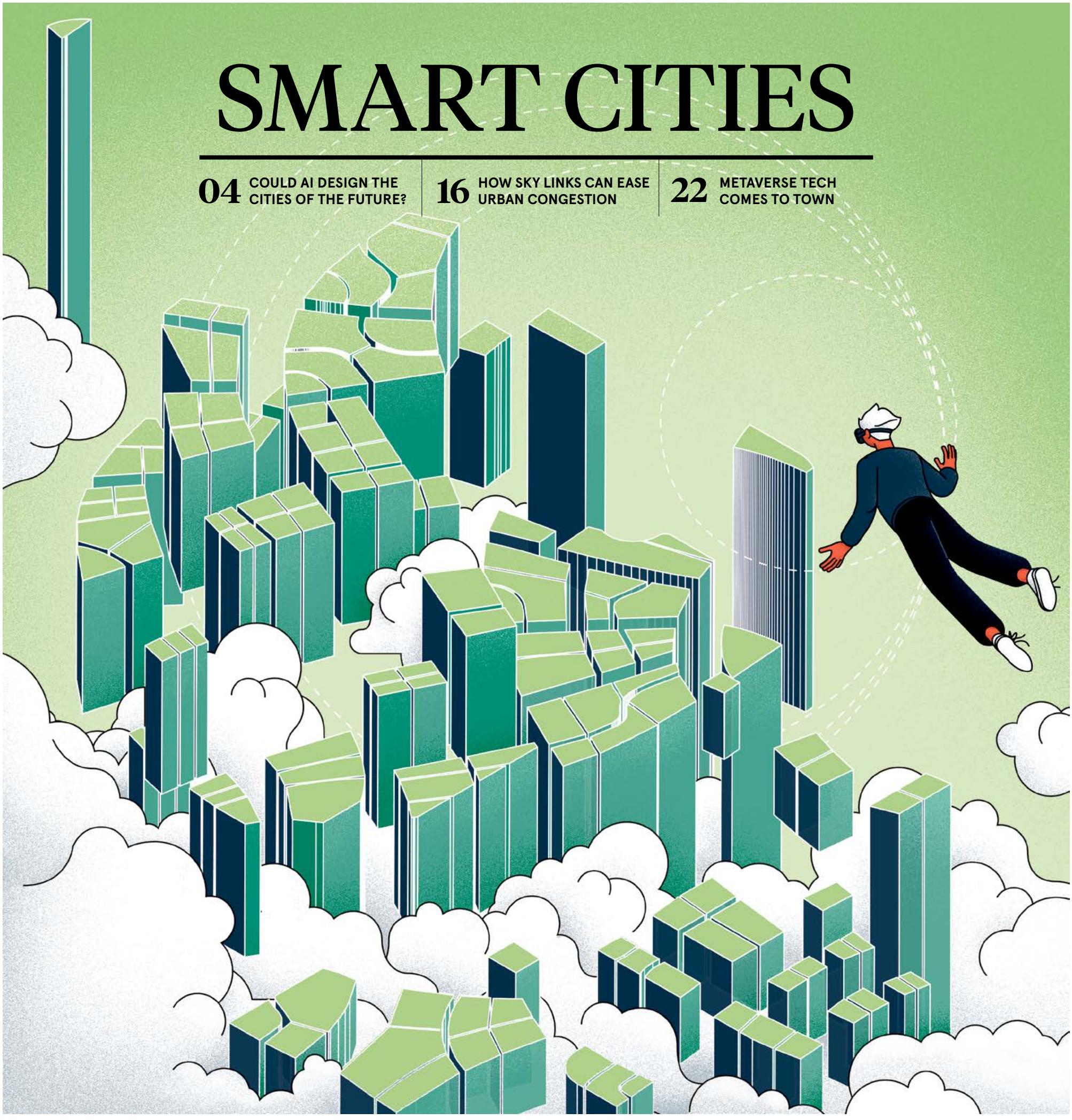
SMART CITIES



SMART CITIES

Distributed in
THE TIMES

Published in association with
C40 CITIES · bee smart city · SMART CITY EXPO WORLD CONGRESS

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CITY PLANNING

Urbane living: how to ensure that no citizen is left behind

A more sustainable and intersectional approach to smart city design is fundamental to improving the quality of life for all residents

Ellen Hammett

Technology is rapidly transforming the way our cities operate and how we live within them. Increasingly sophisticated machines and algorithms add layers of intelligence once only thought possible in science fiction.

But 'smart' cities are not about innovating for the sake of innovation. They are about providing solutions to some of our biggest issues in society, from public health, safety and wellbeing to sustainability, biodiversity and social equity. Fundamentally, they are about improving the quality of life for all citizens and societies as a whole.

By 2050, almost 70% of the global population is expected to live in urban areas and to live for longer. Smart cities must therefore be designed to be inclusive, accessible and resilient to the myriad challenges our planet faces.

Technology has an instrumental role to play but a whole-system approach that also takes into account the built environment, natural world and the diversity of city dwellers is needed for people, cities and societies to thrive.

Faced with a potentially turbulent future, urban planners are advocating a more sustainable approach.

"That means that the planning of housing, employment and services addresses the need for net-zero development and resilience to climate change – while also delivering quality places and green spaces, community infrastructure and job opportunities where people live," explains Daisy Narayanan, who is head of placemaking and mobility at Edinburgh City Council.

This is the cornerstone of the concept of the 20-minute neighbourhood and 15-minute city approaches, which are becoming a key focus area for governments, organisations and communities globally. The idea is that everyone can meet most of their daily needs within a short walk, wheel or cycle from their home.

"We need this level of ambition to achieve a significant shift from longer journeys to active travel and meet our net-zero carbon target by 2030," Narayanan explains. "But it's also about creating more social, inclusive and accessible places by improving access to quality services and empowering local communities."

Amid the global cost-of-living crisis and post-Covid recession, the affordability of cities has become paramount to their liveability. The latest global Smart Cities Index cites access to affordable housing as the most urgent matter for cities worldwide, with citizens ranking it above even unemployment, public transport and pollution.


Bob Douglas via iStock

The government-funded Active Building Centre (ABC) researches methods and technology to drive buildings and the construction industry towards the UK's 2050 net-zero target. Increasingly, ABC works with social-housing providers to design buildings that create 'energy-positive' communities. Dan Cook is the organisation's CEO and thinks a wide range of housing types is "fundamental for all the critical people needed to make a city function".

The intelligent integration of renewable energy technologies allows 'active buildings' to generate and store renewable electricity to meet their own needs and redistribute the surplus to other buildings and back into the grid. Their ability to reduce energy consumption and lower fuel bills, while supporting people to have more control of their energy supply, is a solution to reducing cost-of-living pressures.

Many of these technologies already exist. Cook says the onus is on local governments and the industry to make them mainstream and ensure supply chains are in place to scale up.

With urbanisation increasing the diversity of city populations and adding new complexities, smart cities must avoid embedding existing inequalities and widening divides.

Dr Jo Morrison is director of research and innovation at digital agency Calvium. She believes that a truly accessible and inclusive smart city is one that "embraces a thoughtful, ethical and intersectional approach across the system".

"We can't create accessible smart cities just by rolling out the tech," says Morrison. "We have to get to grips with the city as a whole. Look at its existing structures of discrimination," she advises and emphasises the importance of building smart systems on "responsible data inputs" that minimise the risk of causing harm to citizens.

While key factors such as race, age and gender must be considered, the design process must also seek to engage and empower difficult-to-reach population groups such as disabled people, migrants and people experiencing poverty and social exclusion.

Citizens' Assemblies are integral to the democratic development of smart city solutions, ensuring a wide range of viewpoints in the decision-making process. When Berlin recently launched the selection process for its first Citizens' Assembly for climate change, it used an algorithm to choose 100 citizens at random based on criteria that included age, gender, education and migration experience to ensure the committee mirrored the city's population as closely as possible.

Working with communities to help shape proposals through a robust engagement process is key to improving the lives of all citizens, says Narayanan, with technology such as virtual reality allowing communities to experience what enhanced areas might look like.

"Building these stronger relationships to support local economies and target resources where they're needed should empower communities, helping them create their own solutions for the delivery of the services they need and promote community wealth building," she says.

"This will help to build a longer-term, self-sustaining legacy to ensure the right principles continue at the core of local development for future generations."

Ultimately, for smart cities to unlock their potential to create more inclusive, equitable and enjoyable places for people to live, they must be built on foundations that place the needs of their citizens above everything else.

STREET SMARTS

The top- and bottom-ranked smart cities for housing, employment, education, mobility and pollution

1	Singapore	AAA	109	San José	C
2	Zürich	AA	110	Santiago	C
3	Oslo	AA	111	Athens	C
4	Taipei City	A	112	Rome	C
5	Lausanne	A	113	Nairobi	D
6	Helsinki	A	114	Abuja	D
7	Copenhagen	A	115	Lagos	D
8	Geneva	A	116	Bogotá	D
9	Auckland	A	117	São Paulo	D
10	Bilbao	BBB	118	Rio de Janeiro	D

Smart Cities Index, 2021

URBAN DESIGN

Are we at the dawn of the AI-created city?

A new wave of generative design tools poses existential questions for urban planners and architects about the future of our public spaces

Tamlin Magee

Just over a century since *The Manifesto of Futurist Architecture* declared the city must be rethought and rebuilt like an "immense and tumultuous shipyard" – "everywhere dynamic", and the house like a "gigantic machine", it may be that author Antonio Sant'Elia had things the wrong way around.

Because although his machine-fetishising sketches inspired our common vision of a science-fiction future – as in Fritz Lang's 1927 film *Metropolis*, with its technological Tower of Babel an imposing centre-piece – it might be the gigantic machines that are making our houses.

Architecture and AI visionaries – forming especially around MIT in the 1950s, through to the later work of MIT Media Lab co-founder Nicholas Negroponte – and design pioneers have long thought about automating the creation of our environments. Now the technology is catching up to their ideas, and a radical shift into AI-assisted design is taking hold, with implications that could radically transform the form, feel and function of the places we inhabit.

Completely automated design is not quite there yet. This crop of generative, AI-assisted tools is rather new. But there are signs that we could be on the cusp of a revolution in how our buildings, towns and cities are created. Will these begin to take on a homogeneous shape, recognisable as AI-planned spaces? And is this the beginning of the 'copy-and-pasted' city – or do we already inhabit those, with the identical new-build properties that seem to crop up everywhere?

Advocates argue that AI-based city design could remove burdensome manual labour, allowing architects, designers and planners to focus on creativity. But on the other hand, could AI accelerate yet more of the same – a ruthlessly efficient approach to stuffing more people into buildings and maximising rents. Whatever happens, though, AI-assisted design appears set to radically change the future of architecture.

Despite the long tail of thinking around automated design, the drafting process was largely manual until very recently, even in software such as the ubiquitous AutoCAD or the building information-modelling tools that have added more context to designs and become dominant. "There was always the dream of automating design and urban planning but, little by little, it happened over the last decade or so," comments Imdat As, architect and co-editor of *The Routledge Companion to Artificial Intelligence in Architecture*.

The machine learning revolution has helped create the conditions for adequate computing power, with the imitation-thinking enabled by neural networks finally making generative design commercially viable.

Nudging this AI-assisted world into reality are new tools backed by Silicon Valley such as Delve – owned by Google subsidiary Sidewalk Labs – and SpaceMaker, which was recently acquired by computer-aided design giant Autodesk for $240m (£196m).

Unlike the painstakingly crafted line-by-line processes normally associated with architecture proposals, these tools allow the user to view and play with a huge range of variables. It is possible to prioritise or adjust nuances we may take for granted, such as noise levels, temperature or window views – and then generate design options.

With the traditional approach, planning teams are limited by their time and their tools, so proposals rarely exceed a selection of three to five designs. Using AI-assisted tools, though, planners can explore hundreds, if not thousands, of options, with their subtle differences illustrated on a 3D map, so that various stakeholders can view progress or collaborate as plans evolve.

SpaceMaker AI co-founder and CEO Håvard Haukeland explains that this is one of his platform's key benefits. Urban planning is very much about competing interests, so projects can end up bogged down by meetings where people are spending more time putting forward their cases than exploring multiple solutions. The latter, he argues, is "better for the city, better for the people living in the apartments or using the office spaces, and it's usually better for the economics of the project and the developer".

Haukeland adds that this approach could represent a huge shift in architecture and planning – and one that can virtually eliminate what those in the industry colourfully term 'Oh Shit Moments': when a design has already been fixed, but the team had forgotten to carry out essential tasks like noise analysis, thereby potentially moving project deadlines back – sometimes quite literally to the drawing board.

That was a fate avoided by the expanding Kivistö district in Vantaa, Finland, where a new railway line will see its population swell to 45,000 in the coming decades (a relatively large population in Finnish terms).

For planners, it was crucial to balance new, dense urban neighbourhoods within it with the district's proximity to nature and its silver birch-lined streets, while remaining on course for a 2050 carbon-neutral target. Even at a late stage, designers were able to use SpaceMaker to refine plans for interior courtyards, reducing wind effects and placing a sunny terrace for future residents. "The software almost downright persuades one to try different options," commented town planner Ville Leppänen.

Meanwhile, in Sofia, Bulgaria, city planners applied Delve to a city unit to map out future development strategies for the area. They told architecture magazine *RIBAJ* that the test project provided "valuable and important insight into the many possibilities that parametric planning offers", with one of the key benefits being able to "rapidly change input data and generate output results that may not have been even considered before".

This kind of experimentation was just not possible at this pace or scale previously. Michele Pelino is principal analyst, edge computing and the internet of things, at Forrester Research. She notes that although future-looking cities like Singapore had experimented with digital twin technology – where virtual copies of existing places are used in computer simulations – applied generative design is new terrain and how it will shape our buildings and cities is yet to be determined.

With the right prompts and some patience, algorithms appear capable of helping to create stunning portraits and fantastical worlds, as evidenced by OpenAI's Dalle2 system: an easily navigable fountain of artistry that anybody can use.

