

The future is here

Big Data | BIM | Future of urban water | Lighting 24/7 cities
Low carbon urban transport | Renewable energy | Proton beam therapy

ARUP

The future is here



We live in an age where continually evolving technology and innovation is altering the ways in which we design and interact with our environments.

This issue of A² looks at some of the key changes that are occurring across a number of market sectors. We investigate how big data can be applied to improve the levels of service across the built environment. We look forward to BIM level 3, and discuss how this can lead to the creation of truly connected cities. We predict the future of urban water to understand the challenges that utility providers might face; and we uncover how a new framework could revolutionise the nature of security at airports globally.

This edition also examines the success of electric buses in city centres and assesses how close we are to achieving a low-carbon urban transport future. We see how smarter lighting could lead to 24/7 cities. We also look at how successful renewable energy projects in South Africa could be used as an example to promote sustainability and growth across the region.

Finally, we reveal the steps that are being taken to make proton beam therapy treatment available in the UK, and how this could improve the lives of patients.

I hope you enjoy reading this issue of A² and find the content valuable. If you have any thoughts, questions or comments, we'd love to hear from you at a2@arup.com.

Alan Belfield
Arup Group

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A² magazine is a publication produced by Arup for our clients and reflects our mission to shape a better world.

For more information on any of the topics featured in this magazine, please visit www.arup.com or email a2@arup.com

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Arup recognised as a top employer for women

New research team to tackle disaster risk in urban Africa

Arup has joined the Urban Africa Risk Knowledge (Urban ARK) project, a new, pioneering research programme that's aiming to reduce disaster risk in urban Sub-Saharan Africa.

The firm will help undertake research in cities in Senegal, Nigeria, Malawi, Kenya and Niger to better understand the nature and scale of disaster risks in urban centres. Arup's team will work closely with University College London, and alongside King's College London, Save the Children, UNHabitat and a series of community organisations and African research institutions.

As well as helping to fund the project, Arup will provide expansive applied research experience from previous projects including The Rockefeller Foundation's City Resilience Index project and the Asian Cities Climate Change Resilience Network.

Led by Professor Mark Pelling of King's College London, the project has been awarded £3.3m of funding from the UK's Economic and Social Research Council (ESRC) and the Department for International Development (DFID).

1 Designers at work, Shanghai

2 London Cable Replacement Programme



For the fifth consecutive year, Arup has been named in the UK newspaper The Times' Top 50 Employers for Women. This formally recognises the firm as one of the top 50 firms in the UK for gender equality in the workplace.

Alan Belfield, Chairman, UKMEA Region comments: "Being shortlisted for the fifth

time highlights our continued efforts to encourage and empower all employees, irrespective of gender, race or sexuality, to perform to their fullest potential and contribute to the greater goals of the firm. We still have a way to go, as a firm and as an industry, but awards like these inspire us to keep the momentum going."



Tunnelling complete on London Power Tunnels project

National Grid has completed the final tunnelling on its London Power Tunnels (LPT) project. The project ensures that National Grid has the power infrastructure needed for growth in London as well as securing access to future renewable energy generation.

Arup has been involved in the project since 2009, providing programme and project management throughout, as well as several specialist technical services.

Mark Neller, Arup Project Director, comments: "We are tremendously proud to have been at the heart of one of the most important infrastructure projects in London, helping National Grid deliver the single biggest upgrade of transmission systems since they were built in the 1960s."

LAX CUP celebrates opening with ribbon cutting

Los Angeles International Airport (LAX) celebrated the opening of a new \$438m Central Utilities Plant (CUP) on 24 April with a ribbon cutting event. As the engineer-of-record and lead consultant to the Clark/McCarthy Joint Venture, Arup's innovative design has saved the airport \$20m in capital costs and is expected to save \$7m each year in operating costs.

