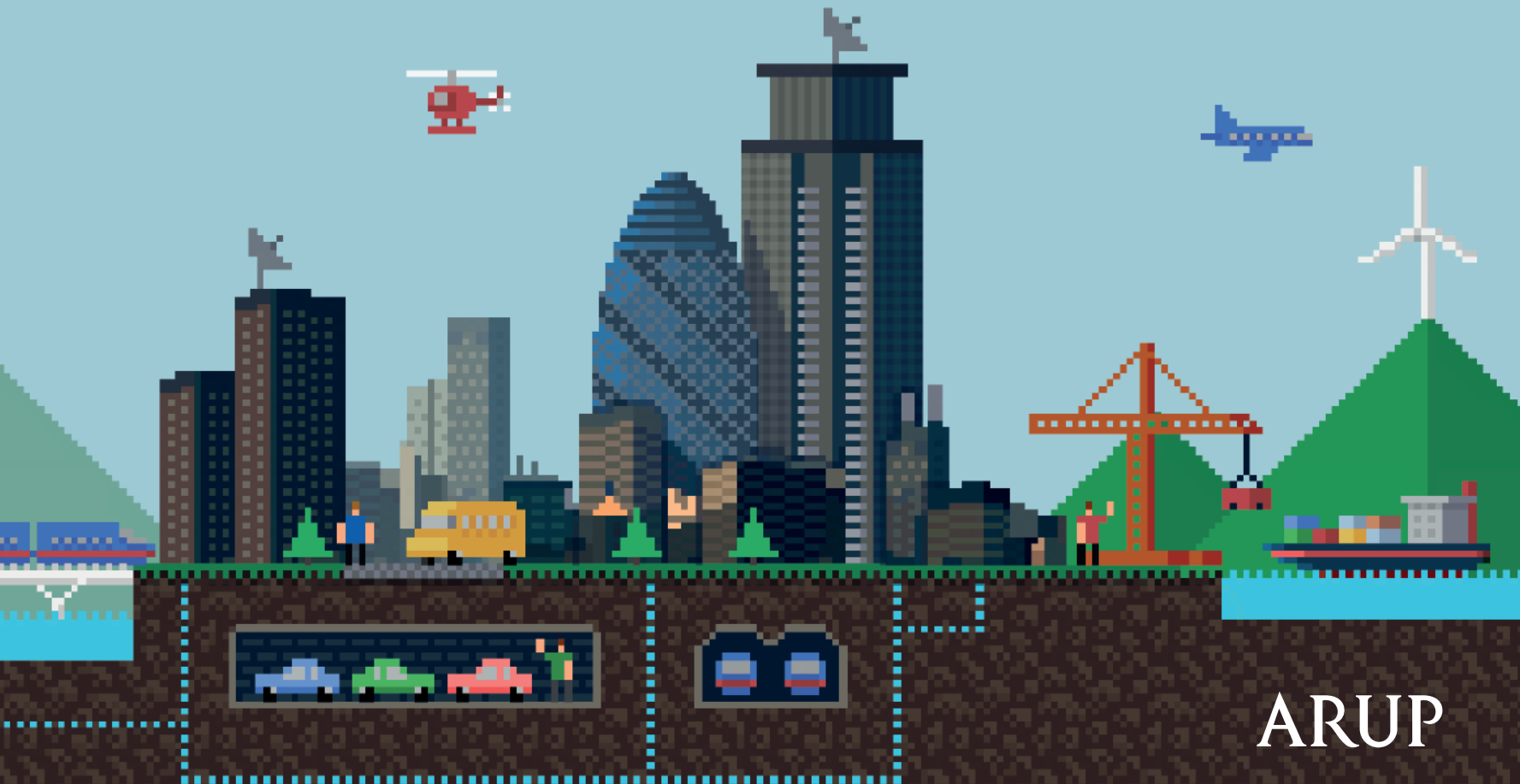




# cities

*How do we respond to the pressures they face?*



ARUP

# Cities



As the world's population urbanises, cities are becoming increasingly important. Yet urban centres across the globe face more pressures than ever before.

Some of these come from natural disasters and other acute shocks and chronic stresses. This edition of A<sup>2</sup> looks at how cities can learn to become resilient in the face of such threats. Conversely, we also take a closer look at the role of nature in making a city healthy and successful, and in bringing it alive.

Putting people at the heart of the cities is the theme of several of our stories. We discuss whether cities should be designed for our senses – to create places that make us feel healthier, happier and safer. And we ask whether cutting the number of cars in cities would make them better places for people.

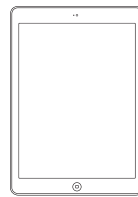
This edition also addresses the tricky issue of accommodating all the people who now wish to live in cities like London. It looks at whether the UK's capital should be allowed to grow – and if so, how. It also investigates whether revitalised town centres could help meet a chronic shortfall of homes.

Finally, we see how iconic buildings can make a city, and look at the role of major events like the Olympics in sparking regeneration.

As ever, I hope you enjoy reading this edition and find the content valuable. If you have any thoughts, questions or comments, we'd love to hear from you at [a2@arup.com](mailto:a2@arup.com).

**Alan Belfield**  
Arup Group

- 03 News
- 06 Becoming resilient
- 08 Should world cities be allowed to grow?
- 12 Addressing the UK's housing crisis
- 14 Step by step
- 16 Fewer cars, better cities
- 18 Sense and the city
- 20 A sporting chance
- 22 Icons
- 25 Rethinking green infrastructure



#### iPad Version

A<sup>2</sup> can now be downloaded to your iPad. The digital edition contains additional interactive features. Go to Apple App Store to download your free copy.



A<sup>2</sup> magazine is a publication produced by Arup for our clients and reflects our mission to shape a better world.

For more information on any of the topics featured in this magazine, please visit [www.arup.com](http://www.arup.com) or email [a2@arup.com](mailto:a2@arup.com)

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# A vision of the future of rail

## New report highlights impact of climate change action

A report created with the C40 Cities Climate Leadership Group and Arup shows cities could curb 13GtCO<sub>2</sub>e in greenhouse gas emissions by 2050.

The Global Aggregation of City Climate Commitments report says that some 228 global cities, representing 436 million people, have already set goals for reducing greenhouse gas emissions.

Paula Kirk, Arup's Energy and Climate Change Leader, led the firm's work on the report, comments: "C40 cities alone have doubled climate action just in the last two years. Clearly, there is momentum for change."

Arup Group Chairman Gregory Hodkinson attended the UN Climate Summit in New York, where the report was launched. "I believe the world can do better. This is why I want Arup to be an agent for change, helping to create the standards we need to deliver a healthier, wealthier and more secure future for all."

The report was produced in partnership with ICLEI-Local Governments for Sustainability, United Cities and Local Governments, UN Habitat, the UN Secretary-General's Special Envoy for Cities and Climate Change and the World Resources Institute.

1 The Future of Rail 2050

2 North Sea oil report



Arup's Future of Rail 2050 report unveils a vision of the future of rail travel in light of trends such as urban population growth, climate change and emerging technologies.

It foresees:

- Predictive maintenance of rail lines by robot drones
- Driverless trains travelling safely at high speed
- Freight delivered automatically to its destination
- Ticketless travel through smart technology

Colin Stewart, Arup's Global Rail Leader, predicts a bright future: "By rapidly developing technology and taking bold steps to overcome capacity and cost challenges, the rail renaissance can deliver a future where it is the backbone of our travel system."

Arup used developments from current rail projects the firm is leading around the world, as well as insight from the Arup Foresight + Research + Innovation team and global contributors, to inform the futuristic predictions outlined in the report.



## Report reveals scale of decommissioning market for North Sea oil and gas projects

By 2040, investment of around £30 billion is expected in the UK Continental Shelf (UKCS) for decommissioning North Sea oil and gas projects – according to a new report prepared by Arup, which was commissioned by Decom North Sea and Scottish Enterprise.

Clare Lavelle, Arup's Scottish Energy Consulting Lead says: "To take full advantage of this opportunity, the industry must build on its existing capacity and capability to service the complex and demanding nature of decommissioning work in the North Sea."

The report highlights a number of key areas for industry to consider, including attracting talent, innovation, and contracting and procurement strategies.

Nigel Jenkins, Chief Executive, Decom North Sea comments: "This report provides an invaluable insight into the potential resource constraints and will be a significant benefit to our members and stakeholders."





## Refurbished Victoria Theatre and Concert Hall opens after four years

The 152-year-old Victoria Theatre and Concert Hall in Singapore reopened its doors on 15 July with a concert by the Singapore Symphony Orchestra. It was the first official event to be held since the national monument closed for refurbishment in 2000.

Refurbishment work centred on improving the public and back-of-house spaces to bring them up to modern, professional standards, whilst still respecting the heritage of the venue. Arup played a key role in the restoration by developing the overall brief for the project, and implementing this with the design team.

Arup's acousticians worked closely with W Architects to improve the acoustics of the Concert Hall. The new theatre is more efficient technically and more flexible for performers, thanks to the input from our theatre consulting team. Our environmentally sustainable design consultants made the building more energy efficient. And our fire engineers carefully designed evacuation routes to fit around beloved elements of this historic building.



## Gold Coast light rail opens

Stage one of the AU\$1 billion Gold Coast light rail system was opened to the public on Sunday 20 July.

The 13km system links key activity areas along the Gold Coast from Parklands to Broadbeach with 15 at-grade stations and one underground station.

Working for the GoldLinQ consortium, Arup was the lead design consultant for stage one of the project, providing detailed design and construction phase services.

Sarah McIntosh, Arup Project Manager, comments: "It was a technically difficult project because the site was constrained by nearby properties and infrastructure, and because the ground conditions were challenging. We designed an innovative embedded trackform solution, integrating the road and light rail environments – a first for Queensland – while ensuring safety was at the forefront of the design."

Arup is also working on light rail projects in the Sunshine Coast, Sydney and Canberra.

## London needs radical change to meet its infrastructure needs

A report from the Greater London Authority (GLA) published in July revealed the capital's strategic infrastructure investment requirements to 2050.

Written with expert help from Arup, London Infrastructure Plan 2050 – A Consultation spells out the infrastructure London needs over the next thirty-five years if it is to cope with a growing population.