This AI-generated art is a window into what will become possible on a larger scale with our buildings, especially when combined with 3D printing, coming together to encompass one automated process. So says Eleanor Watson, IEEE AI Ethics engineer and AI Faculty at Singularity University. This could, she says, build works of incredible complexity but at no extra marginal cost – and would be an opportunity to push back against the "stark utilitarian mass-produced simplicity, inoffensive and timeless yet dull and soulless".

"We might soon see a renaissance, whereby plainness becomes passé, in a world where beauty has become next to free," she says.

First, though, there are many more complexities to creating a building (and even more on the scale of towns and cities) than generating a pleasing portrait image.

With all their variables, location-specific considerations, the context-dependent nature of floorplans, and the algorithmically impossible-to-pin-down overall feeling of a place, it may be some time yet before machines are helping to bring about that renaissance.

For now, it is the nuts-and-bolts stuff where the latest AI-generative tools excel; the design is not quite end to end – meaning, pushing a button won't instantly generate you a building or district to your liking.

But even these optimisations have the potential to change the look and feel of spaces, adds Pelino.

Being able to analyse, calculate and map predicted temperatures, for instance, could help developers avoid the creation of urban heat islands and instead produce cooler conditions for residents as buildings and cities evolve. And as sustainability becomes a more pressing concern, it may be proven that our approaches to buildings and cities are woefully inadequate – and that AI-imagined geometric models surprise designers with the optimised shapes they take.

In time, as technology marches forward, new, surprising, aesthetic forms may crystallise.

> **You want to encourage positive mutations and that's what the rapid processing and multiple iterations of AI and machine learning make possible**

> **Using AI-assisted tools, planners can explore hundreds, if not thousands, of options**

Stephen Barrett, partner at Rogers Stirk Harbour + Partners, believes that AI will be able to take the mechanistic day-to-day activities of planners and designers and "autocomplete" some of the laborious processes. There are "great advantages" to this, he says: it frees up time and space to work on the interesting stuff, to innovate and create.

At present, for instance, an AI-generated Picasso scene will create a rough caricature of the artist's style based on the inputs fed to it. But however impressive it might be, it is no more than an approximation – a kind of evolved copy – of existing images and aesthetics rather than something altogether new.

So, determining the future with algorithms needs to be considered "very carefully", he says: "It's a little bit like Modernist architecture in the mid-to-late 20th century. It was meant to be a form of architecture free of baggage and values. But, in the end, you could argue it was fairly post-colonial dominant – and you have the same buildings in São Paulo as you have in Riyadh as you have in Singapore or wherever.

"You want to encourage positive mutations and that's what the rapid processing and multiple iterations of AI and machine learning make possible," he adds. "But also, to ensure that the output is intelligent, and not simply a reflection of the limitations of the inputs." So designers will have to tread carefully and remain conscious of algorithmic bias, where software reproduces errors due to the prejudices of the software designers.

Haukeland argues that more design options and therefore more variety can hardly ever be a bad thing. But if you look at history, he adds, revolutions in architecture have occurred across thousands of years and in the end, there's always something new, better, or smarter that builds on the past. "It's easy to stand here at the beginning of a new era and say this will change everything," he says. "But in 10, 20 or 30 years' time, we might say that generative design and AI was super interesting but it had its weaknesses. So I don't think humans have come to the end."

Imdat As wonders what designers would work on if AI were to produce 90% of the buildings.

"The top 10 designers – the Zaha Hadids, and so on – will always be there, with new ideas, new aesthetics. Those will be the designers who come up with a new design idea," he says. "And what if they trained in-house AI systems? Instead of, say, 10 buildings a year, they might build a million, all over the world. The power of AI for an architectural company could be amazing. The business structure could be: if you use my AI system, you pay royalties. It could change architectural practice models. I think there will be those types of changes."

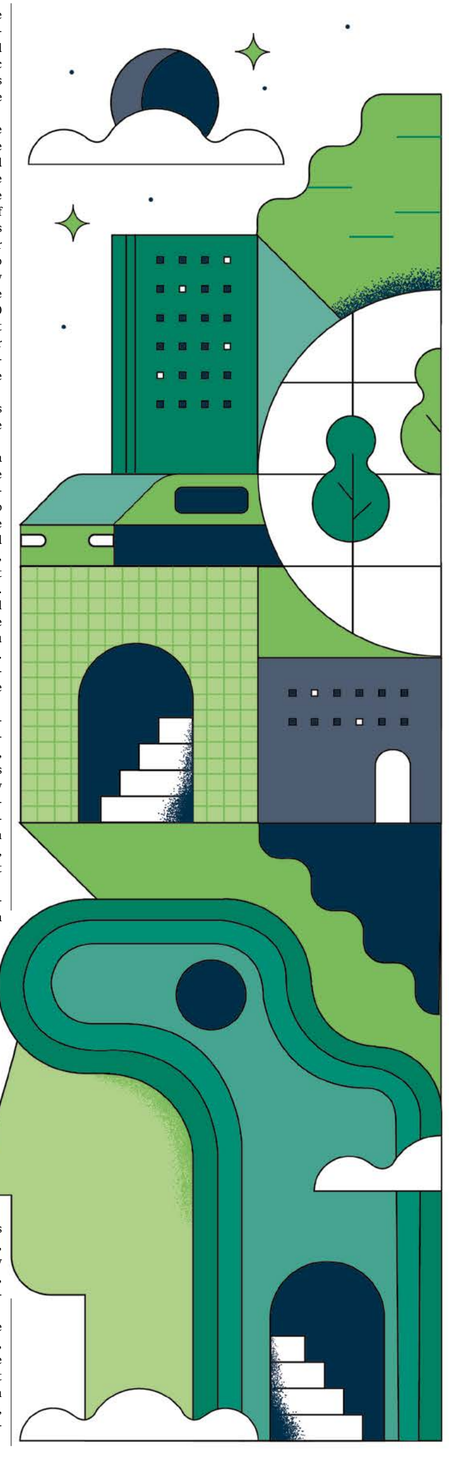
Presently, it is unlikely that residents would notice at all if computers helped to build their housing, angling a complex five or six degrees to maximise liveability. And it may be too early to tell whether algorithmically designed buildings and cities will leave telltale AI marks in their floorplans or on their façades, but As is hopeful that "its own sort of urban morphology" will emerge.

Barrett wonders if the "step-change revolutions you get with accidental, erratic, unique or eccentric human inputs" could ever occur with artificial intelligence thrown into the mix.

"If you took a city like Paris and ran that as an existing data set, you'd have more Paris," he observes, "which is not a bad thing. But would you ever have had a Pompidou Centre?"

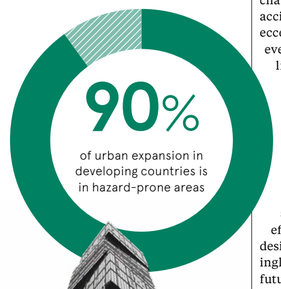
One thing does, though, seem certain. Given the efficiency gains, AI-assisted design will play an increasingly important role in that future planning, developing, building. But just as with software and the complex data sets that inform or mediate our lives, keeping a human in the loop is likely to be a fixture in the foreseeable, "marshalling, judging, and continuing to select", says Barrett.

"After all, while machines are learning to navigate environments, they can never know the experience of doing so," adds Watson. "We must never sacrifice the feel of an urban landscape at the altar of efficiency, nor cause a malfunction in any person's enjoyment of a resource." ●



CHALLENGES FOR CITIES

World Bank



500 million
city-dwellers are exposed to rising sea levels

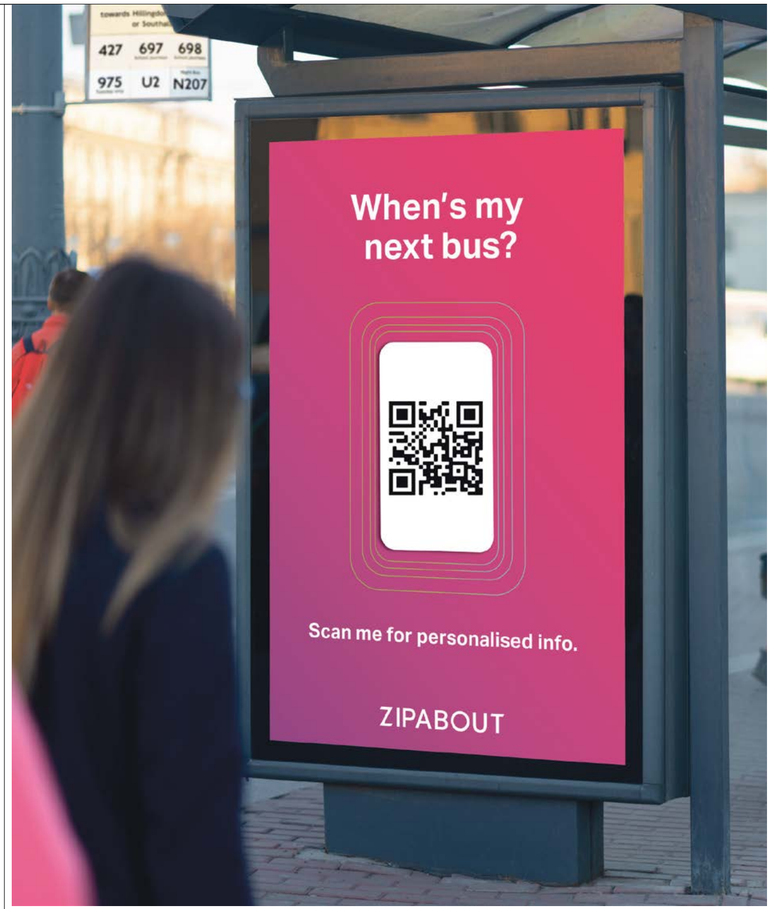
1 billion people live in informal settlements in cities

1.2 million km² will be added to cities via urban sprawl

Commercial feature

Ethical tech will spearhead a new era of urban mobility

A new generation of ethical technology that's free, unbiased and data-led could solve urban transport challenges



Improving passenger experience with real-time info

If cities and towns in the UK, and beyond, are to thrive they need to focus on getting mobility right. In the decades ahead, urban areas must meet net-zero targets and slash car use as well as create cleaner and healthier living environments. But getting people to use more trains, buses or bicycles is no easy feat.

Revitalising ailing urban centres is also a herculean task. They are continuing to struggle in the wake of the pandemic, fuel price spikes, and the cost-of-living crisis. At the same time, the work-from-home culture persists, depriving urban centres of workers, shoppers and commerce. From Belgrade to Birmingham, cities are having to rethink how they operate.

"Mobility is the single most important thing local authorities can focus on. If they get it right, they can achieve multiple goals simultaneously. Making it as easy as possible for travellers to make the right choices is crucial, ones that have no bias whatsoever are also vital, and so is integrating various transport services. This is where digitalisation and data come in," explains Alex Froom, CEO and founder of Zipabout, which is the UK's leading personalised transport information provider.

In the past few years, mobility-as-a-service (MaaS) has been considered the panacea for urban areas. The idea is that if you offer up mobile apps to people with information on transport options and convenient ways to purchase tickets or mobility services, they are then better equipped to manage their travel. Many pilots have been rolled out, with varying degrees of success.

"Most apps have been designed primarily to benefit commercial players: they just make it easier for people to purchase tickets they can already buy, or services they already have access to, more conveniently. This is different to providing impartial, free mobility solutions to real-life communities," says Froom. Zipabout has worked with London, Kuala Lumpur and Zagreb, providing patent-pending tech that predicts transport demand.

"Very few solution providers offer services to, say, socially deprived areas where education and employment are linked to public transport access. Concessionary or discounted tickets don't always make money for MaaS providers, and neither does incentivising people to walk or cycle, which is vital if we're to get more people out of cars. Getting people to where they need to work, go to school or hospital should be the focus, joining up mobility around people's real needs, rather than focusing on ticket sales."

Universal basic mobility – the idea that all citizens should have a decent range of affordable transport options, regardless of socioeconomic status or disabilities – is unlikely to come to many urban areas soon. In England, 1.5 million people are at risk of being transport poor, according to a government study. A figure that's grown since the pandemic.

"Predicting demand is the starting point to solving this mobility crisis. Knowing where people want to go, what their intent is, and when they want to travel is vital to understanding the issues that an urban area faces. How people will use mobility services in the future is also more important than what they've done in the past," says Froom; Zipabout works with National Rail, P&O and the UK's Department for Transport.

Over- and under-utilised transport routes combined with a lack of real-time information can plague passengers, local authorities and operators. Networks are often poorly planned, while schedules don't reflect the reality on the ground. All of which leads to poor-performing transport systems that are inefficient, costly and poorly used. They also don't solve socio-economic challenges and accessibility issues.

Right now, urban mobility solutions are dominated by well-funded digital mobility or MaaS players that make money by selling tickets or paid-for travel solutions. This has led to a proliferation of apps that crowd people's smartphone screens. They also track personal location, but don't support the real transport needs of passengers, authorities and public transport operators in unison. The focus has also been on a wealthy demographic.

"We don't use an app, there are too many. Instead, we use WhatsApp, Messenger or SMS to send the right information to travellers. We don't need or sell personal data, and we don't monetise the end-user. Instead, we direct users to businesses that they may find useful or team up with brands who want to offer unbiased travel information. This is based on a first-of-its-kind ethical AdTech model that enables geotargeting without any location tracking or personal information sharing, which has already been successfully trialled with Pret a Manger and WH Smith," says Froom.

> There's no need for a gimmick accelerator culture which creates yet another app

"Every traveller needs to be given ethical, impartial advice so they can make the right choices. Local authorities need an easy-to-use toolkit that allows them to utilise data, provide insight and communicate with the public. They also need to be able to share knowledge with other cities, so they don't create systems from scratch unnecessarily. This is where we come in. We can only realise ROI for cities by slowing things down and working collaboratively. There's no need for a gimmick accelerator culture which creates yet another app. We partner with local authorities to enable innovation and, unlike others, we offer our technology for free."