The first major design/build project undertaken by the City of Los Angeles, the new LAX CUP replaces the 50-year-old existing CUP with a more modern and efficient facility. Considered the first sustainable utility plant at any airport in the United States, the LAX CUP is expected to achieve LEED Gold certification and will be approximately 25% more energy efficient than the former facility.

Crossrail Place opens at Canary Wharf



New BIM Maturity Measure model launches

Arup has launched the Building Information Modelling (BIM) Maturity Measure, a simple tool to assess the maturity – and success – of BIM on projects.

The tool enables users to assess the use of BIM in 25 areas, across disciplines, and build up a comprehensive view of its implementation on a project. The data can then be used to identify gaps in an enterprise's BIM implementation strategy and shape future investment decisions.

"Our BIM Maturity Measure tool aims to democratise assessment, enabling quick, easy comparisons across all projects," says Arup director Michael Stych. "This also means that we can track performance on projects against the level of BIM maturity to better understand what is working best for our clients, and where improvements can be made to processes."

By making the tool freely available for wider industry use, Arup hopes to demystify BIM, drive awareness of what BIM best practice looks like and raise capability across design and engineering disciplines.



Crossrail Place, a new 115,000 sq. ft. leisure and retail development in London, was unveiled to the public. The opening is a major milestone in the construction of the Canary Wharf Crossrail Station, which is nearing completion.

Crossrail Place is spread over five storeys above the new, fully submerged Crossrail station. In addition to retail and restaurants, Crossrail Place includes more than 4,160m² of landscaped roof gardens under a striking timber lattice roof.

Arup led the design team for Canary Wharf Crossrail Station, developing an engineering solution that allows future changes to Crossrail Place to be undertaken without any disruption to the operation of the station below. Arup has worked closely with architects Adamson Associates, Foster + Partners, and Tony Meadows Associates and the client, Canary Wharf Contractors Ltd, since the firm was appointed eight years ago.

Copenhagen Ring 3 light rail appointment

Metroselskabet has appointed Arup as part of a joint venture with Rambøll to develop the Light Rail on Ring 3 for greater Copenhagen. The new light rail system includes a double track alignment of 27km and 27 stations with a rolling stock fleet of 27 light rail vehicles.

This major project was planned to promote the use of public transport as well as encourage the urban development along the route and the passage across the city to avoid interchanging in the centre.

The line will follow the route of the Ring 3 Motorway Road around the edge of Copenhagen, linking eleven municipalities, from Lundhøfte in the north to Ishøj in the south. The new line will run a service of light rail vehicles every five minutes at peak times with a proposed journey time of 55 minutes for the 27km.

The Light Rail on Ring 3 follows other successful projects which Arup is working on for Metroselskabet, Cityringen and Nordhavn underground.

3 ProjectOVE is Arup's 35 storey, 170m tall BIM building in the shape of a human body

4 Canary Wharf Crossrail Station

5 MCA award logo

6 Greg Stone

7 Derby Multi-Sports Arena

Arup triumphs at London MCA Awards

5



Arup celebrated winning four awards and being highly commended for another two at the 2015 Management Consultancies Association (MCA) Awards held in April in London.

The firm won the inaugural 'Best Use of Thought Leadership' Award for "Cities Alive", a report which rethinks green infrastructure and is supported by the Landscape Institute and Royal Botanical Gardens, Kew. In partnership with Croydon Council, Arup also won the 'Innovation Award' for the Programme Delivery Dashboard for the regeneration of Croydon town centre.

Arup claimed the 'International Award' for its operational readiness, activation and transition (ORAT) work on Mumbai Airport's Terminal 2, and Arup's Kate

Fairhall, Principal Consultant, was named as 'Change Management Consultant of the Year' in recognition of her work on the people readiness training programme for Heathrow's Terminal 2.

In the competitive 'Commercial Excellence' category Arup was highly commended for our work on the cost estimating hub with National Grid. Annabelle Woods was also highly commended in the 'Young Consultant of the Year' category.