Housing and transport represent nearly four-fifths of the investment needed by 2050. They are estimated to have a funding gap of almost £135 billion.

The infrastructure plan envisages the construction of 49,000 new homes a year plus an 80% increase in rail capacity. It also details measures to tackle the energy, green infrastructure and digital connectivity needs of the city.

With an increasing school age population more than 600 new schools and colleges will be needed.

A consultation on the London Infrastructure Plan 2050 will run for three months and the Mayor is expected to publish a final report in early 2015.



## Tristram Carfrae presented with IStructE Gold Medal

Arup Fellow Tristram Carfrae has been presented with the prestigious Gold Medal award by the Institution of Structural Engineers (IStructE).

The award recognises Carfrae's exceptional contribution to the science and structural engineering professions.

He has designed remarkable structures all over the world, including the Beijing 2008 Olympics 'Water Cube', the Helix Bridge in Singapore, and the City of Manchester Stadium.

In the process, he has worked with some of the greatest names in architecture and design, including Renzo Piano, Richard Rogers, Phillip Cox and Thomas Heatherwick.

Nick Russell, President of The Institution of Structural Engineers, comments: "We are delighted to present Tristram with our Gold Medal in recognition of his remarkable career and the outstanding work he does to advance the science of structural engineering."

The Institution of Structural Engineers is the world's largest membership organisation dedicated to the art and science of structural engineering.



# Volunteers build bridge in Panama



A team of nine Arup volunteers has travelled to Panama to build a bridge that will connect the villages of Arriba, Teria Nacimiento and El Caracoral.

The suspension footbridge will be eight metres high and span 46 metres across the river Ciricito. Currently the river floods for four months of the year and cannot be crossed safely, so the bridge will provide vital access to local schools, markets and medical facilities.

Arup is working on the project with not-for-profit organisation Bridges to Prosperity (B2P).

The project will use Arup's BridgeTOOL software, a design and learning resource that enables the rapid design of pedestrian suspension bridges in developing countries.

BridgeTOOL can run on any laptop and requires no specialist knowledge of design software. It also advises on choosing materials, structure and safety while acting as a learning resource to inform, teach and train engineers in isolated rural communities.

3 Victoria Theatre and Concert Hall, Singapore

4 Gold Coast light rail, Gold Coast

5 Tristram Carfrae

6 Volunteers and local children in Ciricito, Panama

7 Singapore Sports Hub

8 Sir David Attenborough



## Singapore Sports Hub opens its doors

Over 50,000 people celebrated the opening of the new Singapore Sports Hub with a fireworks extravaganza, a record-breaking mega-concert and a two-day open house event over 28 and 29 June.

The opening event saw two new Guinness World Records – for the largest Chinese drum ensemble and the largest-ever Chinese orchestra performance.

Designed by Arup, the 55,000-seat stadium is the first in the world custom-

designed to host athletics, football, rugby and cricket all in one venue – converting from one mode to another within 48 hours.

The stadium also gives spectators breath-taking views of both the waterfront and the city. “For us, connecting the stadium back to the city was an important consideration,” says Clive Lewis, Arup's Lead Sports Venue Designer.

“The open design allows the stadium to metaphorically ‘talk’ to the city.”



## World-class facility to lead biological sciences research opens

The new £56.5 million Life Science building at the University of Bristol was opened in October by renowned broadcaster and naturalist Sir David Attenborough.

Arup was instrumental in the mechanical and electrical engineering strategies for the building, as well as working closely with the on-site contractor to provide technical advice.

Designed to achieve the environmental accreditation BREEAM Excellent, the project showcases the best in sustainable design and energy efficiency.

Arup Project Director John Peacock commented: “It was tremendously rewarding to work with a client so committed to reducing the environmental impact of the construction, operation and demolition stages of the project to a practical minimum.”

Heat from the laboratories' ventilation systems is reclaimed and re-used; rainwater collected from the roof is used to flush the toilets; blinds lower automatically when the sun shines and the lighting has been designed to avoid polluting the night sky.



# Becoming resilient

Michael Berkowitz, President of 100 Resilient Cities, on how cities can adapt to withstand, and grow, from acute shocks and chronic stresses



“Urban resilience has never been so important,” says Berkowitz. “By 2050, it’s predicted that three out of every four people will live in cities. And these cities are increasingly exposed to acute shocks, such as natural disasters or terrorist attacks, as well as chronic stresses such as shortages of food, water or energy.”

Pioneered by the Rockefeller Foundation, 100RC takes a broad view of resilience – as Berkowitz explains: “For us, resilience includes emergency response but also embraces elements such as cohesive communities, good stewardship of infrastructure and the natural environment, and strong leadership.”

This contrasts with the more disaster-focused view of resilience taken by organisations such as the United Nations Office for Disaster Risk Reduction (ISDR). “Disaster response is very important,” says Berkowitz, “But we’re taking a more holistic view of how cities can strengthen themselves against day-to-day stresses as well as exceptional events.

“For example, the epidemic of crime and violence suffered by Medellin in Columbia during the 1980s and 90s threatened its very existence. And Detroit in the United States was almost wiped off the map not by an earthquake or a hurricane but by its dependence on the automobile industry.”

To help cities become resilient to both shocks and stresses, 100RC has four interventions. It hires chief resilience officers for cities to help them coordinate their efforts with stakeholders and lead

*For us, resilience includes emergency response but also embraces elements such as cohesive communities, good stewardship of infrastructure and the natural environment, and strong leadership.*

the resilience building process. It also offers cities expert support to help them develop robust resilient strategies, as well as access to organisations that can help with implementation. And cities chosen to work with 100RC are connected in a network so they can learn from and help each other.

This cooperation is something that Berkowitz believes is vital: “Too often cities try to reinvent solutions instead of using the existing knowledge that’s out there. There are a few reasons why they do this. They take pride in ownership and they want homemade ideas. And it can be difficult for them to find the right options. That’s why we’re helping funders, thought leaders, technical assistance providers and technologists to scale their solutions so they fit cities more effectively and efficiently.”

Crucially, says Berkowitz, cities need a framework through which to consider resilience. “Having a framework takes away guesswork about what the hazard is,” he explains. “You don’t have to think about whether your city might be more vulnerable to blackouts or earthquakes or hurricanes or terrorism or something else. If you strengthen your city using the framework, you’ll be better prepared to survive whatever happens.”

100RC uses the City Resilience Framework and accompanying City Resilience Index developed by Arup and supported by the Rockefeller Foundation. “These are two really important tools that our cities will use to help them understand where they’re strong and where they’re weak, and which actions they should prioritise to become more resilient,” says Berkowitz.

He explains that Arup will also help 100RC work with cities around the world: “With its broad footprint, its depth of knowledge in resilience, and its fluency in working in cities, Arup has already proved to be a very useful partner in some of our cities and we look forward to that partnership continuing.”

100RC is already working with 32 cities around the world and will announce its second cohort of successful applicants at an event in Singapore on 3 December.



# Should world cities be allowed to grow?

We look at London as an example of where some radical changes may be required

Cities across the world are grappling with increasing populations. New York has recently reached a record high of 8.4 million. Since 2010, Hong Kong has grown by almost a quarter of a million people. Even in Japan, which has a falling headcount, greater Tokyo surged by nearly 100,000 in 2013. And in January 2015, London's population will reach its highest ever level.

Policy-makers are wrestling with the question of how best to manage this growth and find the money for infrastructure to sustain it. The impact of hundreds of thousands of additional citizens in major cities every year could potentially be messy and harmful. It could lead to a reduction in their quality of life. Handled wisely, population growth can propel world cities such as London into exciting and positive new phases. But to continue to succeed, radical changes will be required.

London is about to eclipse its historical pre-war high of 8.6m citizens. By 2050, that number is set to rise to between 9.5m and 13.5m. This isn't a trend that looks set to reverse any time soon.

"The principal driver of population growth in London is now births," says Alexander Jan, a director with Arup and advisor to the Mayor's infrastructure delivery board. "Official data for the year

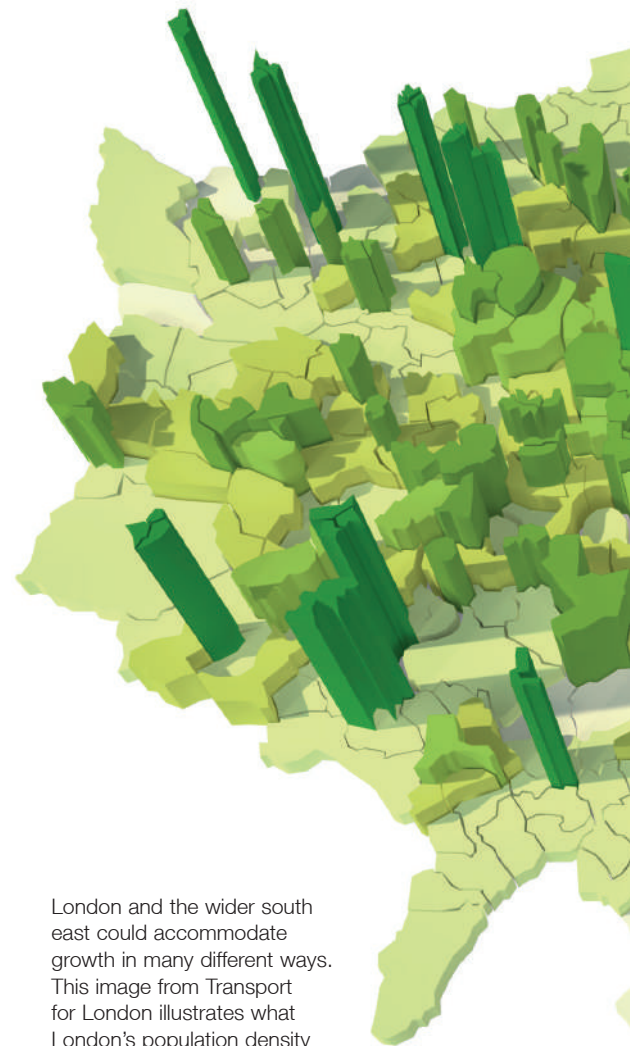
to June 2012 indicate that 80% of London's 114,000 population increase was driven by natural change (births minus deaths). With so much growth driven by sources other than immigration, population growth looks locked in for the future."