Oxfordshire County Council will be the first UK local authority to roll out Zipabout's technology, aiming to cut car journeys in Oxfordshire by a third by 2040. Councillor Andrew Gant, Oxfordshire County Council's cabinet member for Highway Management, says: "It is vital that we can provide people with information that shows the benefit of cycling, walking and public transport, and we hope it will help more people move away from car use. This council strives to be at the forefront of innovation by working with technology partners like Zipabout to provide the best solution for residents. Technology that is driven by data to encourage positive behavioural change away from cars is something we are keen to promote and champion."

Froom comments that even incremental change matters. "Getting 5% more people onto buses and out of cars can cut emissions in some cities by a lot. This 'decelerator' model is the way forward and we're looking for a cohort of international cities to join the forward-thinking authorities like Oxfordshire to achieve sustainable change," he says.

To solve your urban mobility issues go to zipabout.com/local

ZIPABOUT

Greater London Authority

INDUSTRY INSIGHT

'Bold and immediate action is desperately needed to address the climate emergency'

Cities like London are leading efforts to create cleaner and more equitable urban living conditions through determined policy and investments in clean energy. But more international cooperation and political resolve from national governments is needed to achieve our climate goals

Sadiq Khan

This year, record-breaking temperatures across the world have triggered intense wildfires, disrupted transport systems and displaced whole communities. In Europe, deadly heatwaves have claimed the lives of thousands of people, and in London devastating fires have reduced homes to ashes, destroyed businesses and led to the loss of precious personal belongings. At the height of this summer's heatwave more than a dozen major fires were raging across our city at the same time, with the London Fire Brigade facing its busiest day since the second world war.

These events should be a wake-up call for us all. Not only have they laid bare just how vulnerable London is to climate change, but they've also starkly illustrated that no city or country can escape the fallout from man-made global warming. The climate emergency is by far the greatest challenge confronting our world today and it's something we cannot simply wall ourselves off from or wish away.

There is a critical need to address this menace immediately because the costs of inaction are clearly going to be far higher than the costs of decarbonising our cities and our societies now. Cities must lead the transition from carbon-based economies to people-centred economies of the future. This is how we will achieve our climate goals and how cities themselves will reap the rewards of urban climate action – decent jobs, better public health and more resilient communities.

Although there has been relative inaction from national governments, cities are indeed stepping up. In London, we have made real progress in recent years to clean up our air and bring down emissions. We have taken world-leading action, first, by introducing London's ultra low emission zone (ULEZ), and then by expanding it to 18 times its original size. We are now proposing to expand it to the whole of Greater London to further reduce congestion, air pollution and greenhouse gas emissions. Doing this will lead to an estimated 5 million people in outer London breathing cleaner air daily. But our efforts are not stopping there.

We have made a commitment to get to net-zero carbon emissions by 2030 and in January this year, I published a pathway to achieving that target. I've committed to issuing a green bond, which aims to cement London's status as a world leader in green finance, as well as stimulating our economy by unlocking up to half a billion pounds of additional investment in green projects from the private sector.

Transport for London (TfL), the single largest consumer of electricity in the city, has also now launched a tender to secure the first 10% of its power from renewable sources. This will help drive demand for wind and solar farms, which in turn will help to create green jobs, supporting not just employment opportunities in London, but across the UK.

This is a major first step to TfL transitioning to a 100% renewable electricity supply by 2030.

> The costs of inaction are clearly going to be far higher than the costs of decarbonising our cities now

Earlier this year, I was pleased to announce that the London Pensions Fund Authority confirmed it had divested from all extractive fossil fuel companies within its listed equity portfolio. In addition to this, I've also seen to it that our city has signed up to the fossil fuel non-proliferation treaty initiative – making London the first megacity to do so. This is a global plan to phase out fossil fuel production and accelerate a just and fair global energy transition. It places equity at the centre so that no country, community or worker is left behind in the shift to clean energy and zero-carbon solutions.

We know the impacts of climate change in London and across the globe are not shared equally. In London, areas with a higher proportion of Black, Asian and minority ethnic communities are more likely to face the highest climate risk, including flooding, exposure to toxic air and heat risk. The same applies around the world with those in the Global South, who have contributed least to these problems but are the most severely affected by it.

The commitments being made by C40 Cities – a global network of mayors taking action to mitigate and adapt to climate change in their cities – are shining examples of the collective action and cooperation needed to achieve our climate goals and achieve them in a fair and equitable way. As C40 chair, I have also allocated two-thirds of our budget to support cities in the Global South and as we look towards COP27, we must think about how we can scale up our support for those cities and countries that are already at the sharp end of this crisis.

Bold and immediate action of this kind is desperately needed to address the climate emergency, the main cause of which is undeniably fossil fuels. When I formally took over the chair at COP26, I emphasised the role cities are playing as the 'doers', not the 'delayers'. The action we've already taken in London proves this is the case and I remain optimistic that with the political will to be bold and fearless, collectively we can make great strides in tackling the climate crisis.

In our battle against this era-defining challenge, cities are stepping up. But governments across the globe must now do the same. Organisations like C40 Cities stand as examples of what can be done globally, but as an international community we must redouble our efforts. There can be no backward steps. We owe it to future generations to do right by them.

For years, climate change deniers have attempted to thwart climate action. But today the biggest obstacle to reducing our carbon emissions isn't the climate change deniers, it's the delayers. The time for empty rhetoric and hollow gestures is over. The time for urgency and action is now – not in 10, 20 or 30 years' time.

We can tackle climate change successfully if we act now and act together. From getting a grip of the cost-of-living crisis, to ending the tragedy of children dying from toxic air pollution, the answer is to end our addiction to fossil fuels and rapidly ramp up investment in the green economy. This is how we can continue building a better London for everyone – a city that is a fairer, greener, safer and more prosperous place for all. And it's also how we can build a better, more just, more sustainable and more liveable world.


Vladimir Zakharov via Getty Images

DISTRICT COOLING

Cool ideas: how technological innovations can reduce city temperatures

Removing reflective surfaces, increasing natural shade and harnessing the power of sewage are all options to limit the 'heat island' effect – but progress will stall without collaboration and political boldness

Oliver Pickup

Below a cloudless, blueberry-blue sky, where the sun blazes fiercely and gleams from London landmarks, a multi-person mass of liquifying limbs smoulders. The caption for Zoom Rockman's *Private Eye* cartoon reads: "I love London; it's such a melting pot."

But few people were laughing when, on 19 July, the UK temperature exceeded 40C for the first time, according to the Met Office, and the city's infrastructure melted – literally. Half of the six areas to surpass that level were in and around the capital: St James's Park, Kew Gardens and Northolt.

With global warming an increasingly hot topic and residents figuratively melting, the heat is being turned up on politicians, planners and other key stakeholders to keep cities cool.

Just days after the record high temperature, the mayor of London, Sadiq Khan, loosened purse strings. He awarded £2.85m from the Green and Healthy Streets fund to 19 projects, including rain gardens, tree pits and sustainable drainage areas. Further, a £1m grant will support "innovative and exemplary projects" on the Transport for London Road Network, and £150,000 was released to improve walking routes connecting green spaces.

"We cannot shy away from it: the climate crisis is on our doorstep," wrote Khan on LinkedIn in early August, announcing the funding decisions. "We're taking action before time runs out and investing £4m … to make London more resilient to heatwaves."

He added: "Working with London boroughs and TfL, these projects will make London more resilient against extreme weather, plus make our streets more green and pleasant for Londoners. It's a win-win."

Collaboration and careful long-term planning are both paramount to reducing the impact of extreme heat in cities. And investing in innovative technology solutions can accelerate the virtuous circle to which Khan alluded.

Indeed, embracing an approach to building that keeps nature in mind, rather than seeking to dominate it, will lead to better urban spaces for both people and the planet. So says Chris Bennett, co-founder and managing director of sustainability services at Evora Global, a London-headquartered real asset consultancy.

"Our urban environments are dominated by densely grouped buildings made of reflective materials creating a 'heat island effect'," he explains. "This is why it's often hotter in cities than rural areas."

Bennett believes simple tech and nature-based solutions will make a big difference.

"Reducing hard reflective surfaces such as road pavements would help to lower temperatures," he says. "Re-engineering pavements to be permeable blocks, instead of concrete or Tarmac, would allow water to flow through the pavers in wet conditions and evaporate when the heat rises, which helps in creating a cooling effect.

"Also, incorporating trees and plants reduces the reflective nature of the streetscape, provides habitats for wildlife and offers shelter from harsh ultraviolet radiation and solar heat during summer."

Ironically, it is partly due to technology that we find ourselves in this sticky situation. Since the 1960s, planes, trains and automobiles have heavily contributed to global warming, and cities have evolved to accommodate gas-guzzling vehicles. So it's time for a swift U-turn, says Bennett.

"In London, we are blessed with many urban parks and squares that were created by the Georgians and Victorians. But many of the city's trees have been lost to provide car parking spaces," he says. "Planting street trees will increase protection from the climate by reducing heat stress and limiting the degradation of the urban construction materials, making buildings last longer."

Another expert urging cross-industry action is Håvard Haukeland, co-founder and CEO of SpaceMaker AI. His company provides early-stage analysis for architects and urban planners and enables buildings to be designed with the local microclimate in mind to minimise urban heat islands.

> **The way our cities have been designed is no longer appropriate for modern times**

"The way that our cities have been designed is no longer appropriate for modern times," he says. "As temperatures rise because of climate change, the design choices previously made – either due to tradition or practical considerations around energy efficiency – are making our cities even hotter."

Haukeland contends that architects and urban planners need to step up. "While solutions such as additional greenery or reflective roofs can help keep things a little cooler, the reality is the most impactful solutions are done at the early stage when new developments are being built," he continues.

Design adaptations – including rotating structures to "open up" for wind or even altering the shape of a building – can make "the biggest difference to microclimates", Haukeland says. Although these solutions are "much harder to implement", he is clear that designers "must consider microclimates at the outset".

That may be so, but how should cities upgrade older infrastructure so that it is better able to withstand extreme heat? "This is the critical question when you think about the number of heritage and older buildings we have in the UK," says Ian Ellis, smart buildings expert at Siemens Smart Infrastructure. Sensors that capture data and allow deep analysis of how people use buildings – especially as hybrid-working strategies are firmed up – could be the answer.

"This technology is already being used in buildings across the UK, where it can provide usage data on the flow of people through a building, where they congregate and how they use it," says Ellis. "Data like this provides invaluable insights in optimising other technologies like heating and ventilation systems."

Sebastian Peck is a partner at Kompas, an early-stage venture capital firm focused on transforming the built environment. He lists some pioneering solutions to cool cities. "Vertical Field is installing sensor-controlled smart planters that purify the air from carbon dioxide. And, when these are mounted to buildings, they help to insulate them from the sun," he says.

Meanwhile, Lumiweave has developed an innovative fabric that provides shade during the day and harvests the sun's energy to illuminate itself and its surroundings at night. "And," Peck continues, "TreeTube has a patented modular system of tubes that lets tree roots grow safely in a tunnel without disrupting their surroundings."

Peter Hogg is UK cities director at global design, engineering and management consulting company Arcadis. He offers a more practical – but pongy – example. "We're looking at using effluent as a heat exchanger that allows you to extract energy used for cooling with minimal carbon impact. Imagine the potential in a city the size of London, which houses 8.5 million people."

At this stage, no idea should be flushed away. And while there is much work to do, the willingness to force change – and think up unusual solutions – is finally evident, Hogg suggests. "The pandemic was a watershed," he says. "There is a collective understanding that this situation must be addressed. Today, building plans that fail to consider the climate challenge won't manage to attract investors.

> **We're looking at using effluent as a heat exchanger to extract energy used for cooling**

"Before the coronavirus crisis, you would have to go to the Netherlands or the Nordics to find people taking this seriously. We now acknowledge that significant behavioural and structural changes are required, and quickly."

Peck concludes that enough technologies are available to cool cities but to harness their power, leaders must be bold.

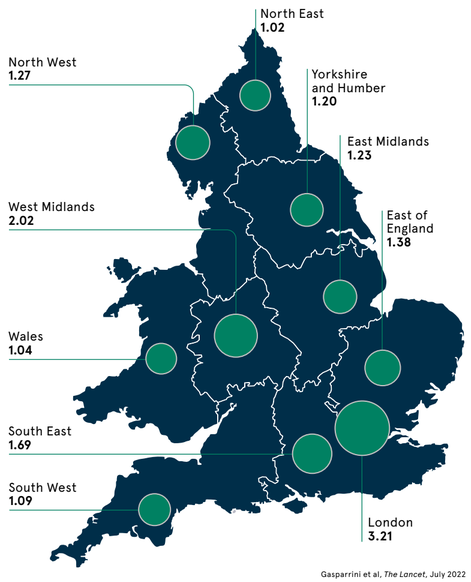
"The difficulty is that urban planners need to rethink our cities, make them greener and ensure water is put to good use," he says. "But changing and building back existing urban infrastructure is expensive.

"Cities are under pressure to demonstrate to the public that their scarce resources are well invested.

"In other words, cooling our cities is not a technological challenge, but a political one."

THE URBAN HEAT CRISIS

Heat-related excess mortality rates



Gasparrini et al, *The Lancet*, July 2022

IoT's impact on cities? – better air quality and greater wellbeing

The ability to measure air quality in a more cost-efficient and intelligent way will prove crucial to increase wellbeing among citizens as cities compete in the new age of the internet of things

Rapid growth in urban populations has accelerated the evolution of smart cities and the technologies that enable them, including the internet of things (IoT), artificial intelligence (AI) and cloud computing. Today, more than 55% of the world's population lives in cities and this is expected to rise to 68% by 2050. In Europe, the figure is already greater than 74%.

To compete on the global stage, cities have had to digitise to meet the ever-increasing demands of their inhabitants for resources and services. A key point of differentiation amidst this rise of smart cities is guaranteeing the maximum level of wellbeing to citizens. First and foremost, wellbeing concerns our physical health, which starts with the quality of air we all breathe.

Reducing air pollution is a health emergency. Countless studies have linked poor air quality to increased mortality and lung disease, and reduced particulate pollution to better public health. But although the air quality situation is urgent, gradual progress has been made and there is still time for cities to take action. An American Cancer Society study in 2009 found the 2.7-year increase in US life expectancy between 1989 and 2000 was strongly linked to reduced PM2.5 air pollution during that period.