Jerome Frost, UK Consultancy Leader, comments: "We are delighted that these awards recognise the breadth and diversity of Arup's work, and that we have been able to share them with our partners and clients. We are looking forward to building on our success over the year ahead."



Ex-Microsoft Australia CTO joins Arup to drive digital services across Australasia

Greg Stone, former Chief Technology Officer at Microsoft Australia, has joined Arup as the Regional Leader of Digital Services across Australasia.

The appointment will bring together a variety of existing digitally-oriented teams across the region that have for a number of years been providing comprehensive digital strategy and technical project delivery capability across the private sector and various levels of government.

Greg Stone comments, "In many ways joining Arup brings my career to a full circle, combining my experience in the technology sector with my original practice and passion for design and architecture. I'm really excited to be joining Arup to lead digital services across the region."



Derby Arena opens

Derby Arena, the UK City of Derby's first multi-sport stadium and velodrome, has opened. It houses the first new-build velodrome in England since the 2012 Olympics, as well as facilities for community sport and fitness activities – including a sports hall spanning the size of 12 badminton courts and a gym.

Derby Arena will primarily be a sporting venue but it will also host cultural events, exhibitions, product

launches and conferences. This new flexible, column-free space holds up to 5,000 spectators for both sporting and non-sporting events.

Arup provided multidisciplinary engineering and consultancy services to the project, and worked closely with project manager Mace, architects Faulkner Browns and contractor Bovermeyer and Kirkland to realise this building on a particularly challenging brownfield site.

Could open data change our cities?

Gavin Starks, CEO of the Open Data Institute, offers his view on how open data can shape our cities

“Open collaboration and open markets are the only approaches that will scale,” says Gavin Starks, CEO of the Open Data Institute (ODI).

“Open data can help people explore opportunities that cut across our built environment, transportation systems, energy, water, healthcare, education and other infrastructures.”

Starks points out that cities around the world are looking to increase their population densities and need to scale by getting smarter. But, he argues, you can't realise the potential of a smart city or scale different parts of our infrastructure without open information and open data.

While sensitive information must be protected, Starks believes that real potential for innovation lies in using open data to involve people in shaping their city. “I grew up in a small village on an island off the west coast of Scotland,” he says. “We had a huge sense of agency in the environment that we were creating. With a population of just 700 people, if something needed to be done you just got on with it and you had to work together. How do we recreate that sense of agency in a city environment?”

Making the data behind cities available to many more people can help address this question, says Starks. In fact, he points out, data about urban environments is already informing policy, impacting daily decisions on travel through things like smartphone apps, and helping to shape the design of buildings through tools such as BIM. So why not open this up to enable greater participation from businesses, researchers, consumers and citizens?

The field of scientific research is doing something similar. “Websites like Zooniverse are enabling citizen science,” says Starks. “They've got over a million people doing everything from classifying galaxies to identifying cancer cells. The next big scientific breakthroughs are going to come from these massive collaborative websites.”

Can this sort of thing be built into the design process and create a sense of inclusion in the built environment? “Doing so will require a cultural shift,” says Starks, “because open data is more about culture than it is about technology. But that,” he argues, “is a shift that other spheres such as software and science are making.”

“What if firms such as Arup had a completely open environment?” Starks asks. “What if they actively engaged everybody in a community and in other communities around the world who have experienced similar design projects?”

“Imagine you've got 50,000 people actively sharing their knowledge to try and solve a problem in an open way. Now compare that to an approach where you're paying a team of 50 people to try and do the same thing. I'd argue you could use those 50 people's time in engaging directly with the users and communities involved. The role of the expert is not undermined, but it evolves to one of direction, curation and leadership. There are many parallels with the open source movement, whose technologies now underpin the majority of our digital experiences.”