This has implications for politicians and policy-makers. "It means the most important question is not whether London should be allowed to grow," says Neil Keogh, Consultant who worked on a long term infrastructure plan for London, "because the growth looks unstoppable. The question is how we should respond to the arrival of three million more Londoners."

But would catering for increases in London's population make the city more attractive – thereby boosting its population even further? As Professor Tony Travers at LSE London has noted, "London is like a dark star. It attracts more infrastructure and investment which then increases the strength of its gravitational pull."

One option is to stymie growth by not intervening. But Jan argues this is politically hazardous. "An implicit policy of encouraging people to leave London by allowing congestion and the cost of living to increase is, to say the least, problematic. A dirtier, more expensive city might indeed encourage some people to get out. But the chances are they will be the very people the city needs most – teachers, hi-tech entrepreneurs, nurses or engineers." No mayor is likely to pursue such an approach.

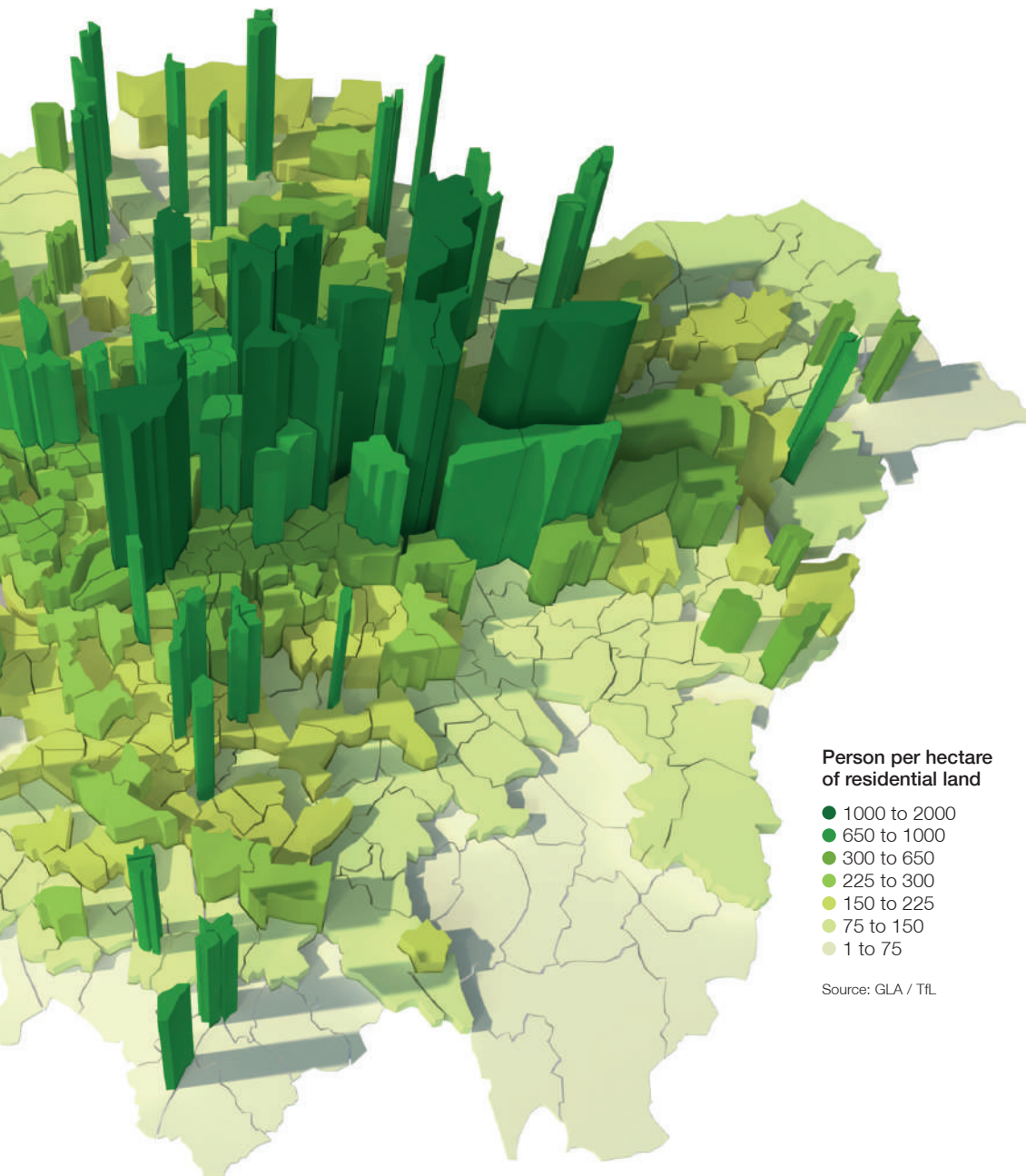
An ever-more expensive London



London and the wider south east could accommodate growth in many different ways. This image from Transport for London illustrates what London's population density might look like if development was focused in town centres.



Source: Greater London Authority; GLA Economics



Source: GLA / TIL

*Official data for the year to June 2012 indicate that 80% of London's 114,000 population increase was driven by natural change (births minus deaths).*

suffering from chronic housing and transport shortages could undermine many attributes of the city. London's squares, parks and historic buildings are amongst the assets its residents, visitors and commuters hold dear. Rising costs could also threaten the social mix of the city, something that is rising up the political agenda in New York as well as in London.

If a do-nothing approach looks difficult, what are the alternatives? "We could encourage or instruct people to leave London – or indeed not to join the city's ranks," says Keogh. "This approach is hugely problematic and it's been proven to be unsuccessful in the long term."

Shifting people out to lower density developments is now seen as 'ungreen'. People living outside large cities typically rely more on cars. And it's more expensive to provide public transport to smaller developments. By contrast, Londoners own fewer cars and use public transport more often than anywhere else in the UK. Tim Chapman, a director at Arup and an infrastructure expert, agrees. "London moves by rail like nowhere else in the UK. Almost 80% of UK rail journeys start or end in London, even though Londoners only make up 14% of the country's population."

“Today, the received wisdom is that labour markets work better when they are ‘deep’,” says Jan. “Firms crammed together are able to draw on a rich supply of skills and labour and benefit from economies of scale. This was one of the key elements in making the case for Crossrail, a new east to west rail link for London.

**Plan for it?**

So it looks as though London will have to plan for population growth, and embrace some big schemes – an approach that’s not without risks.

During the 1960s and 1970s, plans for a third London airport ended in acrimony and disarray. Major road schemes were half-built and then abandoned. Redevelopment plans for the Barbican, Covent Garden and parts of the West End met with fierce resistance and were ultimately ditched. State housing provision has at best delivered mixed results.

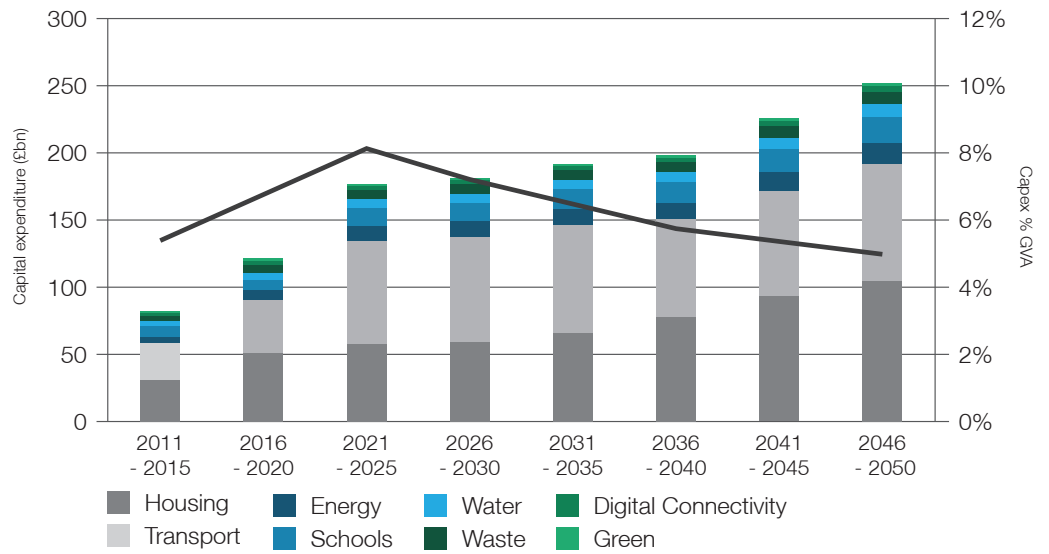
But there have also been successes. The Olympic legacy has transformed a large swathe of East London. King’s Cross St Pancras is now developing into a thriving hub of transport, hi-tech businesses, education, housing and retail development. Over 100,000 people now work at Canary Wharf. Iconic buildings such as 30 St Mary Axe have risen up from the City of London’s streets. An expanded tube network, Crossrail and Thameslink schemes are underpinning the success of the city.

**Yes, but whose backyard?**

London’s leaders are now facing two major challenges, says Jan. “The first is where to put the infrastructure that’s required to support a burgeoning population. And the second is how to pay for it.”

He explains that the prevailing view appears to be that projected growth can and should be provided for within the boundaries of London (roughly the M25).

*London moves by rail like nowhere else in the UK. Almost 80% of UK rail journeys start or end in London, even though Londoners only make up 14% of the country’s population.*



Projected capital expenditure (including enhancements and renewals) by five year period, 2016-2050, and projected capital requirements as a percentage of estimated GVA (£ billion). 2014 prices, including a 2% per annum underlying increase in construction costs. Source: Arup analysis

As Travers puts it: “It cannot be a solution to the demand for housing in thriving places like London to move people even further out in search of cheaper places to live.” He adds, “London is not a high-density city by international standards. If London as a whole had the same density as the borough of Islington, it would be able to accommodate 21 million people – more than double London’s population today.”

The Mayor of London’s latest plan envisages accommodating the next million Londoners almost entirely on previously developed (brownfield) sites. That would buy around ten years’ worth of population growth, Jan and Keogh estimate. Looking further out, increasing density – particularly in several of London’s town centres – could allow the city to meet its central forecast of more than 11 million people by 2050.

