conservation 	

Source: HSBC, UN

Figures 27 and 28 set out green, social and sustainability bonds issued by cities and regions, in Euros and US dollars. Figure 27 indicates how popular green and social bond issuance is amongst European cities and regions. Cities and regions tend to issue bonds in their local currency (most of the city and regional bonds issued by Swedish entities in Figure 27 are denominated in SEK). There are fewer US dollar denominated city and regional green bonds (Figure 28), but this is partly because we have excluded green US municipal bonds from our analysis here.

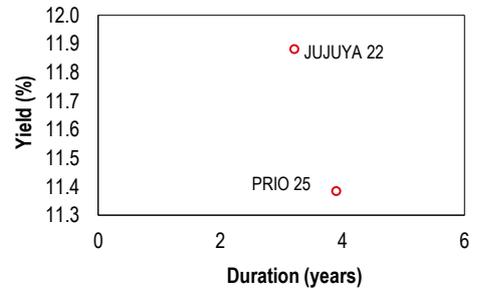
Figures 29 and 30 display green, social and sustainability bond issued by real estate firms in Euros and US dollars. We see that there is a more equal division of real estate bonds between Euros and US dollars. Some of the US dollar denominated real estate green bonds were issued by Chinese companies, including Modern Land and Landsea Green Group.

27. EUR green, social and sustainability bonds issued by cities/regions



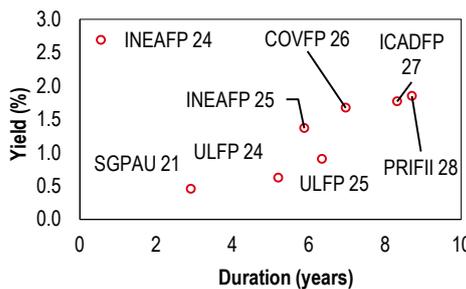
Source: HSBC calculations, Bloomberg

28. USD green, social and sustainability bonds issued by cities/regions



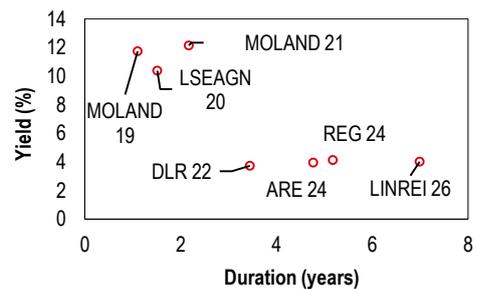
Source: HSBC calculations, Bloomberg

29. EUR denominated bonds issued by real estate firms



Source: HSBC calculations, Bloomberg

30. USD denominated bonds issued by real estate firms



Source: HSBC calculations, Bloomberg

Here we discuss some green and sustainability bonds from cities/regions and property firms.

City/regional green, social and sustainability bonds

Auckland

Auckland Council [AUCKCN] (Aa2/AA) issued a NZD200m 3.17% five year green bond. Proceeds will fund electric trains and associated infrastructure²⁹.

While over ten green bonds are denominated in New Zealand dollars, Auckland is only the second body entity based in New Zealand to issue a green bond (after Contact Energy, the New Zealand electric utility with four green bonds denominated in NZD).

City of Toronto

The City of Toronto [TRNT] (Aa1/NR) in July 2018 issued a CAD300m 3.2% 30-year green bond. The Toronto green bond was issued to fund 'core and supporting infrastructure for sustainable and clean transportation'³⁰. Toronto was the second Canadian city after the City of Ottawa to issue a green bond, a CAD102m green bond in November 2017.

Province of Québec

On 22 February 2018 the Province of Québec [Q] (Aa2/AA-) issued a CAD500m 2.45% five year green bond, maturing on 1 March 2023. The use of proceeds will fund: public transit; energy efficiency; renewable energy; sustainable waste management, sustainable land development; water management; land management; climate adaptation and resilience.

Region of Ile-de-France

The French region of Ile-de-France [IDF] (Aa2Pos/NR) has issued five sustainability bonds since 2012, the most recent being the EUR500m 1.375% of March 2029. This bond's proceeds was used up in the following way: 48.1% was allocated to public and sustainable transport, 20.6% to buildings and facilities for education and leisure, 13.8% for social housing, 8.7% for economic and socially inclusive development, 4.3% for biodiversity, 2.7% for renewable energy and energy efficiency and 1.8% for social initiatives aimed at helping vulnerable populations.

Private sector property green, social and sustainability bonds

Prologis

Prologis International Fund II [PRIFII] (A3/A-), the funding arm of global real estate logistics firm Prologis, issued the EUR300m 1.75% of March 2028 green bond on 1 March 2018. Prologis is a US global logistics or warehouse REIT. Prologis operates in 19 countries, owning or managing around 700m ft² of logistics space. The firm leases distribution facilities to business to business and retail customers.