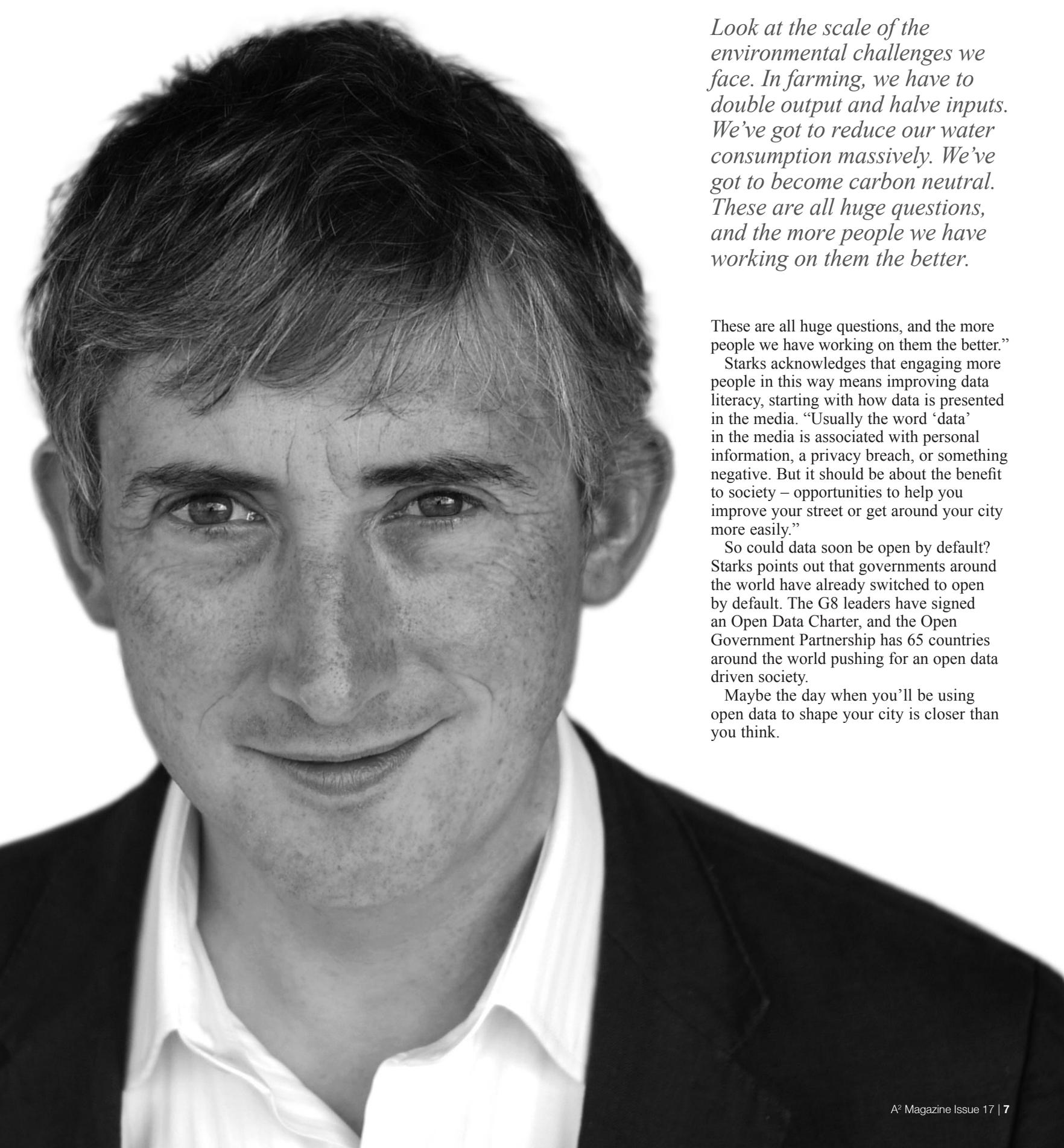
This may be an uncomfortable idea for businesses to take on board, Starks acknowledges: “As soon you start becoming more open you can attract questions and

criticism. The level of anxiety can increase in the short-term. But this is short-term pain for long-term gain. Fundamentally it's a more democratic process.”