Accurate, transparent data is now essential to improving air quality in cities further, empowering citizens with permanent access to real-time insights that drive better decisions for their health and wellbeing. To achieve this, cities need a more complete map of air quality. The more air quality measuring points, the more accurate information they can collect and ultimately share.

Though this may sound simple, the way air quality is traditionally measured presents barriers. Cities typically have several ultra-high-performance air quality measurement stations called 'reference stations' which are, in effect, small chemical laboratories. While the measurements are high in quality, the stations are very expensive to acquire and operate, requiring manual collection of samples and weighing the micrograms of particulate matter on a precision balance.

"The economic and operational challenges associated with reference stations are so prohibitive that many cities cannot viably deploy enough of them to achieve high spatial granularity," says Alicia Asín, CEO of Libelium, which designs and manufactures wireless sensor network devices for reliable IoT and smart city solutions. "Thanks to IoT, however, cities now have a better option."

> **The challenges associated with reference stations are so prohibitive that many cities cannot viably deploy enough of them**

Libelium has designed an air quality station that offers high performance at a much lower price. This station measures the five most important pollutant gases as well as particulate matter, weather conditions and noise levels. But it does more than just collect data. Thanks to AI and machine learning algorithms, simply placing a smart air quality station next to a traditional reference station enables it to share the data with other air quality stations in different parts of the city.

"One of our mantras as a company is 'behind the change, beyond the challenge'," says Asín. "Libelium has been designing and developing smart technology for cities for more than 15 years, even before this technology was called the internet of things. This has allowed us to be behind the change, driving the crucial digitisation and intellectualisation of many public and private companies as well as cities. But we always want to go beyond the challenge too."

In the context of air quality, Libelium sees an opportunity to go beyond the challenge by utilising IoT and AI innovation to suggest or even automate regulations, permits and bans based on its data. For instance, if the data shows air pollution in a part of a city exceeds regulations or healthy limits, Libelium believes it will be able to send notifications to vehicle owners so that they can avoid entering that area, and redirect them to other parking areas with free spaces.

"Since Libelium develops IoT technology in other verticals, such as smart water, waste management or parking, our solutions can build a complete smart city," Asín adds. "This is what cities will increasingly compete on. We are in a green revolution where governments are finally leading a new sustainability paradigm. We are a priority partner on the road to a new economy."

For more information, visit libelium.com, manxtelecom.com/business/iot

libelium
Behind the change. Beyond the challenge.

mtg
MANX TECHNOLOGY GROUP

BROADBAND

Could an overreaching Openreach stall the great British roll-out?

The government wants to provide universal access to ultrafast broadband by 2030. The installation of fibreoptic networks has progressed well lately, but the hardest yards are yet to come

Rich McEachran

If the government is ever to achieve its much-trumpeted goal of "levelling up" the UK economy, the whole country will need reliable ultrafast internet connectivity. This is why Westminster is keen to roll out gigabit-capable broadband nationwide before the end of the decade.

The aim is to enable businesses to compete on the same technological playing field, whether they're in a bustling city centre or a remote rural outpost. A fully fibreoptic cable network known as fibre to the premises/home (FTTP/H) is the way to achieve ultrafast download speeds in the region of a gigabit per second. To give some perspective, 1Gbps is roughly 17 times faster than the average domestic superfast connection – about 60Mbps – which often uses copper cable over the last metres between a distribution point on the street and the premises in a less efficient set-up known as fibre to the cabinet.

The government's intermediate target is to provide at least 85% of the nation's premises with gigabit connectivity by 2025. The pace of the full-fibre roll-out so far suggests that this is in reach. As of 7 July, 69.2% of homes in the UK were gigabit-capable, compared with 42.2% the previous July and only 22.6% the year before, according to comparison site thinkbroadband.com.

Kester Mann is director of consumer and connectivity at research and advisory company CCS Insight. He notes that the roll-out's rapid progress over the past two years has been aided by "long-overdue investment" from BT subsidiary Openreach, the sector's dominant player, and the arrival of dozens of alternative network providers, known as altnets.

"Many of these have backing from wealthy investors," he adds. "It's a far cry from years of non-commitment and inactivity."

Despite the encouraging signs, full-fibre deployments in most other European countries are further advanced. The latest data from industry body FTTH Council Europe shows that, as of September 2021, Iceland, Spain and Sweden were leading the way, while only Austria, Belgium, Germany and Greece had a lower full-fibre penetration than the UK.

> **There isn't a level playing field when it comes to securing private and public funding to build fibre networks**

Openreach's CEO, Clive Selley, told the *Financial Times* in June that Brexit was making it harder for his company to hire skilled workers from the EU and thereby "constraining the rate of fibre build" in the UK.

These labour shortages, combined with energy price inflation, rising interest rates, and supply chain disruption, are threatening to dampen some of the recent momentum, according to Mann.

It's clear that more will need to be done to support the roll-out, especially in rural areas, if the government wants to prevent its 2030 target from becoming nothing more than an ultrafast pipe dream.

Matt Rees is chief network officer at altnet Neos Networks, which provides telecoms services to the public and private sectors. He observes that "it is, of course, more economically viable for new fibre to be laid in dense urban areas – which has been the focus of early deployments. But that leaves 'notspots' in more rural areas, creating bigger disparities across the country."

One of the big challenges of building rural networks is dealing with wayleaves. These are contractual agreements between telcos and land owners granting the former legal access to private property so that they can build and maintain equipment. Securing one can take several months to a couple of years. If a wayleave cannot be agreed, the telco may have to reroute its planned network.

The industry is asking the government for more help with wayleaves as part of the Project Gigabit, the latter's £5bn programme to level up the 20% hardest-to-reach premises in rural areas.

Westminster has committed less than a quarter of the pledged funding so far, according to Mikael Sandberg, executive chairman at VX Fiber, a Swedish FTTP network provider. This slow disbursement, he says, "has left industry players concerned that the 85% target remains challenging".

Rees adds that other elements of the government's plan leave much to be desired. "The strategy is great in principle, but in reality there isn't a level playing field when it comes to securing private and public funding to build fibre networks," he says.

This has tended to put the altnets at a disadvantage. For instance, Openreach has hiked the prices they must pay in order to use its ethernet products to feed their FTTP broadband to customers. To complicate matters, towards the end of 2021 Ofcom approved Openreach's so-called Equinox offer to cut the price of its FTTP network for internet service providers in return for their long-term commitment to using it. This prompted immediate protests from altnets that had been pumping billions into rival FTTP networks – most notably, CityFibre.

The concern is that the Equinox pricing scheme could weaken full-fibre competition and infrastructure deployment and innovation by undercutting altnets' prices and locking internet service providers into lengthy contracts. If altnets struggle to attract customers as a result, it could drive some out of business.

Equinox has been described by analysts at Barclays as a "land grab" that weakens the business case for altnets. The Independent Networks Cooperative Association has predicted that altnets will cover nearly 30 million British homes by 2025, but that forecast has started to look over-optimistic.

What's more, where altnets do deploy their networks, there's a real possibility that Openreach could simply build over them.

"Multiple providers laying fibre in the same area, all targeting the same households, is an inefficient, costly scenario," Mann says. "That would do little to assist the government's plans to bring more people online and narrow the digital divide."

The race to be the first to lay fibre in an area risks fragmenting the market, he warns. It means that some altnets are destined for commercial failure. For many of the smaller players, then, joining forces may be the only way to survive.

Ultimately, Openreach's Equinox gambit and overbuilding could result in full-fibre infrastructure losing its value altogether.

As Rees observes: "Levelling up is required in the supply chain too."

THE PACE OF GIGABIT-CAPABLE BROADBAND ROLLOUT HAS ACCELERATED

Percentage of residential and business premises with access to gigabit-capable broadband, postcode-level data

Thinkbroadband.com, 2022

Commercial feature

Taking the heat out of climate change

To achieve energy efficiency as part of a wider carbon-reduction strategy, cities should reconsider the way they use their heat

During a summer marked by record high temperatures so severe in some parts of the world that they resulted in wildfires, understanding the implications of 'heat' in a climate change context is becoming increasingly important.

At the most recognised level, it is now well established that unless the average global temperature can be prevented from rising by more than 1.5°C over the next decade or so, we are likely to experience further severe heat extremes.

Interestingly though, as well as being part of the overall global warming problem, heat also promises to become part of the solution as a means of helping to cut greenhouse gas emissions and eliminate energy waste.

Carbon footprints in the city

The situation is this: by 2050, around four out of every five people around the world are expected to live in cities, up from 55% today, according to the World Economic Forum.

The problem with this situation is that while cities cover less than 2% of the Earth's surface, they currently produce 75% of all global CO_2 emissions, points out UN-Habitat. Its mission is to create a better quality of life for people living in urban environments.

As to why cities have such a high carbon footprint, it is because they are responsible for consuming 78% of the world's energy – a figure that, without intervention, is likely to increase, not least due to innovations, such as a shift to electric cars.

Electricity and heat production are big factors behind these huge consumption levels, and account for just under a third of all carbon emissions too. But such emissions are also growing, according to the International Energy Agency's latest Global Energy Review: in fact, during 2021, they rose by a noteworthy 6.9%, hitting their highest level ever at almost 14.6Gt. This situation was driven by the highest year-on-year growth ever in terms of global electricity demand.

How to make cities more sustainable

In other words, cities are currently major contributors to the climate crisis, with electricity and heat production being key factors here. This means that at a time of aggressive urbanisation, finding ways to reduce waste and increase energy efficiency are crucial if cities are to become more sustainable without residents' quality of life being severely impacted.

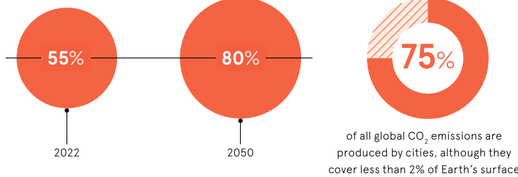
As Michael Lewis, E.ON's UK CEO, says: "We need to recognise that gas central heating – now one of the UK's largest sources of emissions – must be replaced with cleaner alternatives. This means electric heat pumps for the majority of domestic heating needs, as well as low-carbon heat networks utilising waste heat as a source."

One way of doing this is to transform one or more buildings in a given location into massive energy-saving devices by connecting their electricity, heating and cooling systems together using a flexible grid. Doing so creates what might be described as a 'living organism'.

Like an ectothermic creature, such as a snake or lizard, which can control its own body temperature, this organism is able to use thermal energy intelligently and efficiently by circulating, sharing or storing it until it is required. It is why we chose to call our innovative technology in this space E.ON 'ectogrid'.

URBANISATION WORLDWIDE

Share of world population living in cities



World Economic Forum, 2022

UN Environment Programme, 2020

Balancing unit of ectogrid, Medicon Village

The brains behind ectogrid, is E.ON's Energy Infrastructure Solutions business unit, whose goal is not just to help cities but also industries reduce their CO_2 emissions with state of the art innovative solutions such as the said ectogrid.

The power of the ectogrid

The technology works by turning previously separate heating, cooling and electricity systems, whether they are located in individual buildings, neighbourhoods or entire cities, into networks, or ectogrids, that are coordinated and managed using E.ON ectocloud artificial intelligence software.

Each building on the ectogrid has its own heat pumps, cooling devices and storage systems that E.ON ectocloud controls and operates in real-time, enabling it to constantly adjust the site's temperature based on local requirements. Rather than wasting energy, which is generally the case today, any excess heat or cooling capacity is sent to other buildings for reuse. New energy is only added to the system if all existing capacity has been consumed.

The algorithms in E.ON's ectocloud software likewise collect and analyse data about external factors, such as energy demand, the weather and market prices, thereby continually optimising the system's performance based on wider patterns of activity.

One of the key advantages of balancing, sharing and storing the available energy on each network in this way is that consumption is drastically reduced. Moreover, because E.ON ectogrid acts like a giant thermal battery, it also makes it possible to use intermittent renewable energy sources, such as wind and solar, more effectively without destabilising the system.

As Stefan Håkansson, CEO of E.ON Energy Infrastructure Solutions, points out: "Using energy intelligently equals cutting urban carbon footprints while at the same time preserving people's quality of life. Key to this are the decentralised energy systems of the future, such as E.ON's ectogrid, as they'll help us achieve zero-emission levels in individual buildings, whole neighbourhoods and even entire cities."

Ectogrids in action

One organisation that is making the most of this groundbreaking technology is the Medicon Village science park in the grounds of Lund University in Sweden. The site, which hosts 170 life science companies, introduced a pilot project using E.ON ectogrid in 2020 in conjunction with the Research Institutes of Sweden and the Swedish Heat Pump Association.

Mats Leifland, Medicon Village's former CEO, explains the rationale: "It is as important for us as it is to our tenants that the environmental footprint of everything we do is as small as possible. Ectogrid is an innovation that fits well into what we want to be – a sustainable and innovative science park for research and innovation."

The trial included 15 commercial and residential properties, which reduced their energy consumption by a huge 64%, cutting total costs by 20%. Before the system was introduced, the buildings had consumed a total of about 10GWh for heating and 4GWh for cooling, but the long-term aim is to reduce this figure to 3GWh. The money saved will be reinvested into further research initiatives.

Put another way, if real change is to come about, it will simply be imperative to factor 'heat' into the equation.

"Heat production and consumption are terribly wasteful processes today, so if the energy transition from fossil fuels to renewable sources is to truly succeed, an effective 'heat' transition will be vital too. But it's clear that the time for talking is over - the time for action is now," Stefan concludes.