Higher density brings benefits, adds Travers. “It can sustain businesses and services such as transport which would otherwise not exist. It adds to the liveliness of a city. It is no accident that the markets of Brick Lane, Petticoat Lane and Spitalfields are located in areas that were historically densely populated.”

Without some increase in supply, neighbourhoods and business districts risk being overwhelmed. Jan agrees. “Pressure on residential and office prices can squeeze out the activities and variety that residents, civic leaders and visitors hold dear. Soho and other parts of the West End are perhaps under the greatest threat from rising real estate prices.”

Jan points out that densification of London’s outer areas, as mooted in the Mayor of London’s latest thinking, is not for everyone. While Newham, Tower Hamlets, Southwark and Lambeth welcome growth and the opportunities it affords, boroughs such as Bromley, Sutton and Richmond may struggle to convince residents of the merits of growth within their boundaries.

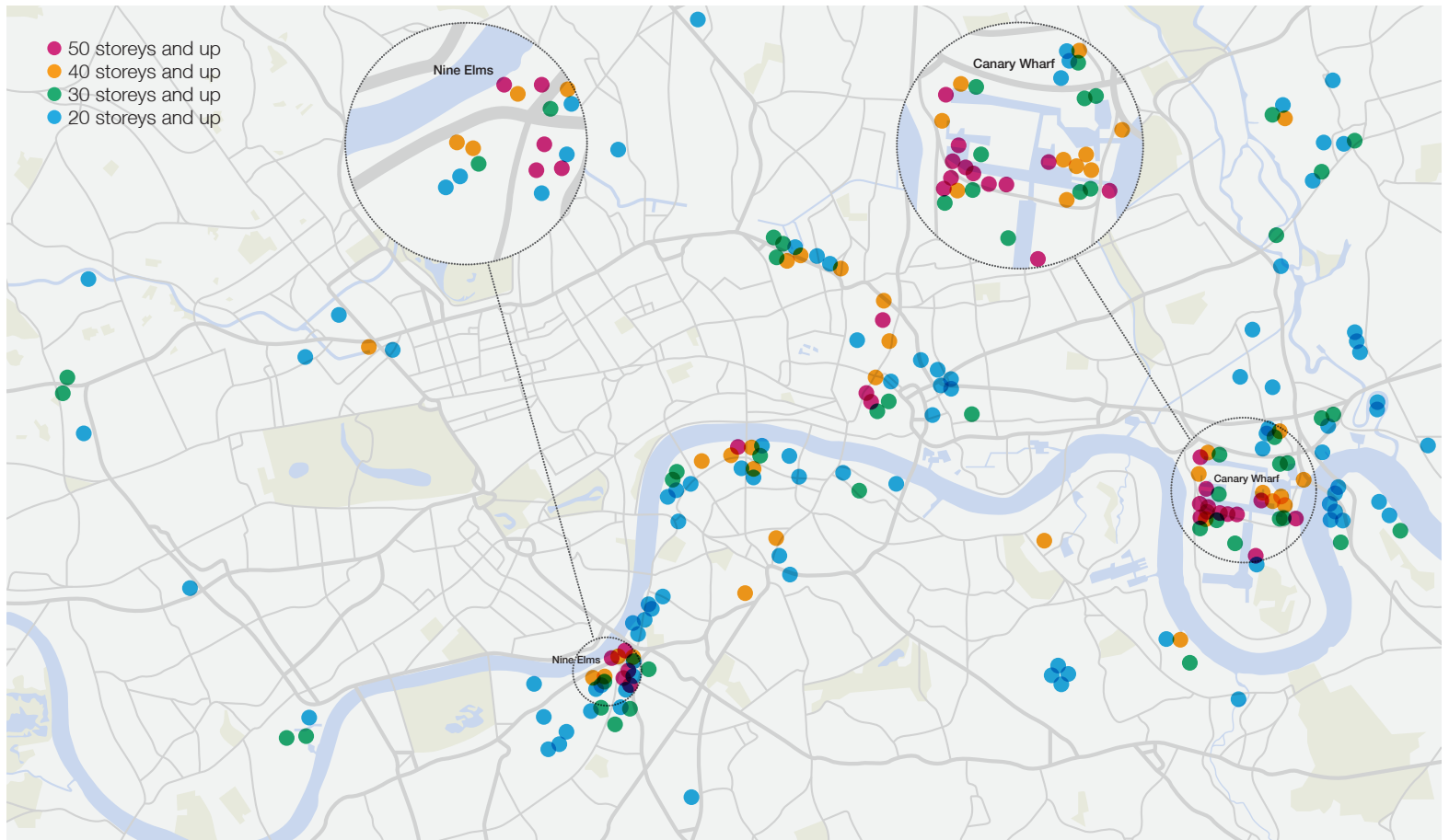
According to New London Architecture, a think tank, there are more than 230 tall buildings planned or on the drawing board for London. Some of them are slated for outer London. If even half of them were to be built, that would have lasting impact on the city’s skyline and urban form.

Travers believes local authorities need greater powers to deal with the potentially adverse effects of construction and to manage the impact of densification. “Residents will typically oppose any development because they have no faith that the system will protect their quality of life,” he says. “But if there was a fine every time the road was wrongly dug up or noisy building works overran, that would soon focus minds.”

**How much did you say?**

Jan believes policy needs to go further than containing the impact of growth. “There needs to be something tangible and valuable that residents in particular can point to,” he says. “Developers often stump up for social housing, new sports centres, resurfaced roads and new green spaces





Map and data from New London Architecture (NLA) and GL Hearn, showing proposals for tall buildings over 20 storeys in Greater London (April 2014)

through planning gain (negotiated as a Community Infrastructure Levy or ‘Section 106’ agreements). But the combined impact of these initiatives is modest compared to the scale of investment required to cope with large-scale housing and infrastructure for 11 million people.” Paradoxically, by heaping demand for public goods on to new sites, developments risk being more bulky – to be able to pay their way. That in turn can increase local opposition to them.

So paying for London’s new infrastructure and renewing what it already has presents perhaps the greatest challenge for city leaders. Analysis by Arup for the Greater London Authority suggests that some £1,300 billion will be required to build and renew infrastructure by 2050.

New projects account for four-fifths of that figure. And it would mean more than doubling the proportion of London’s economic output that’s spent on capital projects.

Housing is probably the most challenging area. The Mayor’s plan calls for an extra 1.5 million homes (over £500 billion) with a build rate of around fifty thousand per

annum - twice the rate being achieved at present. Then there is transport investment (£460 billion). This would buy a fifty percent increase in public transport capacity and a number of major road schemes and more runways. In other sectors, there will also be a call for resources. With a cost of just under £150 billion, a twenty percent increase in energy supply for London will be needed, equivalent to as much as five percent of total peak power capacity for England and Wales. 40 new waste facilities might need to be constructed (£14 billion) alongside an extra 9,000 hectares of accessible green space that can also deliver sustainable drainage and other environmental benefits (£22 billion).

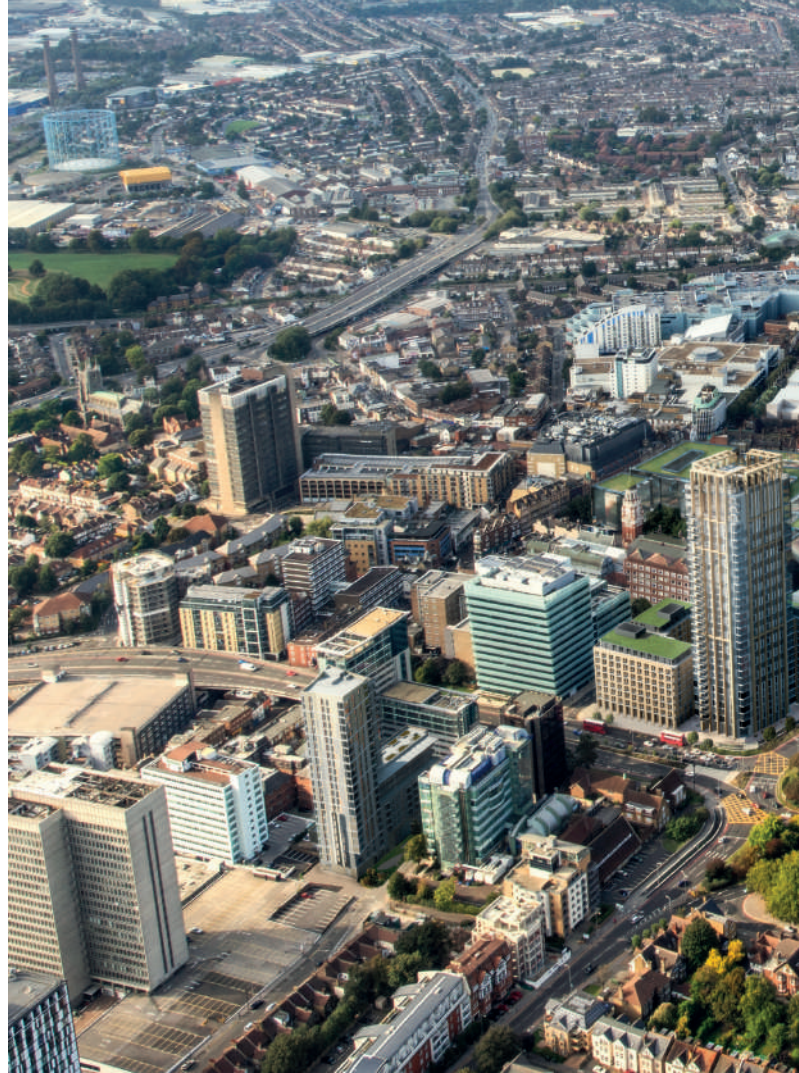
The list is long and the gap not insignificant. Arup estimates that the shortfall between projected future public sector costs and income sources in the housing and transport sectors could be £135 billion. All this presents a generational challenge for city leaders. Decisions they make now will shape the London of 50 years’ time.