Starks believes that the built environment is already becoming open. There are sensors that publish information about their environment on the web. There are cameras that post pictures of the built environment on Twitter. There are several companies sending tiny satellites into space to offer whole-Earth observation in real-time.

“Whether architecture or built environment practitioners open up their information or not is actually irrelevant because it will eventually become open through other means,” says Starks. “So it's far better to engage in this open landscape and say: ‘how can we collaborate? How could we improve the energy efficiency of the city by 50% in a quarter of the time that we're currently planning? What if we had a million people engaged in designing a new building?’”

“Look at the scale of the environmental challenges we face. In farming, we have to double output and halve inputs. We've got to reduce our water consumption massively. We've got to become carbon neutral.



Look at the scale of the environmental challenges we face. In farming, we have to double output and halve inputs. We've got to reduce our water consumption massively. We've got to become carbon neutral. These are all huge questions, and the more people we have working on them the better.

These are all huge questions, and the more people we have working on them the better.”

Starks acknowledges that engaging more people in this way means improving data literacy, starting with how data is presented in the media. “Usually the word ‘data’ in the media is associated with personal information, a privacy breach, or something negative. But it should be about the benefit to society – opportunities to help you improve your street or get around your city more easily.”

So could data soon be open by default? Starks points out that governments around the world have already switched to open by default. The G8 leaders have signed an Open Data Charter, and the Open Government Partnership has 65 countries around the world pushing for an open data driven society.

Maybe the day when you’ll be using open data to shape your city is closer than you think.

Powering economies

Can renewable energy drive economic development?

“If developing countries are to lift their people out of poverty they need reliable and affordable sources of energy,” says Justin Wimbush, Arup’s renewable energy leader in South Africa. “Fossil fuels are increasingly being challenged by cost-effective renewables in a world that requires greater self-sufficiency.”

Despite the fact that South Africa has extremely good wind and solar resources, as recently as 2010 the public power utility Eskom generated more than 90% of the country’s electricity from coal. South Africa’s experiences of shifting towards renewable energy could point the way for others in a continent where centralised, state-owned power utilities have been the norm, but have tended to limit rather than enable much needed economic and societal growth.

That shift to renewables is being driven by economic necessity, explains Wimbush. “Where coal once provided abundant cheap electricity for South Africa’s industrial economy, today that ageing centralised generation can no longer meet demand. The result is load-shedding, where power supply is interrupted to some areas.”

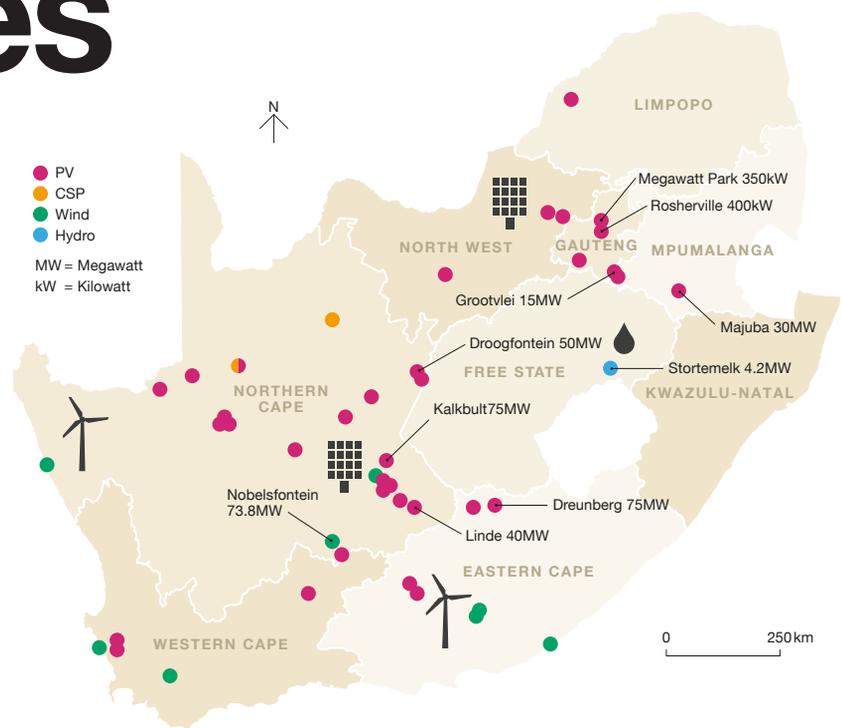
Wimbush points to analysis conducted by Arup that shows South African companies can expect to be subjected to load shedding for the next three to five years. Against this backdrop, interest and investment in renewable energy has grown – spawning