For more information visit eonenergy.com/carboncountdown

e.on

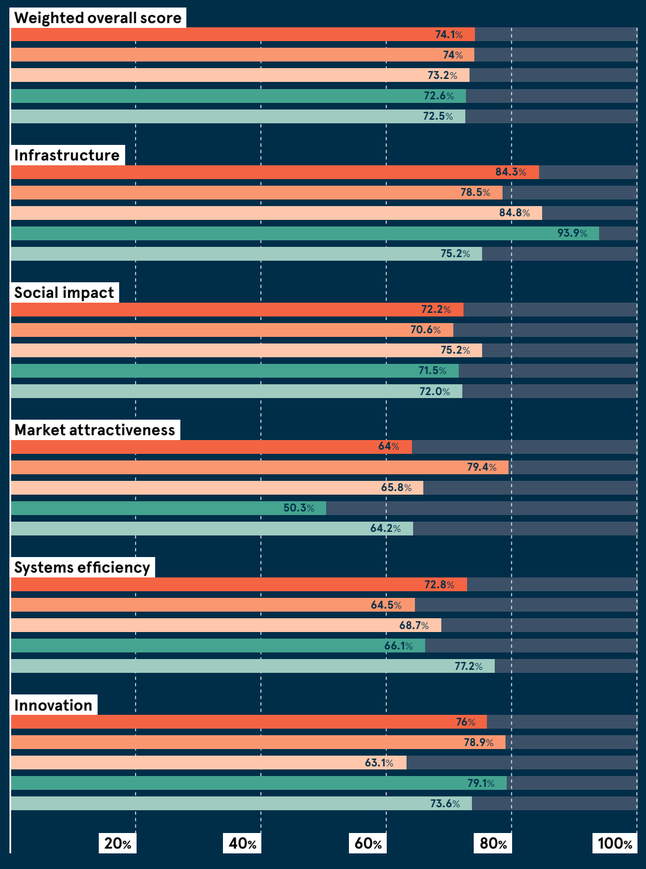
MOBILITY IN SMART CITIES

A key component of the cities of the future is the ability of their citizens to move quickly and sustainably from point A to point B. To make urban mobility as efficient as possible, cities must first lay the foundations with reliable ICT infrastructure and clear policy and regulations to support smart mobility. The end goal is a seamless, fully connected transportation environment bringing together planes, trains and automobiles (and escooters, buses, bikes)

THE URBAN MOBILITY READINESS INDEX

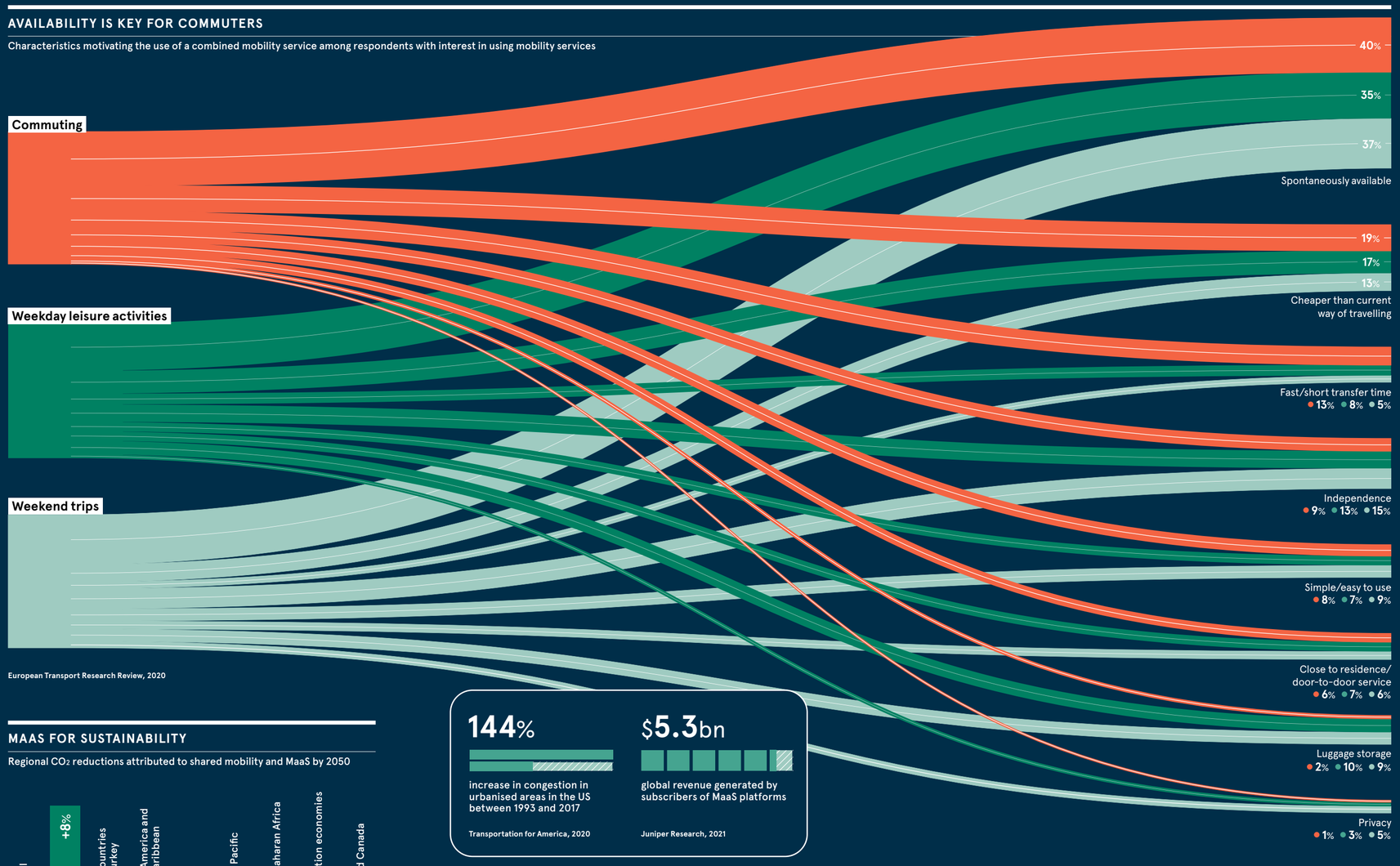
How the leading cities score on the index

Oliver Wyman, 2020



AVAILABILITY IS KEY FOR COMMUTERS

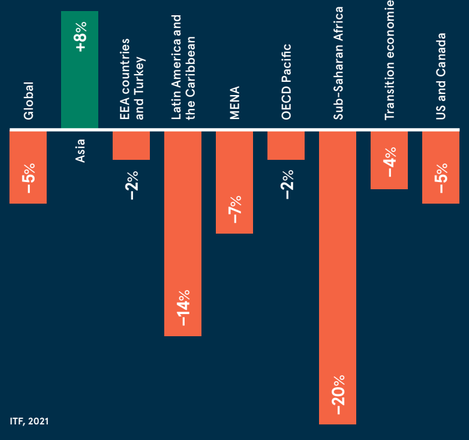
Characteristics motivating the use of a combined mobility service among respondents with interest in using mobility services



European Transport Research Review, 2020

MAAS FOR SUSTAINABILITY

Regional CO_2 reductions attributed to shared mobility and MaaS by 2050



ITF, 2021

144%

increase in congestion in urbanised areas in the US between 1993 and 2017

Transportation for America, 2020

$5.3bn

global revenue generated by subscribers of MaaS platforms

Juniper Research, 2021

REASONS BEHIND THE USE OF NEW MOBILITY SERVICES

Motivations of 8,500 urban respondents, worldwide

Arthur D Little, 2021

Commercial feature

Citizen-first approach in downtown Doha

Some cities are smarter than others; some are more sustainable. Some, like Doha, strive to be both; and the regeneration of its downtown district is key to its success

As the capital of Qatar, Doha is home to 80% of the country's entire population. The success of its urban regeneration is therefore measured on a national scale. This places its newly constructed district of Msheireb Downtown Doha (MDD) firmly in the spotlight.

Developed by Msheireb Properties, MDD is strategically located at the heart of Doha. Its vision for climate-aware urban living seeks to preserve the traditional architecture, while integrating both sustainability best practice and smart-city innovation.

Sustainability at scale, by design

Sustainability is central to Qatar's national development plans. Focused on positive climate action, the government has set a 25% carbon reduction target by the end of the decade.

The country's rich natural resources and track record for environmental performance and attracting international investment further strengthen the value proposition of MDD.

MDD already has a high concentration of properties rated gold or platinum in the LEED green building certification scheme (Leadership in Energy and Environmental Design). But the sustainability remit extends beyond individual buildings.

Not surprisingly, the sun is the primary renewable energy source, with more than 6,400 rooftop solar PV panels providing generation onsite, plus 1,400 solar units for hot water. Conservation of non-potable water accounts for 70% of total city consumption. To support the circular economy, advanced collection and segregation systems allow most waste to be recycled or reused.

In a boost for sustainable urban mobility, a self-powered tram provides green transportation. Those who prefer to walk can do so even during the hottest months, as the streets have been carefully oriented to capture the cool breeze from the Gulf; pedestrian routes include shade from the hot sun.

Such criteria underpin MDD's focus, which puts the wellbeing of citizens first. As well as excellent healthcare facilities, residents enjoy quality-of-life benefits such as playgrounds for children and bicycle paths.

In principle, urban living should always be designed with the citizen in mind. In practice, smart technology can help, says Maryam Sultan Al-Jassim, directorate manager at MDD: "The purpose of technology is to create an easier life for people, in a healthier and safer community. This is how a smart city works – for its citizens. MDD embraces a people-first approach, focused on comfort and welfare so its residents can 'live smart, live better'."

Smart is built-in, not a bolt-on

Smart city solutions need to be built in from the start of redeveloping a full-blown city district, not bolted on at the end. MDD has integrated residential accommodation with commercial and retail space, plus provision for leisure, education, culture and religion. Msheireb Properties has therefore separated the smart rollout programme into four main phases: infrastructure, systems, applications and services.

Much of the infrastructure work goes unseen, as it is often underground – in the case of 430km of fibre-optic cable – or in the digital domain, with full public Wi-Fi.

The systems phase covers a range of requirements, from emergency response to building management and automated smart waste collection. In terms of smart applications, the to-do list spans from 3D data analysis to facilities management and monitoring air quality.

The fourth phase, smart services, encompasses more citizen-facing solutions such as digital signage, a car-location app plus mobile monitoring of home energy and water consumption.

Meeting place for tradition and tech

For MDD, though, the biggest challenge was a classic redevelopment dilemma: how do you treasure architectural traditions while innovating with the most advanced smart tech?

In response, the architectural language of Msheireb was developed in collaboration with some of the world's leading architects, academics and urban planners. Outputs were then captured by Msheireb Properties in the doctrine of the Seven Steps – integrating the spirit and aesthetics of Qatari architecture with the best of sustainable design and technology.

This concept of a living legacy is clearly expressed in the building designs inspired by traditional architecture and patterns used, the Freej-style neighbourhoods, plus townhouses that resemble the familiar Qatari properties, with majlis and courtyards.

Going forward, getting the balance right has proved invaluable, concludes Al-Jassim:

"Maintaining the Qatari architectural language and local identity within the parameters of a cutting-edge modern city is a big achievement. MDD is the true legacy of Qatar, brought to life as a shining example of our heritage that is both smart and sustainable. So, whilst MDD respects and reflects our proud past, it also represents the city of the future, now."

For more information visit qf.org.qa

Qatar Foundation

MSHEIREB DOWNTOWN DOHA

> Maintaining the Qatari architectural language and local identity within the parameters of a cutting-edge modern city is a big achievement

Green Island catalyst for recycling in Qatar

Waste and recycling is a growth market in Qatar. Since 2016, hundreds of start-ups have formed in response to government calls around carbon-neutral goals.

Today, almost every waste stream can be treated by specialised companies, with the right technologies to either recycle, upcycle or transform collected materials.

One problem remains, though, and it is not the industry – it is the infrastructure.

Lack of national waste-segregation infrastructure is putting the brakes on the drive towards a circular economy, leaving eco-aware families and individuals short of recycling options.

Hub to empower community change-makers

In response, Qatar Foundation's Education City campus will soon become home to Green Island, a hub designed by Arab Engineering Bureau to bring together all the country's national recycling companies.

Each firm will install and manage a free waste-collection container accessible to the public, complete with a screen to show how trash gets treated and where it goes.

In total, the 8,000sq m recycling hub will comprise 95 end-of-life shipping containers, donated by maritime and logistics company, Milaha. It will offer six recycling streams: paper, plastic, aluminium cans, e-waste, batteries, and organic waste.

The ambition is for Green Island to provide a go-to eco-lifestyle destination that functions not only as a learning hub, but an interaction space, with a mix of 'infotainment' on offer.

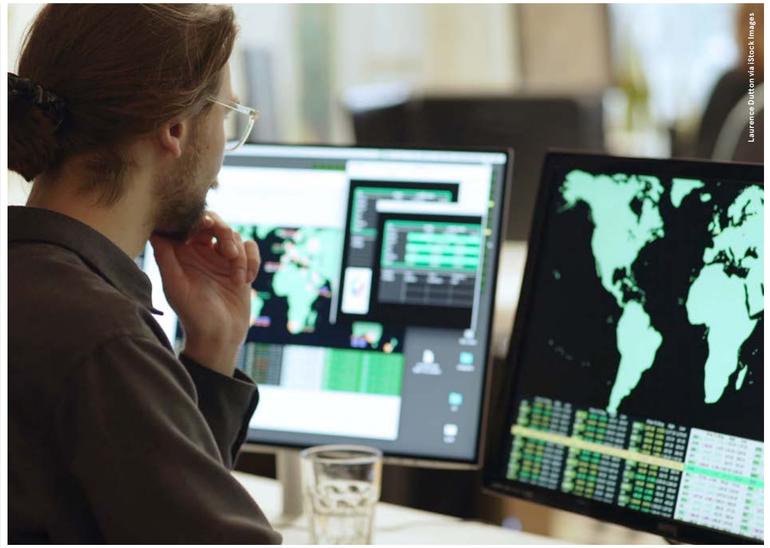
Anyone who segregates waste at home can then dispose of it safely, as part of a unique and rewarding visitor experience. In this way, Green Island will act as a catalyst, concludes Ouassim Alami, Strategic Initiatives Adviser, Qatar Foundation:

"Education City is a test-bed for behaviour-change. We've seen in the past how impactful initiatives such as a car-free day are welcomed and readily adopted. So, our role at Green Island is to empower the community to become active change-makers, themselves."

PRIVACY

Who controls the future?

How do we strike a balance between collecting comprehensive data about citizens to maximise the benefits of smart cities, while protecting privacy rights?