To Jan and Keogh it’s clear that radical

change will be required. To gain support from London’s residents, local councils will need to become closely connected in financial terms with the success of their parts of the London economy. Transfers of power and resources from Whitehall to local government will be needed. That would improve accountability and decision making. Local authorities should be allowed much greater freedoms to tap debt markets – such as raising bond finance – within so called prudential borrowing limits. This could be matched by allowing city authorities to retain property taxes as recommended by the Independent London Finance Commission. Ultimately, a greater proportion of public and private consumption will need to shift to capital investment. “To deliver so much infrastructure efficiently, an Olympic-style effort in financing, delivery and renewal is needed,” says Jan. “London is running in a competitive race with other world cities such as New York. To accommodate growth successfully it needs to prepare for an infrastructure marathon.”

# Addressing the UK's housing crisis

How revitalised town centres can meet a shortfall of homes



There is currently great interest in the Garden City concept of urban planning, coupled with a renewed drive to develop new settlements to help tackle the UK housing crisis. Is this the right approach? Jerome Frost, leader of Arup's Global Planning business, believes the answer lies in existing towns.

"The image conjured up by recent studies and narratives," says Frost, "is one of completed towns on virgin land, with the right balance between housing, jobs, shopping, open space and leisure, and with happy residents and thriving businesses. What they ignore is the lengthy process of development and the evolutionary nature of city building that means the final form rarely matches the original designer's idea."

Frost points out that even the original Garden Cities of Letchworth and Welwyn took almost 70 years to reach critical mass and that they were expanded and added to several times in their 100-year lives. Both experienced changes to concept and needed additional investment in the post-war era. Today they house 34,000 and 42,000 people respectively.

"That's not to say they aren't great concepts," he acknowledges. "Residents of both enjoy where they live and are fiercely proud of their unique environments. So the Government's eagerness to press on with developing Garden Cities at Ebbsfleet and Northstowe is to be commended. However, these new communities will not solve the immediate housing crisis alone."

He points out that, even if the UK were to build these new settlements at three times the speed of their historical comparators, it would take the equivalent of 50 Letchworths to meet the 750,000 homes needed over the next 10 years. Something more radical is needed, says Frost.

## Applying the Garden City ethos to existing towns

"The recent Wolfson Prize winners are to be applauded for an eminently sensible concept of capitalising on existing infrastructure to underpin growth. However, with constraints on finance and resources surely the solution is not further expansion of the edges of our cities and towns."

Expansion, says Frost, risks environmental damage and over-reliance on the provision of new costly infrastructure. And in the face of significant public opposition, it may not

be possible to deliver it at the pace needed to address the crisis. He points out that expansion on the greenfield edge has, to date, always been too politically charged to make a major contribution.

Instead, Frost argues, crisis-busting housing growth must surely come from revitalising the post-war town and city centres that have seen little investment since the last great wave of shopping centre and commercial development in the 1970s and 80s: "A new impetus for growth must surely focus on places such as Hertford, Harlow, Aylesbury and Stevenage, where the redevelopment potential of the centre can offer significant housing provision and address the need for a post-Amazon response to the future of the town centre.

"By increasing the density of the centre, reintroducing streets, squares and landscape coupled with the introduction of a substantial quantum of new housing within, above and adjacent to the retail and commercial core, planners and developers can tackle the housing crisis whilst also bringing about the resurgence of the high street. All this could be built on the back of existing rail, road, power and communication infrastructure – far cheaper and more efficient than new town





### An integrated delivery programme for Croydon

Croydon could be an ideal candidate for an approach based on renewing town centres. Arup has created an Integrated Delivery Programme for the London Borough of Croydon that underpins its innovative approach to realising the town's transformative ambitions.

Planners in Croydon are already proposing a £5 billion regeneration programme including 7,500 homes in the next five years, a new Westfield/Hammerson shopping centre and growth in employment and commercial activity fuelled by digital media.

To make this a success, Croydon needs additional rail, road and power capacity, and the school places, leisure facilities, libraries and even cemeteries to serve the new town centre residents. It was investment in these elements that formed the backbone of the garden cities' success and distinguished them from later new towns.

The good news for Croydon is that all this investment builds on existing infrastructure so it can be quickly implemented and is relatively cheap. The challenge is that it generally needs to be paid for before the fiscal benefits of new housing, commercial space and development value are realised.

This autumn Arup supported the London Borough of Croydon in its launch of an ambitious strategy for devolving tax resources to help fund its plans. As part of the implementation plan the London Borough of Croydon is proposing an innovative Public-Private Development Company vehicle.

or edge-of-town infrastructure, with far less opposition from existing residents.”

Frost acknowledges that there is no magic bullet to solve the housing crisis, but he says: “We need to apply the garden city ethos – focusing on how people actually want to live – to existing town centres.

Places that already have good infrastructure, but whose popularity is waning, would be ideal candidates. If you could reinvigorate them and make them more attractive to people, they would be ideal places to build more homes because they could sustain larger, happier communities.”

Because this reinvigoration approach would make use of what's already built, Frost argues it would be much cheaper than starting from scratch and that it has the potential to make a quicker impact on the housing crisis. He also believes it would be easier to garner popular support – as well as helping to preserve countryside that would otherwise be under threat of development.

“In London, post-industrial rail yards at Stratford, Gasworks at Greenwich and the post-industrial landscapes at Wembley and Old Oak Common have demonstrated the scope for the resurgence of suburban centres,” says Frost. “Perhaps the harder, but nevertheless doable, 1960s and 70s

commercial centres of Ealing, Croydon, Wembley Town Centre, Old Stratford, Wood Green and Archway could come next. I see this as the next generation of ‘new towns’ for London and a major step towards solving the housing crisis.”

### A new kind of public-private funding

How will the UK pay for this development? “A new kind of public-private funding package may be appropriate,” says Frost, “one that capitalises on the best elements of all the previous programmes.”

He believes forming development companies could hold the answer. “These would be publically owned entities with 49% private shareholders or bondholders (including everyone from large corporates to homeowners). They would deliver and manage the hard and soft infrastructure needed to support the development proposals.”

Just like the original Letchworth Garden City Corporation, they would recycle revenue and other income into new infrastructure and maintenance, and pay dividends. The public ownership element would ensure they had the powers, access to resources and accountability to avoid the failings of the early Garden City companies.

But without substantial land ownership these companies would struggle to raise the sums needed to establish themselves or fund early investment. Nor would they be able to easily extract rental income from privately owned housing or commercial property.

Frost has an answer to this: “The Government could support their setup financially and grant them special dispensation to retain stamp duty (perhaps indirectly through government funding or shareholding), business rates (as with Enterprise Zones) and betterment levies. Bondholders might be incentivised through lower taxes on profits, just as with the Build America Bonds in the US.

“In the current climate we can be reasonably confident in market support and in many cases these financing initiatives would be merely capturing the windfall benefit created by the relaxation of permitted development rights for conversion from commercial to residential use”.

Ultimately, Frost believes it comes down to understanding where and how people want to live, and what makes a successful place: “With this in mind, it's perfectly possible to reinvigorate existing towns from the core outwards to help address the UK's housing crisis.”





# Step by step

How incremental improvements to transport infrastructure can make a big difference to towns and cities

Bigger isn't always better. Small, incremental changes to transport infrastructure can deliver improvements in our cities while remaining flexible enough to respond to evolving needs.

"Incremental change enables you to evolve and adjust your plans as you go along," explains Susan Claris, an associate director in Arup's Transport Consulting team. "It's more dynamic and more responsive than change through large infrastructure projects – which are difficult to alter once planned. It's also generally easier to gain public support and political buy-in for an incremental approach than for big projects."

Incremental changes to improve transport may be as minor as removing pedestrian guardrails to help people cross the road more easily. Or they could be larger-scale, such as replacing a roundabout with a junction that provides for pedestrians and cyclists. The key, says Claris, is that they're aligned with a long-term strategy.



*An incremental approach will usually be more affordable on an annual basis, but that doesn't mean it's less effective.*



more affordable on an annual basis, but that doesn't mean it's less effective. It's about value for money rather than absolute price."

Making changes step by step also removes uncertainty, Lyons argues. "If everything hinges on a major piece of infrastructure removing through traffic from a town like Guildford, people are asked to trust whether that's going to be the case - and whether they will see the results they expect for their homes and businesses."

In fact, Lyons says that uncertainty is a dominant issue for transport planners looking at the coming decades: "We simply don't know how the relationship between transport, land use and society will evolve. This is why consistency is important. You need to manage uncertainty by taking an incremental, adaptable approach, but with clearly agreed principles for what a town like Guildford should be like in the future."

#### **Freiburg: 40 years of incremental changes**

A prime example of how a series of interventions can build a sustainable transport system can be found in Freiburg in Germany. The city has spent 40 years making incremental changes that take it towards its long-term vision of a city that promotes walking, cycling and public transport.

It has certainly worked. Research published in the International Journal of Sustainable Transportation has shown that over the last three decades, the number of bicycle trips in Freiburg has tripled, public transport ridership has doubled, while the proportion of trips made by car has declined.

What's the key to Freiburg's success? "The city has followed a long-term vision, albeit one that has adapted over time," says Claris. "And it's implemented most of its policies in stages. If everyone in a street wanted traffic calming measures, the city implemented it for that street - and when they saw it in action people living in other streets wanted it too."

This is another advantage of a step-by-step approach: it can make it easier to win over the public. When Stockholm wanted to introduce road pricing, it didn't try and enforce a citywide scheme immediately.

Instead, it put a temporary scheme in place to let people try out the idea. Having seen road pricing in action, residents then voted to make it permanent.

New York's transportation commissioner under the Bloomberg administration, Janette Sadik-Khan, used temporary measures too. She famously advocates bold experiments that are cheap to try out rather than trying to model and forecast every last detail. And her tenure saw the advent of dedicated bike lanes, cycle sharing, and even the pedestrianisation of Times Square.

"Small measures that can be implemented quickly on a street-by-street basis demonstrate to people that change is happening," says Claris. "In places like Freiburg this has produced cities where government, citizens and businesses are united behind a vision of sustainable transport."

Lyons is equally keen on trialling measures on a temporary basis. "I think it's a massively underused approach with huge potential," he says. "Trialling measures makes people less anxious about change while showing them how they can adapt and giving them the chance to see the benefits first-hand."

Ultimately, says Lyons, cities should have the political courage to set out what sort of places they want to become and believe in the ability of people and businesses to adapt their behaviour to suit.