Prologis includes three categories in its eligibility criteria: i) green buildings ii) renewable energy, and iii) energy efficiency. For the green bond proceeds to be spent on green buildings, the new, existing or refurbished building must have received at least one of the following classifications: LEED (Leadership in Energy and Environmental Design) platinum, gold or silver: DNGB; platinum, gold or silver: BREEAM, outstanding, excellent, very good or good: HQE, exceptional, excellent, very good and good: CASBEE (S, A or B+).

²⁹ 'Green bond issue a success with USD200m raised for electric trains', Our Auckland, Auckland Council, 27 June 2018.

³⁰ 'Toronto goes green, raises CAD300m and saves on interest by doing so', Financial Post, 18 July 2018.

Moody's on 21 March 2018 published a report arguing that the fact Prologis issued a green bond framework was credit positive for Prologis. Moody's argued the green bond framework helps to: "attract and retain tenants who are increasingly focused on environmental issues".

Unibail-Rodamco

Unibail-Rodamco issued two green bonds in 2014 and 2015, the EUR750m 2.5% of 2024 and the EUR500m 1.00% of 2025. The proceeds of the bond will be used to help finance the building of shopping centres or offices that meet its sustainability criteria. The criteria have been approved by sustainability analysts Vigeo³¹.

Modern Land

Modern Land is a Chinese property developer focused on energy-saving residential buildings. Throughout 2017, Modern Land's land banking focused more on third and fourth tier cities in China, such as Quanzhou and Wuxi. Our credit colleagues in Hong Kong expect it to continue to be tough for Modern Land due to their small scale, making it difficult for them to compete in first and second tier cities (*The View: Asia's Bond Markets*, December 2017). Modern Land set up separate US operations in 2015, based in Houston. The group does not have a policy to hedge its FX exposure.

Fannie Mae

We normally exclude Fannie Mae's green bonds from our data analysis for a number of reasons³². Nevertheless it is significant that in 2017 Fannie Mae sold USD27.6bn of multi-family green mortgage-backed securities (MBS), up from USD3.6bn in 2016. Fannie Mae issued USD67bn of multi-family MBS in 2017, of which USD27.6bn was green.

Multi-family occupancy involves a large block that is owned by a company, where the flats are rented out separately. So with multi-family, the borrower is the company that buys the whole block. That borrower receives rent from families and individuals renting the flats.

Mitigating credit risk

The optimal project is most likely to aid the city and provide appropriate benefits, without imposing an excessive financial burden. We think the optimal project will be

- ▶ designed at the local level; as opposed to being a 'top down' solution
- ▶ cognisant of the knock on impacts of project
- ▶ organised by entities with appropriate spending powers

Footfall in many city centres is down

One should also be cognisant of the fact that urban living and shopping patterns are changing very rapidly. Valuations in particular on retail related property can fall rapidly, especially given the switch we are seeing in shopping from in-store to on line.

Transport for London (TfL) issued a green bond, the GBP400m 2.125% of April 2025 bond, on 16 April 2015. We note press reports suggesting TfL will make an operating loss in the financial year 2018/19 of 'almost GBP1bn', up from an operating loss of GBP784m in 2017-18. The deteriorating finances are being blamed on a withdrawal of its central government grant, set to end in 2018/19, and an unexpected drop in ridership. The ridership fall was not expected, given that the economy is growing, but it could be due to a rise in home working, on-line shopping, more young people living within central and urban areas of London requiring a shorter commute and a rise in Uber use instead of public transport.

³¹ 'Unibail-Rodamco's EUR750m green bond 'could be first of many'', Environmental Finance, 21 February 2014.

³² Fannie Mae reports on these bonds on a lagged basis; does not provide a second party opinion for most of these bonds, and these bonds fund both work to make buildings green and to buy the buildings.

Green bond issuers might be hit by climate change

Another factor to bear in mind is that some issuers of green bonds to combat climate change, might themselves be overrun by climate change. The situation regarding the Cape Town green bond is worth discussing in this regard. The City of Cape Town (Baa3Rfd/NR) in July 2017 issued a ten year, local currency green bond, the ZAR1bn 10.17% of 17 July 2027 bond, equivalent to USD76m. Over 90% of the bond proceeds go to water projects, including water capture, storage, treatment and distribution. But when Cape Town suffered from a severe drought, Moody's on 29 January 2018 published a note 'Cape Town...water supply crisis is credit negative'. Tourism and agriculture may be hit, impacting city revenues.

Disclosure appendix

Analyst Certification

The following analyst(s), economist(s), or strategist(s) who is(are) primarily responsible for this report, including any analyst(s) whose name(s) appear(s) as author of an individual section or sections of the report and any analyst(s) named as the covering analyst(s) of a subsidiary company in a sum-of-the-parts valuation certifies(y) that the opinion(s) on the subject security(ies) or issuer(s), any views or forecasts expressed in the section(s) of which such individual(s) is(are) named as author(s), and any other views or forecasts expressed herein, including any views expressed on the back page of the research report, accurately reflect their personal view(s) and that no part of their compensation was, is or will be directly or indirectly related to the specific recommendation(s) or views contained in this research report: James Pomeroy, Davey Jose, Ashim Paun, Michael Ridley and Peter Barnshaw

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