Laurence Dutton via iStock Images

Ouida Taaffe

The collection and analysis of data in smart cities holds lots of promise. According to the UK government, it can "raise productivity, create jobs, improve safety, provide environmental benefits, and make public services more efficient and accessible". It can also, the government says, do that cheaply. The £24m Future City Glasgow project is said to have had an initial return on investment of £144m.

One aspect of smart cities, though, is more worrisome: the threat to privacy and the potential for surveillance and control. In the dystopian 1982 film *Blade Runner*, it's hard to tell who's a replicant and who's human, because the machines have such excellent artificial intelligence (AI) that they're "more human than human". In the real smart cities of the future, making a distinction between man and machine should be trivial. In principle, all 'things' will be networked as part of the internet of things (IoT) and can be constantly monitored and tracked. But for smart cities to work, they will also need data on the human population.

"Smart cities present an interesting opportunity to make society more efficient and sustainable," says Andy Yen, founder and CEO of Proton, which was set up in 2014 by scientists who met at CERN and want to build an internet where privacy is the default. "But as with any digital innovation, we have to be very careful when considering the long-term implications on privacy. The volume of data that could potentially be collected on individuals is enormous and brings with it significant risks."

There are two main issues when it comes to network privacy. The first is the security of the underlying infrastructure. "The networks that we use every day weren't designed for security," says Vito Rallo, an associate managing director in the cyber-risk practice at Kroll. "They were designed to carry data from A to B. They have been patched, upgraded and encrypted, but networks will always be hackable as long as they follow the paradigm of not having security by design."

The second is that hacking may be the least of our worries. Yen argues that the business models of big tech firms – what he calls surveillance capitalism – are inimical to personal privacy. "We have already seen ... social media and other platforms used to monetize and profit from people's most private information," he says. "Meta, Google and Apple have each been accused of exploiting user privacy for business gain multiple times in the last year alone. Smart cities open up additional opportunities for surveillance capitalists to gather more data on people than ever before."

But what could firms or, indeed, governments monitor in a smart city? You might not care very much whether the system knows that you travelled from Holborn to Liverpool Street, or that your voice payment for coffee suggests you're a little tired. But there is the potential for things to get very personal, very quickly. There is already technology that can assess your heartbeat without the need for a physical examination – so-called remote monitoring of physiological quantities. That needn't be sinister. It has obvious value in, say, telemedicine, but it could be used to track individuals in ways that many would find intrusive.

The fundamental question, then, is whether there has to be a trade-off between privacy and using technology and data in a smart city. "While such a trade-off is not necessary, it has unfortunately been treated as one by smart city projects," says Udbhav Tiwari, senior manager, global public policy, at Mozilla. "We think it's possible to optimise service delivery while also balancing privacy and security concerns... The adoption of best practice can go a long way in ensuring that risks are adequately accounted for and mitigated at every stage of a smart city project."

But getting to the right standards could be a challenge. "Having overarching standards for the internet of things has been a problem for years," says Rallo. "And that lack of standards in IoT is a problem for smart cities. The reason why the many proofs of concept and pilots haven't gone mainstream is that we've never been able to reach the level where we could trust them blindly."

Rallo argues that the chain of trust – that is, trust in the entire technological system, rather than in single devices or networks – is essential to using the IoT. "We already live with the idea of the chain of trust even if we don't realise it," he says – pointing out that we're all quite confident about using mobile banking apps.

> The adoption of best practice can mitigate risks at every stage of a smart city project

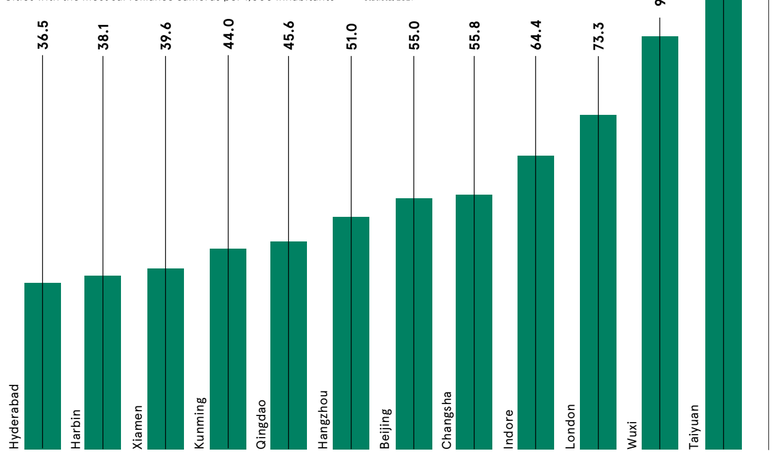
One aspect of the chain of trust is believing that the system won't spy on you. "At any time, the smart city should be able to protect data subjects' rights, for example, the right to be forgotten or the right of access," says Rallo.

The snag, of course, is that the more personal data a user provides, the better the service that a smart city can offer. Rallo says that it is technically possible to draw a sharp line between what is personal and private data and what is not. That applies, he says, even when it comes to training AI systems that need a lot of data to build reliable models, such as those in autonomous driving. "In principle, all the data used by the AI system could be sanitised to ensure that no personal information is included. The question is whether it has been sanitised," says Rallo.

Tiwari also says the promise of smart cities can be realised without a dystopian edge. But it won't be easy, or quick. "Given the rapid digitisation of society, the underlying tension between privacy and convenience in such projects is bound to persist into the near future," he says. He thinks regulators, civil society and industry will have to work together "to ensure that human dignity and the fundamental right to privacy are given their due, both via technological advances but also better governance". ●

SOMEONE'S ALWAYS WATCHING

Cities with the most surveillance cameras per 1,000 inhabitants Statista, 2021



TRANSPORT

City transport systems look skywards

With urban areas set to boom, cable-car systems are a solution to reduce congestion sustainably

Tamlin Magee


John Coletti via Getty Images

When the historian and critic Lewis Mumford said that adding car lanes to deal with traffic congestion was like loosening your belt to cure obesity, his sardonic advice was rarely heeded. Traffic remains one of those facts of life: dirty, congested, rage-inducing, inevitable.

But picture for a moment the last time you were stuck in traffic – gritting your teeth, trapped in your car – and imagine instead you were sailing above it, getting from A to B in half the time of that miserable drive.

That may soon be a reality for Parisians where, from the south-east of the city through to the hilly suburbs of Créteil, 10,000 passengers a day will be able to use a transit line with a difference: rather than by tram, rail or road, this route will be suspended in the air – via a new 4.5km aerial tramway, the Câble 1 (C1), set to open in 2025.

First proposed in 2008, construction begins this year – connecting Paris's populous south-east suburbs to the Métro Line 8 station, delivering passengers into the city in just 17 minutes. Faced with a challenging, hilly environment and much of the region's ground-level space accounted for, Paris decided to build upwards. The cable car route is being built with universal accessibility in mind and, despite the soaring mode of transit, will be boarded at the ground-floor level – with no need for stairs, escalators, or elevators.

"We are convinced of the importance of the cable car in an urban environment," says Lucie Coursaget at Atelier Schall, which is designing the Émile-Combes station for the new line. "They're economical, eco-friendly, 100% electrical, fast to build – and a pleasing means of urban transport for passengers."

Unlike the significant investment costs and planning headaches that are associated with transport infrastructure, building aerial tramways is relatively painless, according to *Innovation Seilbahn* author Frieder Kremer.

"You don't have to build roads or dig tunnels – you just need the columns," he explains. "There's no requirement for a lot of large infrastructure. And if it doesn't work, it's easy to remove and rebuild them elsewhere."

Cable cars are generally associated with tourists ascending ski slopes, but aerial tramways have become a buzzy topic of conversation among urban planners in recent years. As well as Paris, projects are underway in Lagos in Nigeria, Dominica in the Caribbean, and Dubai in the UAE, joining existing networks like those serving Ankara in Turkey, Constantine in Algeria, Caracas in Venezuela, Medellín in Colombia, and La Paz in Bolivia.

In Medellín and La Paz, these *teleféricos* are integrated with the city's existing public transport networks, and ferry 30,000 and 90,000 passengers daily. The outer reaches of these metropolises – both located in valleys within the Andes – were traditionally difficult for locals to travel to and from. With these aerial transit systems in place, previously disconnected residents were, all of a sudden, able to access the beating heart of their cities – affording much-needed opportunities and allowing them to more easily take part in civic life.

Our cities are set to swell, with some projections forecasting that 68% of the world population will live in cities by 2050 and by 2030, 10 new cities will reach megacity status, where populations topple the 10 million mark. Mobility then becomes an increasingly pressing question.

This growth poses a challenge for cities new and old. As urban sprawl spreads and traditional road or rail networks become pollutant-spewing bottlenecks, commute times become unmanageable and quality of life suffers. Meanwhile, retrofitting or expanding existing infrastructure in older cities often proves complicated and expensive.

> **Cable cars are economical, eco-friendly, 100% electrical, fast to build – and they are a pleasing means of urban transport for passengers**

"What happens in most cities is that congestion levels establish themselves at equilibrium level, that is, the limit of what's bearable for people," says Alexandre Bayen, former director of the Institute of Transportation Studies at the University of Berkeley and co-author of the Urban Mobility Readiness Index, which is produced by the Oliver Wyman Forum and UC Berkeley.

Without proper regulation and careful planning, these choke points of congestion can spiral out of control. When that happens, cities need to relieve the pressure.

Aerial tramways could be one method to manage this congestion. For example – and this is a back-of-the-envelope calculation, says Bayen – a cable car with one cabin arriving every 10 seconds or so, capable of carrying six people, could roughly mirror a single lane of a regular highway at capacity.

"It's not a crazy solution for decongestion, as long as it's for very specific local use," Bayen says. "They're one way to do demand management – but you need to find the right origin-destination pairs, where they make sense."

Kremer discovered that, provided they don't exceed distances of 7km, aerial tramways are incredibly efficient. Anything further, and railways are better. And because they are purely electrical systems, they have the lowest emissions of any other form of mechanised transport. Compared to 1.45g per passenger kilometre in cars, a cable car system measures in at just 0.01g – beating even rail, at 0.02g.

Daniel F Morris is clean energy lead at Climate Investment Funds, which is supporting a new aerial tramway in Lagos, Nigeria, to connect Lagos Island to Victoria Island. He explains that, provided an area's energy system is relatively clean, cable cars essentially plug right into the grid.

"You don't have to worry about burning diesel," he says. "Electrification will be one of the main ways we see the world decarbonising over the next decade or two."

So if they're energy-efficient and convenient, why aren't our skylines crowded with silhouettes of intersecting cable cars? One possible reason is as simple as public perception, adds Kremer. Because most of us think of cable cars as gimmicky forms of transport relegated to scenic holiday views, they've rarely been considered a genuinely useful form of urban mobility.

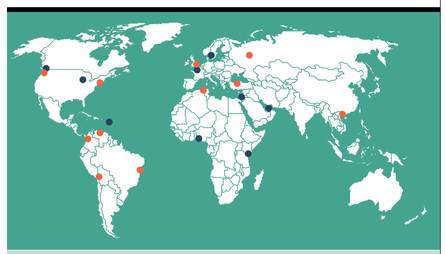
And while people think cable cars are only useful to cross obstacles, that isn't the case, Kremer adds. "If you have two points that should be connected, it doesn't matter if there are houses underneath or a park or a river. It isn't a requirement to have physical obstacles in the way."

Paris's C1 project, though, may help to change these perceptions. For a long time, urban cable cars have been associated with problems of altitudes, explains Coursaget. "Cable cars allow much more than serving territories with different altitudes, it allows us to cross rivers, highways, railway lines. Entire neighbourhoods can be opened up in record time, whereas until now, vehicles, buses and tramways were forced to take long, tedious detours."

While it's unlikely that our future megacities will resemble a sci-fi skyline of bisecting aerial trams, Bayen notes that these systems could be one effective way to alleviate mobility pressure in urban areas.

"It's not a patch, but something that can improve connectivity on a surgical basis, as long as there's economic viability to it," he said. Like home-working, micro-mobility and the extension of tram and rail networks, cable cars could play an important role in providing a bit of extra breathing space in our progressively crowded cities.

Nearly 400 years since Dutch engineer Adam Wybe built the first functioning cable car on multiple supports in Gdansk, it seems these contraptions may finally lift off – connecting hard-to-reach spots within cities, plugging gaps in existing systems. And all at a fraction of the emissions costs. ●



Gondolas take over the city skyline

In operation
Ankara, Turkey
Caracas, Venezuela
Constantine, Algeria
Halong Bay, Vietnam
La Paz, Bolivia
London, UK
Medellín, Colombia
New York, US
Nizhny Novgorod, Russia
Portland, US
Rio de Janeiro, Brazil

In planning stage
Burnaby, Canada
Chicago, US
Dominica, the Caribbean
Dubai, United Arab Emirates
Gothenburg, Sweden
Jerusalem, Israel
Lagos, Nigeria
Mombasa, Kenya
Paris, France

Commercial feature

Mobilising green finance to transform city development

Cities are on the front line of climate action, with 70% of global emissions coming from urban areas. Leveraging green finance at scale and at pace to invest in sustainable green cities is urgent, says **Nina Schuler**, sustainable finance expert at infrastructure consultancy AECOM

Whether you're transforming cities in developed or emerging markets, the opportunities offered by green finance are enormous. Of course, the scale of today's environmental challenges are huge too, so there is an urgent need to swap ideas and plans for implementation and action.

COP26 in Glasgow last year highlighted just how important this decade will be for change, and the good news is that green finance is increasingly available from investors to achieve this. In Asia-Pacific alone, for example, the investment opportunity is estimated to be $1.4tn. Additionally, institutions such as British International Investment, the International Finance Corporation and the UK Infrastructure Bank are looking to provide catalytic funds to support green investment and to make it attractive to more private investors.

Across the globe, prioritising smarter, cleaner and greener cities has become policy for national governments, regional leaders and local authorities. They're all now outlining projects large and small, as well as looking towards stronger legislation and ESG commitments. This has meant the key question we are now asked by cities is: "How do we access more green finance?"