Arup's strategy for creating sustainable mobility in Guildford has four key principles.

#### **1. Adaptability and flexibility**

The long-term strategy can be modified as conditions change around Guildford, and as the pace of change varies with social, technological, economic, environmental, and political cycles.

#### **2. Resilience and sustainability**

The strategy will help the town deal with future shocks and events, such as fuel price hikes or floods, providing alternative and efficient ways to travel within and to the town.

#### **3. Incremental change**

The strategy does not rely on a major scheme to solve all the problems; it enables small steps to be taken through shorter-term, independent projects integrated into a longer-term strategy.

#### **4. Balance and choice**

The strategy is not forcing people to do anything; it provides a balanced offer and a real choice about how they move around the town.

#### **A value-for-money approach**

In the UK, Arup helped the town of Guildford develop a strategy for sustainable mobility based on the idea of incremental improvements. Glenn Lyons, Professor of Transport and Society at UWE Bristol worked with Arup on the Guildford Town and Approaches Movement Study.

He points out that an incremental approach also has financial advantages: "An incremental approach will usually be



# Fewer cars, better cities

If car ownership falls, could cities become more liveable?

As some studies point to car ownership and car use reaching a peak in Western cities, declining traffic could open up new opportunities for city leaders.

## Healthier, safer and friendlier

“Eliminating cars from the streets so they can be places again is one of the best improvements a city can make,” says Arup architect Demetrio Scopelliti. “It not only reduces pollution, it frees up public space for new uses and makes the city safer for people who walk and cycle. It fosters social cohesion and a sense of community, bringing vibrancy to local shops and business. This is because people can now use spaces that were previously choked with traffic.”

Scopelliti points out that walkable neighbourhoods are proven to improve the quality of life. This in turn makes cities more attractive places to live. And this means they become more competitive on the world stage because they attract skilled workers who value living somewhere with a strong sense of community and good walking and cycling links.

Freeing up public space can make a big difference to a city, as Milan’s deputy mayor, Pierfrancesco Maran, points out: “Today in Milan, despite a reduction of around 100,000 cars in the past 15 years, there are still more vehicles parked than official parking spaces available. The improper use of sidewalks and green areas of boulevards as car parks reduces the potential space for bus lanes and cycle paths. So more useable public space also means an opportunity to establish a virtuous circle where more people can give up their cars.”

## Low-cost interventions

So how can a city shift its focus away from cars? “Traditionally, changing a street was seen as a slow process,” says Scopelliti. “But there are good examples that show how you can shift public space from cars to people quickly, easily and inexpensively – and in ways that people will appreciate.”

He highlights perhaps the most famous example: Times Square in New York. Once an icon of traffic congestion, the square was turned into a plaza over a weekend using temporary street paint, chairs and tables in 2009 – a transformation that has now been made permanent.

Another example is Los Angeles, where commuters waste 64 hours each year stuck in traffic. The city is now making it easier for people to walk and cycle with its People St initiative. The programme allows local communities to nominate redundant and underused roadways for transformation into pedestrian public spaces, using a kit of pre-selected designs for chairs, tables, planters and other furniture. With this do-it-yourself initiative, people contribute to the maintenance and operation of these spaces, providing ongoing neighbourhood outreach.

“These examples show how you can achieve high-value change with low-cost interventions,” says Scopelliti. “They represent the first step on the road to more permanent structural change.”

- 1 Times Square, New York © iStock
- 2 BikeMi station, Milan © Jens Room
- 3 Madison Square, New York © Anna Peccianti
- 4 People St Parklet, Los Angeles © Jim Simmons/LADOT
- 5 Marconi/Piazza Duomo, Pedestrian area, Milan





In January 2012 Milan implemented the first congestion-charging scheme in Italy. Known as AREA C, it replaced a previous pollution-charging initiative after a referendum in which almost 80% of voters declared themselves in favour of more restrictions on traffic if it would improve quality of life in the city.

After six months, AREA C had already produced a host of benefits. For example, it had cut traffic by an average of 34%, increased the running speed of buses by 7% and reduced accidents by 28%.



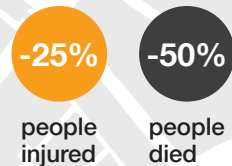
**New registered car**



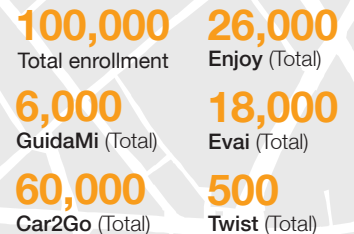
**Benefits within Area C (after 2 years)**



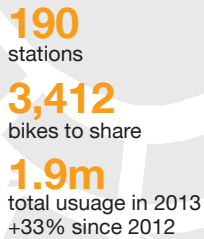
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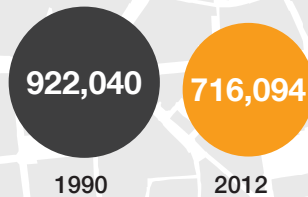
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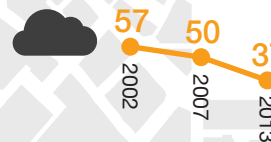
**Bike sharing users**



**Car ownership**



**Yearly average concentration of PM10 (in microgram/m<sup>3</sup>)**



**Passengers using public transport (millions)**



**Changing behaviour**

Ultimately, reducing the number of cars in a city relies on a long-term vision requiring behavioural changes. “You have to consider what influences people’s behaviour,” says Scopelliti. “If you give people a solution that saves them time and money they will happily get out of their cars.”

He believes that if local governments want to change people’s habits, they should aim high and not be scared of initial opposition. “The best way to convince people is to show them the change, combining top-down solutions designed around people with bottom-up ones that involve people in shaping their own environment – for example by proposing or designing new solutions.”

Following this approach, Milan combined the implementation of prohibitive measures such as congestion charging with new opportunities such as car sharing. Maran explains that the charge was initiated by a referendum, but only enjoyed greater

consensus once it was implemented, and when people could see its benefits. At the same time, car sharing proved a great success because it allows people to save money while maintaining or even improving the accessibility of the city.

**New approaches to public transport**

Scopelliti believes that innovation schemes are needed to address the crucial last mile in each journey – something that infrastructure such as metro lines can’t cover. It’s an opinion shared by Fabio Casiroli, a founding partner of transport planning consultancy Systematica.

Casiroli argues that historic cities like Milan, which do not have the potential to build large new infrastructure, must take a new approach to public transport if it is to effectively compete with the car: “Individual public transportation (or micro mobility), manifested in new-generation electric bike and car-sharing services, could cover the first and the last mile of any given

journey – the real weak point of collective public transport.”

Maran agrees on the need for innovation. “We face a technological challenge as to how we can move effortlessly at between 15 and 20km/h without motor vehicles,” he says. “Solving this problem will be the only way to end the use of private cars in the city. Cycling and bike sharing can only be a part of the solution.”

Once this last-mile question is answered, what will cities like Milan be like? Casiroli comments: “In historic cities like Milan I expect future mobility will be characterised by lower private car ownership, a gradual reduction in traffic in city centres and a significant increase in electrical, shared, rented and even driverless vehicles – plus more cycle paths and large pedestrian areas. I have no idea how the ideal future city will look. However, I firmly believe that each city needs to be understood starting from its deepest roots and that from there its future can be imagined and drawn.”





# Sense and the city

Shaping the way a place feels can help it succeed

## City Park, Bradford

City Park in Bradford provides an excellent example of an integrated design team delivering a highly complex and challenging regeneration project in a busy city centre; a space which interacts with people's senses to make visitors feel healthier, happier and safer.

Paying careful attention to the way cities interact with our senses could help to make people feel healthier, happier and safer – while boosting the economy.

## Supporting a 24/7 economy

Many cities aspire to a buzzing, round-the-clock culture and today New York is far from the only 'city that never sleeps' as urban centres forge economies that work 24 hours a day, 365 days a year. But creating a successful 'always-on' culture requires careful thought about how a city will feel

and function at different times of the day and throughout the year.

Artist and Arup lighting designer Leni Schwendinger argues, for example, that the approach to night-time lighting is often one-dimensional: "Many cities are turning off their lights late at night purely to save energy and money. But what about service workers who need to find their way safely to late-night shifts? The issue is more nuanced than many people first think."

If cities need to consider how they're seen at night, perhaps they should also consider how the weather affects the way they feel? Polly Turton, an environmental design

and climate consultant at Arup, believes so. "You need to ask things like: How can you increase the possibilities for people to do things outdoors even when it's hot or rainy?" she says. "How can you enhance the use and comfort of buildings and external spaces without being profligate in the use of energy? These are important questions."

Turton points out that when London experienced a heatwave back in 2003, one of the economic impacts was that sales on Oxford Street plummeted: "Nobody wants to go to a busy city centre shopping street when it's hot; everyone goes to the park, or the paddling pool, or leaves the city completely.





*Then we sallied forth into the streets, arm in arm, continuing the topics of the day, or roaming far and wide until a late hour, seeking, amid the wild lights and shadows of the populous city, that infinity of mental excitement which quiet observation can afford.*

Edgar Allan Poe

By understanding how people behave during extreme weather, city planners and designers can respond accordingly.”

She argues that by integrating green and blue infrastructure – water features as well as parks, green roofs and living walls – cities can create environments that are better able to deal with the weather and encourage positive use. They can provide shelter and visual interest when it’s raining, and shade and cooling when it’s hot. This can change the way we feel and use external spaces in different types of weather.

Greening and shading devices have acoustic benefits too, as Arup acoustic consultant Peter Mumford points out. “The noise reduction benefits are relatively modest,” he acknowledges, “but green spaces have much more positive sounds; people like hearing leaves rustling, and they like hearing the birds that inhabit the greenery.”

### **An overlooked aspect of design**

Arup’s Cities Alive concept (see page 25) sets out how cities could derive a host of social, economic and environmental benefits from creating ecosystems of linked green and blue infrastructure. So why aren’t cities paying more attention to elements like microclimate, lighting and sound that affect how urban areas feel to people?