Risks, actions, outcomes

Accessing green finance involves understanding the risks, prioritising key actions and measuring outcomes.

For instance, the dramatic environmental shifts we are seeing due to climate change have accelerated the need for work on mitigation, but less focus is currently being placed on the importance of adaptation measures. Adaptation includes nature-based solutions to help cities handle extreme rain and storm events, coastal protection interventions, and also smart design to reduce urban heat island effects. However, as this is an area with a significant financing gap, there is a critical need to invest in these measures, as well as continuing to fund mitigation.

Here, what is required is an improved understanding of what's at risk. Knowing this is critical to designing the right intervention. At AECOM, we train financial institutions to understand climate risks and how to assess and prioritise climate projects, as well as how to support public-private partnerships to deliver truly sustainable infrastructure.

City leaders have a key role too. They must fully grasp what risks their citizens and infrastructure systems face, and better identify cost-effective improvements. To be credible, they must be able to articulate and monitor what tangible benefits these investments will deliver. Without this, many projects will never leave the drawing board.

> **Knowing what's at risk is critical to designing the right intervention**

Financial institutions willing to provide green finance want to be clear on the exact aims and solutions of city measures, whether that's tackling extreme summer heat, fires and drought, or the winter flooding that causes damage to infrastructure and disruption to the water supply. The long-term returns also need to be clearly outlined, along with data to show that investments will be safeguarded, with the money spent wisely to achieve the biggest positive impacts.

Evidence-based tools like EBRD's Green City Action Plans and Green Financing Roadmaps help both sides navigate this journey together. In Tirana, Albania, a recent Green Financing Roadmap focused on nine priority areas to increase the readiness of the city's key green projects, as well as strengthening the capacity of municipal staff around green finance.

Investing in the future

Beyond capital cities like Tirana, there is an increasing realisation that secondary cities across the world, from Turkey to Kenya and India, will be critical growth centres of the future. This presents an opportunity to get ahead of the curve by embedding climate change mitigation and adaptation measures from the start. In Kenya, we are supporting the World Bank to embed climate resilience in urban planning practices and infrastructure investments across secondary cities.

Longer-term and more radical solutions are also needed. Nature-based solutions to climate change can replace traditional grey infrastructure systems and deliver the same urban resilience objectives while enriching biodiversity and delivering multiple additional benefits across air and water quality, urban heating, public health, noise, amenity, liability, and land value. Convincing decision-makers in cities to consider these alternative solutions requires measuring and quantifying their outcomes and longer-term economic returns even more important.

Smart tools and approaches – such as those being tested in our Natural Capital Laboratory in Scotland – can quantify the benefits of nature and this intelligence can be integrated into investment decisions.

Smart solutions for fairer cities

Smart cities will grow out of a multitude of data streams, analysed by artificial intelligence and machine learning in real time. So, at all phases of development, such data must identify and prioritise green improvements ready for investment.

People-focused green investments are critical too, particularly around climate justice for poorer areas and communities so often on the front line of climate disasters.

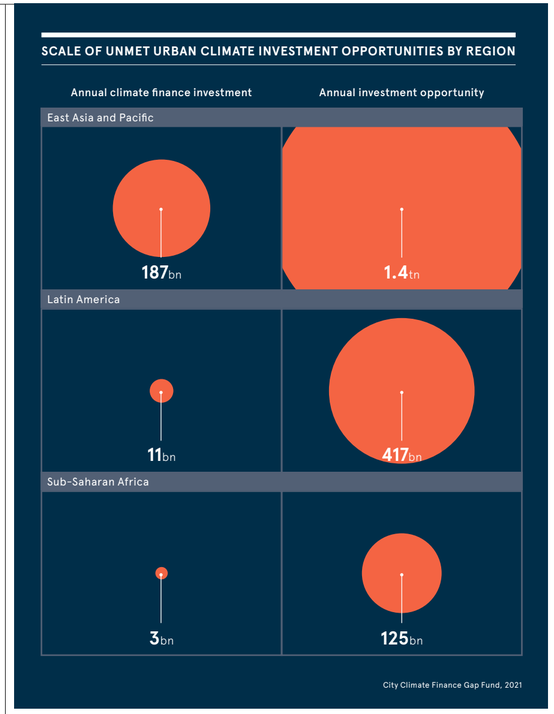
In the US, for example, the city of Baltimore is embracing an equity-based business process to address historical imbalances within the city. Technology is an enabler and facilitator, with data defining areas of need and intervention. It also empowers officials and citizens to make the right decisions toward desired outcomes.

An opportunity to thrive

The UK will need to leverage green finance to create liveable, thriving, and smart cities of the future. Green finance is available, but regional authorities and councils need a greater understanding of where this money is available – and how to access it. New institutions such as the UK Infrastructure Bank are coming online with significant ambitions and £22bn in infrastructure finance.

The need to invest in climate-positive resilient infrastructure is enormous. But city governments – both in the UK and globally – are not alone. Finance institutions and private investors are ready to scale up the green finance for well-prepared climate projects.

It's time to take seriously the crises we're facing by linking post-Covid recovery, cost of living measures and our climate change goals into a sustainable development agenda.



Find out more about our ESG advisory and implementation services at publications.aecom.com/sustainable-legacies

AECOM

Three tips for cities seeking green finance

1 Learn from networks and organisations such as C40 Cities, CCFLA and the Global Covenant of Mayors. See what they are doing and benchmark where you are against their progress and achievements.

2 Invest in good analysis to know your biggest risks and your biggest opportunities. Quantify those risks and benefits. Be sure to explain to your electorate how they can contribute and benefit.

3 Do your housekeeping. Investors will want to see what your municipal accounts look like and know how they are audited. Set yourself up to make fast decisions and take strong and sustained action.

HEALTHCARE

Alliance of science

Citizens with shared healthcare interests are developing data-sharing forums that are giving them greater agency. Could these smart health communities become a key component of the public healthcare system?

Nichi Hodgson

Until the early 20th century, healthcare in the UK was traditionally administered in the community, with medical professionals routinely visiting patients' homes to deliver their services. Since then, it has migrated to hospitals based predominantly in large towns and cities. But, if the Covid pandemic has taught us anything, it's that community-based provision is key in both treating and containing disease, gathering data about the health of people in a particular group and ensuring the dissemination of accurate information.

This is why smart health communities are becoming increasingly relevant to our future wellbeing. These are tech-enabled, scientifically informed networks of people seeking to make better health choices with the help of the latest data. They inspire personal responsibility and self-care.

Daniela Diaz is a mindfulness expert and head of content at Meditopia, an app that helps people to use meditation and other practices designed to improve their mental wellbeing. She notes that, while smart cities use IT "to sustainably promote improvements in all areas, smart health communities use data not only to encourage disease prevention and overall wellbeing in a community, but also to tackle barriers such as minorities' poor access to mental health services and to strengthen a sense of belonging."

Smart health communities are an integral part of the prototypical smart city, linked by social media and networking tools that can unite individuals with similar health needs. Take the Shuggah app, which enables people with diabetes to both monitor their blood glucose levels and connect with each other to provide assistance, encouragement and information about the latest advances in the treatment of their disorder.

Smart health communities are designed to work alongside the health service, providing it with information and offering other forms of support. Diaz says that "they allow us to understand better how our surroundings affect us and vice versa, while improving the efficiency of the traditional healthcare system".

Smart health communities are more about preventive medicine than anything else, according to Hammad Ahmed, the founder and CEO of Longlive, an AI-based app that uses health data gathered from wearable tech.

The intention, he says, is "to help everyone, from health workers and informal carers to the patients themselves, manage chronic mental and physical conditions in the community, thereby reducing the need for in-clinic treatments or hospital stays. Our three core objectives are to empower our users, to promote the sharing of care among family members and to prevent and detect illness. Based on these, we provide all stakeholders with the tools and information they can use to evolve into a smart health community."

> **It's imperative to have the regional technological support that guarantees people's access to high-quality internet services**

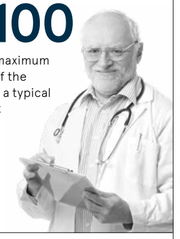
THE POWER (AND VALUE) OF HEALTH DATA

55 million
patients the NHS holds data about

£5bn
is the estimated value of that data, per year

£5,000
is the maximum value of the genomic data of a cancer patient

£100
is the maximum value of the data of a typical patient



EY, 2019

For Mike Reid, co-founder and CEO of healthy ageing app Goldster, smart health communities can even step in where traditional services fall short.

"When the NHS was created more than 70 years ago, that was a great thing. But something like three-quarters of demand on the service now is driven by failures in wellness. If you were to redesign a health system today, you would have a national wellness umbrella above it rather than the other way around, as per our current model," he argues. "This is where smart health communities come in."

Given that the free flow of data is key to their success, smart health communities rely on the quality of the IT infrastructure they use. High-bandwidth 5G connectivity in particular will be crucial to their advancement in the medium term.

Ahmed says: "Their most important aspect is personalisation and connecting people to the most relevant groups. Then comes the flow of key data points, which should aid in the prevention and early detection of diseases."

Wearable tech will be an important part of how smart health communities collect useful information online, he adds. "Consider the Covid pandemic. A truly smart community with the help of sensors and connections could have predicted any signs of infection well before the symptoms had shown up."

But, if smart health communities are to truly flourish and offer the maximum benefit, what they'll really need is greater public support. In the West, that's been somewhat slower to win than it has been in China and the Middle East, for example.

"In the East, there is a real appetite for these things, whereas cultural receptivity isn't as high in the West, where we haven't seen many committed drives to rewire whole cities," Reid says. "The challenge is that many of them are nice enough to live in already."

Yet there may come a time when standards of living in western cities decline enough for such action to become necessary. At that point, getting politicians and other influencers onside would be key to building support for developing smart health communities. But achieving that would require a lot of trust, Ahmed stresses.

"First, we must create a culture of supportiveness and responsibility in these communities, holding members accountable for their actions," he says. "Then there's the task of monitoring the information that flows through the network to ensure that it's not harmful."

But none of this can come before a sufficient level of healthcare knowledge is widely disseminated. As Diaz explains: "We need a broader understanding. In particular, mental health and wellbeing must become familiar concepts for these communities and their governments."

And, of course, the appropriate IT infrastructure must be in place, she says, adding: "It's imperative to have the regional technological support that guarantees people's access to high-quality internet services, especially in rural areas."

> **If you were to redesign a health system today, you would put a national wellness umbrella above it**

As digital tech advances and human life expectancy increases, it seems inevitable that smart health communities will become a fixture in smart cities.

"Increasing demand for a more intelligent way of ageing will become a leading political force," Reid says. "Once it becomes possible to significantly extend our lifespans, that will become the number-one issue for politicians. And then it'll be a matter of not only living longer but living well."

For the evangelists, smart health communities will be the 'wellness glue' that our fragmented society will require to thrive. The strength of that bond will be a question of trust. But what is most definitely clear is that the outbreak of another deadly contagious disease would only expedite their growth.

Energy Superhub Oxford

Largest EV charging network goes live

The world's largest hybrid battery to be connected to the electricity transmission network is helping the National Grid balance supply and demand

Sean Hargrave

If the UK is to hit its 2050 net-zero target, the way that we travel and heat our homes will need to change dramatically. And so will the way that the National Grid balances supply and demand on its transmission network. To understand what these changes will need to look like, a division of EDF Renewables, Pivot Power, teamed up with Oxford City Council and several partners to build the Energy Superhub Oxford (ESO).

There are three main components to the £41m project, which is part-funded by the UK innovation agency Innovate UK. There is the world's largest hybrid battery to be connected to an electricity transmission network, as well as the UK's largest electric vehicle charging scheme. Additionally, heat pumps have been installed in 60 homes.

The battery has been installed in Cowley, close to the Mini Oxford plant, to show how the technology can help the National Grid manage peaks and troughs in supply and demand. One part of the hybrid installation is a massive 50MW lithium-ion battery while the other, smaller, 2MW battery uses the latest vanadium flow technology. The latter has a longer life and the ability to discharge and charge over longer periods but hasn't been used for the entire battery because it is newer technology and so currently more expensive than lithium ion.

Connecting the hybrid battery directly to National Grid's transmission network, says Tim Rose, the ESO's project manager, makes it easier to balance supply and demand peaks and troughs while encouraging the decarbonisation of the country's electricity supply.

"Renewables are a central part in how we decarbonise. But they are less predictable than traditional sources of energy," he explains.

"The National Grid has to finely balance supply and demand and we're demonstrating how battery technology can help. It can store excess power when needed to balance the grid and feed it back when demand is higher than supply."

Deciding when to charge and discharge the hybrid battery is a complex business. It involves factoring in the Grid's need to store or reclaim energy, and the supply and demand needs of numerous energy supply companies. Oxford-based Habitat Energy developed an algorithm that helps with making the decision. This not only involves charging the battery when prices are low, then selling energy when prices are higher but also helping the Grid to stabilise the frequency on the transmission network, explains Habitat Energy's business development manager Ralph Johnson.

"We always look around 48 hours in advance to work out if we have the right state of charge," he says. "We use machine-learning forecasting tools to forecast prices across all the available markets where the battery can trade.

"So that's the power markets, but also the ancillary service markets, such as balancing services required by the National Grid to allow it to run to a fine tolerance around the 50Hz it needs to operate."

Peaks and troughs in supply and demand can cause the frequency of transmission on the National Grid to fluctuate either side of the 50Hz that it needs to operate smoothly. Even a small movement can cause outages and so the hybrid battery can be used to add or remove energy from the network to provide greater stability.

The most public-facing part of the ESO was officially launched on 5 July, when the city's Redbridge Park and Ride facility officially unveiled the country's largest electric vehicle charging service. It is made possible by a high-capacity underground cable linked directly to the National Grid's transmission network, which originates from the same site as the hybrid battery.

The 10MW connection supplies power for 42 charging points, split between those for Tesla cars, ultra-fast chargers for any electric vehicle and lower power terminals that will top up a car over a few hours while its owner is shopping or at work. Due to the power cable being connected directly to the National Grid's transmission network, there is scope to expand from the initial 42 charging points to 400.