“I think many people overlook important questions about lighting,” says Schwendinger. “Is it more important to save energy or to have good-quality light? How bright is too bright? Is certain lighting okay for an elderly person? When designers don’t consider lighting conflicts, then

they may decide street lighting is merely a specification rather than thinking more deeply. Many of us think about how the streets and sidewalks will work in the day, but neglect the characteristics of night.”

Sandy Isenstadt is Professor of History of Modern Architecture at the University of Delaware. He agrees that architects and planners have traditionally overlooked people’s experience of cities at night. “I think that all of architectural criticism and architectural history presumes daylight and ignores half the diurnal cycle,” he says. “In a lot of ways the city used to disappear at night. There’s a lot of unrealised potential for designing the feel of places at night.”

He points to the Broken Light project in Rotterdam as an example of a different approach that uses lighting to change the mood of an area. Here, artists and lighting designers created an atmosphere of tranquillity in an ordinary residential street by replacing the street lighting with custom-made fittings. These project wavy, underwater-like patterns of soft light on pavements and strips of light on apartment facades.

### **Interdisciplinary design is key**

So how can designers consider senses more widely? For Schwendinger, an interdisciplinary approach is key. “I would posit that we’re talking about the way people feel, the effect that different elements of design have on the senses,” she says. “That’s why I call my discipline ‘night-time design’ instead of ‘lighting design’, because it embraces other senses too.”

If design disciplines work together

to consider the sensory experience as a whole, they could produce more effective environments. “Restaurants are a classic example of design missing out on important issues like acoustics,” says Mumford.

“Walk into a restaurant and the chances are it will be too loud, too ‘echoey’, because they only focused on how it looks and how the food service works. This makes for a brash, harsh environment. It’s quite a contrast when you go into a restaurant that’s less acoustically reverberant. You feel yourself relax and it contributes to a sense of luxury.”

Turton believes such higher-quality environments come from planners and designers thinking more widely. “There’s a functional minimum, which we should all be designing to as standard,” she acknowledges. “But above that we need to think about improving the experience of an environment, and how to optimise the way spaces work, look and feel for people. It’s not always the client’s priority, but there are opportunities for designers to add value for not much extra cost.”

A change in the design process would certainly help, believes Isenstadt. “Concepts of quality of life and ideas about curating sensation in a city are not skillsets that planners have historically been educated in. We need to ask what disciplinary knowledge is needed to address these ideas. Perhaps you need a physiological psychologist, for example. Maybe you need to draw from a wider range of specialities. I think other disciplines have to get involved in the design process earlier, or at least be part of the literature that designers consult.”

# A sporting chance

## Major sporting and cultural events can catalyse city development

It's estimated that the world will need to build the equivalent of its entire infrastructure again within the next 30 years to sustain a population that is expected to have more than doubled between 1980 and 2050 to reach 9.55 billion," says Jerome Frost, leader of Arup's Global Planning business.

"Major events such as Olympics and Paralympics, World Cups and Commonwealth Games can help host cities realise long-term plans for transformation and infrastructure investment – but only with the right approach."

"There's no guarantee of success," agrees Godric Smith, the Director of Communications at the Olympic Delivery Authority. "And if you fail, then you fail in a very public way – you don't achieve the urban regeneration that you need and you suffer massive reputational damage. But if you succeed, you succeed on a massive scale. That's why you have to make sure that you deliver what you say you are going to do."

There's a long history of major events being used successfully to spark regeneration. The 1972 Munich Olympics fast-tracked development of a derelict 280-hectare site, with work that had originally been expected to take 20 years completed in just five. For the 1992 Barcelona Olympics, the city injected public funds into a citywide transport infrastructure effort and convinced private

investors to follow suit. Others have been less successful.

London had the most ambitious plans to date when it was chosen to host the 2012 Olympic Games; ambitions which extended to well beyond the Games-time period, hence the term 'legacy' was coined. Frost explains that: "Plans to extend the city eastwards, including extending underground and overground rail connections, were underway well before the Olympic bid. But the Olympics enabled a 30-year masterplan to happen in just seven years. It meant the area reached critical mass, fuelling billions of pounds worth of public sector investment. And this in turn made it an attractive opportunity for private investors."

Crucially, it is public support that really makes a success of an event and its legacy. Frost adds: "Perhaps the biggest potential obstacle to successful delivery is public opposition." From the beginning, London focused as much on the legacy the Games would leave behind as on the event itself. "Planning for legacy is every bit as important as the planning for the Games," says Smith, "this broader objective was crucial to garnering a positive sense of good value for money and public support, reflected in the polling undertaken since".

"For example, improving transport integration through Stratford made a fundamental difference for the Games but it has also greatly improved connectivity in legacy. Similarly, some other cities have struggled to find long-term uses for sports venues. We've already got the Aquatics Centre, the Handball Arena (the 'Copper

Box'), the Velodrome all being used; and we've got BT Sport basing their whole operation out of the Broadcast Centre."

Smith also points to the importance of political leadership aligned behind a major event and the regeneration it catalyses. However, he cautions that cities need to be realistic. "The Olympics can make a big difference, and London 2012 has certainly made a massive difference to regeneration. But, equally, I think there's sometimes a sense that these events are a cure-all for the socio-economic problems of a city. You need to set the bar high, but also be realistic about what you're going to achieve. London 2012 has kick-started the city's move eastwards, but it will be long process overall."

Glasgow has followed London's approach and used the recent Commonwealth Games to further its long-term improvement plans for the areas of Dalmarnock and Shawfield. These include investment in road and rail infrastructure as well as new housing and a £4.75 million pedestrian bridge across the Clyde linking the two areas. And development is set to continue into the future with the UK Government committed to an ambitious City Deal for Glasgow, which includes establishing a £1.13 billion Glasgow Infrastructure Fund.

"There is always much talk about legacy," says Frost, "but it's apparent from London and Glasgow's example that the planning and vision started long before the bid. This is what ensures the event becomes a means of accelerating development as cities prepare for future population and economic growth."





1960

**Summer Olympics, Rome**

Heralded as the first time the role of the Olympic Games stimulated major infrastructural development.



1972

**Summer Olympics, Munich**

Represented an opportunity to fast-track redevelopment of a 280 hectares derelict site within five years that had originally been scheduled for rejuvenation over a 20 year period.



1976

**Summer Olympics, Montreal**

A combination of factors, including economic recession, construction problems, labour disputes and rising costs, conspired to accentuate the financial burden of staging the Games and this resulted in the city facing high levels of indebtedness over many years.



1992

**Summer Olympics, Barcelona**

More than 100 hectares of what had been industrial land was redeveloped as was the seafront. Major ring roads and other transport infrastructure were also put in place for the Games.



2000

**Summer Olympics, Sydney**

The commercial viability of Stadium Australia – with a post-event capacity of 80,000 – proved to be questionable after the Sydney Olympics because of the paucity of major events suitable for an arena of this size and also the competition from smaller existing, new or refurbished stadiums.



2006

**Winter Olympics, Turin**

Notable for transforming a large industrial city as well as acting as a tool of wider regional integration.



2010

**Winter Olympics, Vancouver**

A strong focus on new transit infrastructure for the City whilst also creating a new urban district in False Creek.



2012

**London Olympic and Paralympic Games**

Enabled billions of pounds worth of public sector investment, which in turn made a more secure and attractive opportunity for private investors.



2014

**Glasgow Commonwealth Games**

Regarded as the culmination of a 30 year image transformation project for the city, leading to extensive regeneration, redevelopment and investment opportunities.

# Icons

How buildings, parks and public spaces become systems for whole cities







Durban's beachfront promenade, South Africa  
 Photos © Angela Buckland

*“There is enormous potential in pairing visionary architecture and urban design with imaginative engineering,” says Lee-Zane Greyling, Arup’s leader for building engineering in Southern Africa. “The resulting building or new space can do far more than meet a client’s needs or retain a site’s long-term value – it can become something that genuinely thrills, makes people proud and becomes a symbol for a city.”*





St Pancras railway station, London

Photo © Hufton+Crow

*Cultural buildings and stations are often the projects that become icons of a city's emergence onto a national or global stage, or symbols of resurgence following a period of decline. The reason is simple – these are buildings designed for public use and enjoyment.*

Tate Modern in London is a powerful example of what Greyling is talking about. When residents saw how architects Herzog & de Meuron and Arup had transformed Bankside power station into a riverside art gallery, they wholeheartedly embraced the renewed building. Tate Modern quickly became a symbol of London's renewed urban confidence.

The gamble taken by the Tate trustees to refurbish the long-derelict building paid off spectacularly as Londoners and tourists began to visit in droves. People marvelled at the successful repurposing of the redundant industrial building and its cavernous turbine hall. Tate Modern rapidly became one of the UK's top-three tourist attractions and kick-started the regeneration of a large urban area. It remains one of London's biggest tourist draws.

This is not a unique phenomenon, as Greyling explains: "Cultural buildings and stations are often the projects that become icons of a city's emergence onto a national or global stage, or symbols of resurgence following a period of decline. The reason is simple – these are buildings designed for public use and enjoyment."

New or revitalised public spaces such as Durban's now-buzzing beachfront promenade also have the potential to become symbols of a city's confidence and pride, as are developments linked to major sporting events. "An arena can become a public favourite and symbol of a city's regional status – but only if it both works well and looks good," explains Martin Radley, a director within Arup's London buildings practice. "I'd say the Millennium

Stadium in Cardiff, Wales, does this and the recently completed First Direct Arena in Leeds, designed by Populous and Arup, is well on its way to achieving this, too."

#### Form and function

Another UK sporting venue tipped for iconic status is the London Aquatics Centre, designed by Zaha Hadid Architects and Arup. It's not just the building's striking exterior and interior forms that have drawn admiration, but the way the building provides precisely what the area needed: a new high-quality leisure amenity in a place that had precious few.

How does engineering contribute to iconic urban design? "Often, it does so by making the seemingly impossible possible, allowing an ambitious architectural vision to be realised," says Radley. "And engineering is essential in a second way: it delivers lasting, high-quality function. A new building that looks like no other will only be fêted by the public if it works – and continues to work.

"The world is littered with wacky and wonderful sculptures, buildings and bridges that have been labelled 'failure' largely because they didn't stand up to day-to-day use," Radley continues. "The wisest architects – and clients – are those that recognise the often-invisible contribution made by robust engineering and the time, care and, yes, money that this demands."