That direct connection to the network also provides additional electric vehicle charging options along its 7km route to the park and ride station. The Oxford Bus Company already has a connection set up that will power up the fleet of electric buses it has on order. There is also an ongoing conversation about the city council being able to hook up facilities so that its electric vehicles can be charged. The ESO project has already contributed to the council purchasing 40 electric vehicles, including a bin lorry.

Charging throughout the day not only helps decarbonise transport but also avoids the prospect of a surge in demand as owners plug in their electric vehicles at the end of the working day when they get home. This desire to spread out demand for electricity can also be seen in the part of the ESO project that has equipped 60 Oxford homes with heat pumps.

> **The National Grid has to keep supply and demand finely balanced and we're demonstrating how battery technology can help**

Matthew Trewhella is CEO of Kensa Group, the organisation that fitted the heat pumps. He describes how the company's technology can help to manage demand during the peak early evening slot.

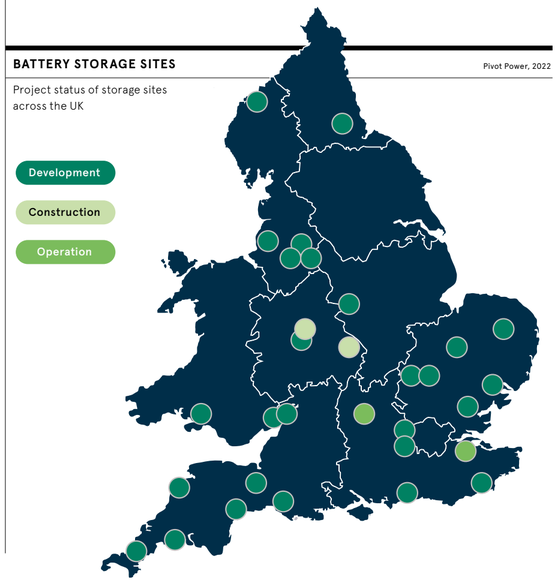
"We want to avoid people using electricity between 4pm and 7pm," he says. "So, to help with that, our system learns the temperature profile of a home and makes sure it starts getting the house warm before then, possibly heating it 2 degrees higher than the actual thermostat setting, so that it isn't switched on during the peak period."

The Oxford project has proven so successful that there are now plans to roll out the idea of sharing local power from the transmission network. There are currently 40 potential sites of interest, including in Coventry and Birmingham where discussions for a grid-connected battery are already under serious consideration.

BATTERY STORAGE SITES

Pivot Power, 2022

Project status of storage sites across the UK



Commercial feature

Tackling future energy demands and security

Whether newly-built or retrofitted, smart cities will need secure digital solutions to monitor, understand and adapt energy consumption, argues **Alex Dopplinger**, director of product marketing, building and energy, at NXP Semiconductors

Global energy consumption and scarcity is in the spotlight like never before – and it's of critical importance to powering smart cities of the future.

For these connected urban landscapes to improve how we live and work, we must plan their energy management and storage effectively.

Whether these communities are newly built or retrofitted, secure digital solutions are required to monitor, understand and adapt our energy consumption – both at a city-wide level and in individual premises.

Where that energy is drawn from does not matter; wider national or regional grids, fed in via a micro-community grid made up of just a few streets, or generated through renewable sources installed by homeowners and businesses who then sell spare capacity back into the system.

What does matter is how smart city planners work with energy networks and providers, OEMs and those supplying the technology inside smart devices to ensure energy is managed and distributed in an intelligent way. Only then will energy management and storage work most efficiently and most securely.

Managing the spikes

Today's global energy emergency clearly demonstrates the importance of grid resilience to handle both expected and unexpected demand. Energy management is at the core of this challenge.

As homes, buildings and infrastructure get smarter, so should control over our power. Artificial intelligence and machine learning will play a huge part, monitoring a wealth of individual usage data streams across entire cities.

Installing smart metres helps us to understand the ups and downs of usage at all levels of demand. If individuals have access to this information, they can manually reduce their energy costs. Smart metres can advise when energy use might be cheaper, encouraging the overnight charging of an electric vehicle, for example, or shifting appliance use to off-peak hours.

On a larger scale, this could make an even greater impact if the management was done centrally through autonomous control. Homes and businesses could opt in to allow energy providers to make efficiency decisions for them. Energy management and savings are then achieved at a more accurate and more specific machine level.

NXP technology supports these concepts, allowing OEMs to choose the option that best fits their energy market and needs. Neural processors inside our devices support machine learning algorithms that can build energy profiles and make predictions about individual locations. Granular data can know whether a single light bulb needs to be on, or understand which neighbourhoods have a larger than average number of EVs to be charged.

As machines become better at recognising local patterns, times of peak demand can be managed more effectively. Central management could have air conditioning or heating systems turned down automatically to reduce the overall city burden.

Understanding storage needs

Smart city energy management is just one piece of the puzzle; designing the right level of energy storage is just as vital.

Providing enough short- and long-term storage is the answer to underpinning energy resilience, as growing amounts of renewable power are generated from solar panels, wind turbines and thermal ground sources.

> **As homes, buildings and infrastructure get smarter, so should control over our power**

Within smart cities, this could increasingly be at an individual level through battery or ground source storage, specific to all kinds of buildings from houses to apartment blocks to offices, factories and other workplaces.

In-home or in-building energy storage systems (ESS) will help to reduce or ride through the increasing number of outages likely to occur during extreme summers and winters due to climate change.

If a demand spike in one area places strain on a grid – city wide or groups of streets – power can automatically be drawn from batteries or ground sources (or by pumping water) to deal with it. Where it has been taken from battery storage, it can then be returned once the spike subsides.

This solution is one way for individual ESS owners to earn money from the grid, selling any spare capacity from the power generated. Owners could even potentially be paid a premium if extra capacity is required at times of increased or unexpectedly high usage.

Installing a large number of individual ESS across a smart city supports two-way charging, where energy is stored via direct current (DC) to the ESS, and then converted back to alternating current (AC) needed to run items in your home. This method can also draw energy from the fully charged EV battery if the grid you are connected to fails.

Securing the front door

Energy management and storage happens in the background 24/7. An unimaginable amount of very small individual signals send and receive time series data about energy current and voltage levels through smart metres and access panels. Each can monitor a single energy action from bulbs and appliances to boilers and smart thermostats.

With smart metres providing this information, the power grid can rebalance itself continuously, reacting to every little change in the system. Once electric vehicles are the norm, this will be critical as thousands of people charge their vehicles at the same time.

But just as you wouldn't leave your front door wide open all day, every smart city must ensure every entry point into its energy provision is secure. This means securing all gateways within the technology of energy providers, grid operators or individual customers.

Data communication at the gateway must be secured at the edge, immediately alerting if a device is not behaving as it should be. A single chip with security built in can now achieve this, with devices further authenticated and designed to protect against hacks as sensitive information is fed into, and then managed, in the cloud.

Privacy is paramount too. As people permit the system to know every tiny energy action they take, they will expect their data to be secured. By securing the gateway at the edge, within the smart metre, smart device, or charging point, these concerns can be overcome.

What's certain is we can't stay on the path we're on. The result will be grids that fail.

Energy costs money: someone somewhere must pay for it. Therefore the goal is to make technology decisions that transform smart cities to be more comfortable, efficient and safe.

Key technologies to achieve this include larger capacity batteries in smaller form factors for residential and commercial buildings, AI-powered energy management at the edge – and in the grid – and user-friendly, reliable and secure on-site energy solutions.

These electrification and energy innovations will help ensure our energy future.

For more information visit nxp.com/energy

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WEB 3.0

The metaverse: city planner's dream or urban nightmare?

The rapid advance of Web 3.0 offers municipal authorities new opportunities to govern towns and cities more efficiently. But, like many bleeding-edge technologies, it also presents risks

Simon Brooke

Imagine that you're a visitor to Seoul, exploring landmarks such as Namdaemun Market and Deoksugung Palace. After a few hours, you decide that you've had your fill of South Korea's oldest marketplace and seen enough of the home of the former royal family, so you simply slip off your headset and immediately you're back at home.

Similarly, as a resident of Seoul, you might meet a local government official in their office to discuss a problem with your rubbish collection or local bus service, but without having to bother leaving your own sitting room.

Launched last year, with a bell-ringing ceremony taking place in both the virtual and physical realms, Metaverse Seoul claims to be the world's first Web 3.0 virtual communication system designed to cover all aspects of municipal administration. It enables citizens to visit a digital city hall and complete transactions such as paying rates, filing planning applications and registering complaints about public services. They can even create an avatar to enter a 3D simulation of the mayor's office.

As the tech underpinning the metaverse has advanced in recent years, urban planners have been producing so-called digital twins – virtual representations of their cities – to model new developments. New Zealand's capital, Wellington, has created a digital twin aimed at educating people about the effects of climate change on the city, for instance. It was among 15 municipalities worldwide to be awarded $1m (£830,000) last year after its project won an innovation competition sponsored by Michael Bloomberg, philanthropist and former mayor of New York.

The use of digital twins has the potential to extend into other aspects of urban planning and management, notes Jean-Philippe Vergne, associate professor of strategy at University College London's School of Management.

"For instance, a property developer from the UK should be able to have an avatar walk into a digital replica of Boston, say, and bid on a plot of land with a proposed price, lease term and building design," he says. "If that application is granted, the transfer of ownership would happen upon the city receiving a cryptocurrency payment. The developer would then have to build the real-world project according to the specifications approved in the digital world."

The city of New Rochelle, New York, has built a virtual-reality platform called NRVR to help local people understand what proposed developments would look like in reality, for example.

Tom Winstanley is chief technology officer and head of new ventures at NTT Data UK&I, an IT consultancy that has worked with municipal authorities in Rome and Las Vegas, among others. He says that metaverse tech enables local government officials to "safely simulate inefficient or dangerous situations in a city-wide context and implement changes proactively. Instead of collecting data and putting safeguards in place after an incident has occurred, planners can use the metaverse to stay ahead of the game. Gridlocks can be predicted, say, and traffic can be diverted before a problem escalates."

The effectiveness of municipal services rendered in the metaverse naturally depends on the quality of the digital infrastructure over which they're provided. Seoul is one of the world's best-connected cities, with more than 95% of its 10 million residents subscribing to 4G or 5G services. There is also a comprehensive public broadband network that provides more than 100,000 free Wi-Fi access points around the capital. But few other urban areas are anywhere near as advanced.

"I see two key infrastructure challenges," says Mimi Keshani, COO of Web 3.0 startup Hadean. "The first concerns networking capabilities. Replicating cities in the metaverse will involve streaming data from thousands, if not millions, of smart devices. Consolidating all of that material – and making sense of it all – will require new kinds of networking infrastructure."

The second challenge concerns "how we process all this data. Cloud and edge computing have opened access to more and 'nearer' computing power, but scaling up applications across so many disparate machines is problematic. Governments will need to use the latest Web 3.0 tech to solve both challenges."

> **Instead of putting safeguards in place after an incident has occurred, planners can use the metaverse to stay ahead of the game. Gridlocks can be predicted, say, and traffic can be diverted before a problem escalates**

One way to deal with such a vast new IT requirement is to build a smart city from scratch. Neom, a $500bn settlement that's being developed in Saudi Arabia, offers a glimpse of the next stage of the relationship between cities and the metaverse. It will be possible to visit Neom both physically and virtually, as an avatar or hologram. The city will also host a marketplace for cryptocurrencies and non-fungible tokens. The aim is for the virtual version to inform the construction of its physical manifestation. In effect, visitors will be invited to 'crowdsource' its design.

But there are caveats when using the metaverse for city planning purposes, warns Mischa Young, assistant professor in the department of urban environments at the Université de l'Ontario Français in Toronto.

"It's important that city officials ask their citizens what they want from the metaverse, so that they can have 'buy-in' from the public," he says. "There's also a question of the digital divide and inequality, with some citizens having better connectivity than others."

Another issue that civic authorities seeking to use the metaverse will need to manage is what Jane Jacobs, a prominent critic of urban planning practice in the late 20th century, described as "eyes on the street". Based on the theory of safety in numbers, this is the idea that cities thrive and become more liveable when they host large numbers of people, who feel reassured by the visible presence of others around them. Empty streets, on the other hand, seem dangerous and frightening. Could civic leaders' keenness on the metaverse end up turning urban areas into ghost towns?

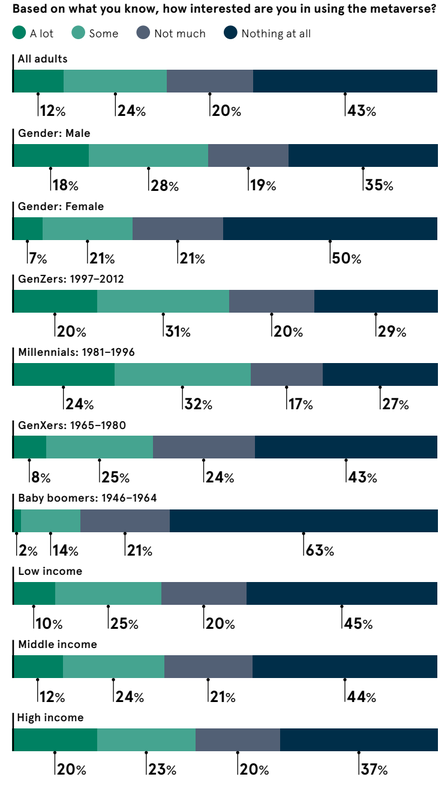
Alongside the technological hurdles, local and national governments must reassure citizens that bringing the metaverse into their communities will bring tangible advantages, not dystopian cityscapes. While the public's understanding of the metaverse is not yet well developed, a recent survey of consumers' attitudes to it by management consultancy Momentive found that many more respondents found it scary (32%) than those who found it exciting (7%).

Much of the incentive for introducing the metaverse into planning and other aspects of urban life is based on the promise of better engagement with citizens. The challenge for local government leaders will now be to manage their use of the metaverse in a way that wins public support for the concept itself.

A CONVINCING PROPOSITION?

Survey of 4,420 US adults, March 2022 — Morning Consult, 2022

Based on what you know, how interested are you in using the metaverse?



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