But public reaction remains unpredictable. "No one can make the public fall in love with a new building," says Greyling. "After all, who predicted the love the British public would feel for

the renewed St Pancras and King's Cross railway stations in central London? Even as a visitor to London I am drawn to the new spaces and place-making that has happened there." Equally, who can be sure which of the Middle East's emerging set of major art galleries, museums and other cultural buildings will become iconic? Will it be Frank Gehry's Abu Dhabi Guggenheim, Jean Nouvel's Qatar National Museum, or some other project?

There are, of course, many examples of buildings that were designed to be icons but that were subsequently dismissed by the public. The reasons for this rejection vary, but parliamentary buildings and other official symbols of a state can be particularly vulnerable to a cool reception. At times, this is simply because the public needs a focal point for dissatisfaction with its leaders. That said some parliamentary buildings do become public favourites.

Enric Miralles' Scottish Parliament building in Edinburgh is one such example. A building project once routinely criticised has quietly become an attraction. It's now a place that Scots will show to visiting family and friends as a symbol of both their nation's political power and of Edinburgh's capacity to integrate contemporary architecture into its historic urban fabric.

One thing is certain: whether it's a new building, public park or pedestrian bridge, all iconic structures rely on engineers and technical specialists. "We can never guarantee that a project will become an icon," says Radley. "But we do everything we can to realise a project's vision and to ensure it functions well."



# Rethinking green infrastructure

Can the power of nature help cities as they face an uncertain future?

Global research shows that green infrastructure can deliver significant social, economic and environmental benefits; engendering a better quality of life for people, and integrating climate change resilience. Given this, green infrastructure needs to be acknowledged as the ‘fifth critical infrastructure’ alongside energy, transport, water and waste.

Linked ‘city ecosystems’ of parks, open spaces, urban trees, streets, squares, woodland and waterways can help create healthier, safer and more prosperous cities. That’s the idea behind the Cities Alive concept.

Created by Arup and supported by the Royal Botanical Gardens, Kew, and the Landscape Institute, Cities Alive puts forward the case for ‘green infrastructure’ linking green corridors, city streets, squares,

plazas and parkland to create healthier, safer and more prosperous cities.

Tom Armour, leader of global landscape architecture for Arup, explains: “More sustainable urban development cannot be achieved without recognising the vital role of the natural environment,” he says. “There is now clear evidence showing that urban green infrastructure has a fundamental impact on economic prosperity, health and wellbeing.”

Armour points to some examples from many included in the report – research shows that contact with nature reduces stress levels, stimulates better health and helps people recover faster from illness, thus reducing the cost of healthcare. “A greener city will also increase biodiversity and foster convenient sustainable forms of mobility such as cycling and walking,” he adds. “Where space is at a premium, green roofs and walls can enrich crowded parts of the city and contribute to cleaner air.”

## CASE STUDY: Queen Elizabeth Olympic Park, London

The Olympic Park was to leave a valuable legacy of open space and biodiversity to act as a catalyst for the regeneration of this area.

By employing a multifunctional design approach that weaves flood protection and nature into its fabric, it positively demonstrates what a green infrastructure-led design can achieve. It illustrates how obsolete areas of the city can be successfully retrofitted for the future; and become important city spaces that are both adaptable and sustainable, whilst also linking to a much wider network of natural ecosystems.

Most of the facilities used for the Olympics will continue to be used by local teams and organisations to promote sport and healthy lifestyles. Considering alternate uses for open and public spaces that are adaptable to changing lifestyles is an important thinking point for a Cities Alive initiative.

Download the full Cities Alive report at [www.arup.com/homepage\\_cities\\_alive](http://www.arup.com/homepage_cities_alive).





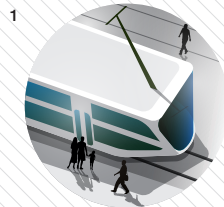
### Supporting resilience

Armour points out that green infrastructure also supports the long-term resilience of a city: “Urban wetlands, permeable paving, water roofs and sustainable drainage help cities cope with extreme rainfall. Canopy cover provides effective protection from fluctuating temperatures and wind. These solutions produce more liveable microclimates, act as vital carbon sinks, absorb pollution, and improve people’s psychological and physical wellbeing.”

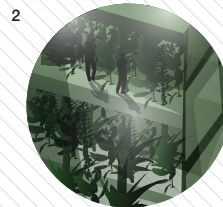
Sue Illman, President of the Landscape Institute, also stresses that if cities are to realise these benefits, they need to focus first on water. “The way we’ve developed our built environment has disrupted the natural water cycle,” she says. “In the past we’ve focused too much on our ability to engineer water so now we need to reinstate natural water cycles in cities.”

Illman argues that, with cities like London still using Victorian sewer infrastructure, it’s high time to innovate. “By using sustainable drainage or water-sensitive urban design, we can attenuate water flows and allow them to infiltrate, reinforcing base flows and reducing flooding. The water cycle behaves more like it would in nature.”

Keeping water within a city this way, says Illman, means it can be used to support green infrastructure – a tree can’t help reduce air pollution if it doesn’t have enough water to survive, for example. But cities also need water for their burgeoning populations to drink, for food production, to help keep them cool and – through vegetative systems – to help tackle pollution.



**1 Automated public transport** is advancing rapidly. In the future we can expect to see more driverless electric trams, buses and trains in the streetscape. This will reduce the dominance of and our reliance on the car; lower pollution, noise and congestion; increase safety; make cities for people; and provide the opportunity for green corridors.



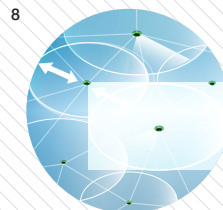
**2 Vertical farming** may become more popular as urban populations explode and available space shrinks. The use of roofs, vertical spaces and basements to grow arable crops could result in shorter, more environmentally friendly distribution routes, healthier diets and fresher foods.



**3** With land at a premium, creating city space for people will call for courageous design. As cities expanded in previous times urban railways went underground—why not **underground roads** now? Burying key highways will significantly lower pollution, noise, congestion and barriers to movement. This will create huge gains by freeing up city space for people and enhancing the city environment.



**7 Green corridors** provide important routes for wildlife to migrate and travel through the city. Urban green spaces are far more effective when linked; this is a key objective of a green infrastructure design approach. Another is multifunctional design, and these corridors can also provide natural drainage solutions and better airflows for climate change resilience.



**8 Smart weather covering** could help keep public spaces usable in varying conditions. This may include covers that automatically unfold during rain events or when sunshine is intense. By collecting solar energy during daytime they could provide “smart lighting” that responds to the presence of people, providing security whilst also saving energy.

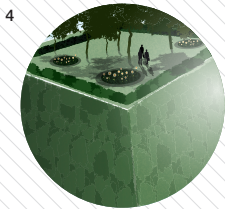


The urban environment will need to work harder in the future in cities to provide flexible uses when city space is in demand. **Adaptable public spaces** can be designed for multiple functions: as meeting places, markets and entertainment and education places. This approach will help local business and engender local community pride.

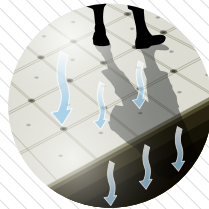


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**Green roofs, walls and façades** are likely to become more prominent in cities, as we need to exploit and retrofit the layers of the city to find space for recreation and nature. Supporting valuable ecology, or as pleasant places for urbanites to hang out, these features also provide pollution mitigation, natural warming/cooling, rainfall attenuation and insulation to lower energy costs.



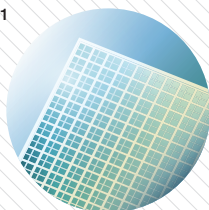
**Permeable paving** and soft landscape areas will help urgently convert grey to green in future city environments. This is a simple technology, but a vital one to improve water absorption and slow rain water run-off. This will help cities cope with extreme weather events and increased precipitation whilst significantly visually improving the environment.



**Green bridges** can retain important links in green infrastructure city networks. They also act to provide continuous wildlife corridors to benefit city biodiversity and bring opportunities for healthier traffic-free routes and pedestrians crossings over waterways and roads.



**Bike sharing** is already very popular in many cities, and research shows significant health benefits to city dwellers who are provided with convenient cycle ways and good facilities. This trend needs to be encouraged—cycling will deliver lower public transport and public health costs; along with innovative solutions such as underground bike parks, it could save valuable city space.



**Solar panels** are likely to become more commonplace as cities look to spread the energy load. Panels are increasingly a cornerstone of municipal environmental policy in many cities. With zero carbon emissions they can effectively provide heat and power to urban structures.



**Glowing trees** are being researched as a way of providing lighting without the use of electricity. Using bioluminescence technology they would provide all the benefits of large trees as well as provide secure and shared public space for people to enjoy.

### Making it a reality

So how can cities combine blue and green infrastructure into the ecosystems envisaged by Cities Alive? “Delivering Cities Alive will require an integrated, collaborative approach to urban design where landscape architects work with government, authorities, developers and city design consultants,” says Armour.

“We have to recognise the potential of green infrastructure, but also understand how it can be integrated with other urban systems like energy, transport, water and waste. To realise this vision, green infrastructure has to be regarded in an essential role in the planning and design of cities and as an equal partner with the other critical urban systems. By realising that green infrastructure can be economically integrated and retrofitted into the city, we see the potential to create more resilient, inclusive and healthier cities.”

Illman thinks that every piece of development in a city should make a contribution towards a city ecosystem. “I call it ‘nibbling’,” she says. “Even if you’re just doing a small pedestrianisation scheme or a highways improvement, you need to ask how you can bring nature into it to create wider benefits. If you keep nibbling away at the problem like this, you make the problem smaller.”

Arup has been working with the Greater London Authority on the London Infrastructure Plan 2050 which has been recently published for consultation. The plan includes a section on green infrastructure (written by Arup in consultation with Peter Massini, Principal Policy officer of the GLA’s urban greening unit). The inclusion of green infrastructure in the plan is a significant step as it signals that green infrastructure needs to be considered as much a part of the city’s vital systems as energy, water, waste and transport infrastructure.