diverse opportunities and business models.

“As they look to cope with load-shedding, businesses are considering ways to become less reliant on the grid,” explains Arup energy consultant Vivienne Roberts. “We’re seeing a lot of interest in photovoltaics (PV) as a result. The marginal cost of electricity generated from renewable energy is becoming increasingly competitive, particularly when compared to the cost of electricity to be generated by the new coal power stations under construction.”

Frank Spencer, Chair of the Embedded Generation Committee of the South African Photovoltaic Industry Association, points to a range of different models that are emerging for embedded solar PV: “In the commercial, industrial and agricultural sectors, there is quite a lot of appetite to self-own projects, particularly with a lot of

In South Africa, large-scale renewables facilities are going up in places that haven’t previously enjoyed many economic opportunities.



the big property companies,” he explains.

“Emerging ideas for this include a hybrid model where a separate private energy company owns, say, 50% of the asset and the company itself owns 50%. Then there are companies looking to become independent power producers by building PV plants on third parties’ roofs and selling them electricity.”

Spencer explains that all of this is happening on a grid-parity basis. “We don’t have any feed-in tariffs,” he says. “We don’t have any real subsidies for solar PV. There are some exceptions to that, but the reality is, this has been driven by financial reasons, related to grid-parity energy prices, and also by energy security.” To have renewables demonstrate market credibility on their own merit, in an economy that offers limited subsidies, provides a clear sign that the



sector points to a more sustainable future.

Embedded generation isn't the only opportunity in renewable energy. "There are opportunities in the supply chain from procurement to manufacturing," says Wimbush. "We're seeing factories set up to manufacture wind turbine components as well as thermal and solar panel components.

"There's also a very big business emerging in solar hot water heaters because Eskom is providing a rebate. Many areas do not have gas supplies so water heating accounts for the largest slice of the average household's electricity consumption."

Other countries without rebates for solar hot water are missing out on the opportunity to make the most of an abundant resource. "In Malawi, my home country, solar hot water panels are prohibitively expensive for individual home-owners," says Wimbush. "So although the country is short of electricity, solar hot water isn't generally installed in homes."

The growth of renewable energy also offers countries the opportunity to bring prosperity to their poorer regions. "In South Africa, large-scale renewables facilities are going up in places that haven't previously enjoyed many economic opportunities," says Roberts. "For example, there are a

lot of solar projects taking place in the hot, dry Northern Cape. This introduces economic and employment opportunities to communities that have had very high unemployment for quite a long time."

While there is now a well-established programme for the procurement of utility scale renewable energy facilities, there remain plenty of challenges for South Africa to overcome for the successful uptake of embedded generation. "The key problem at the moment is that for projects to work, you have to generate on-site and behind the meter," explains Spencer. "You can't transmit or export your solar PV electricity to the grid so you have to use everything you produce."

The South African National Energy Regulator's new framework is looking to address this situation, whilst ensuring municipalities that distribute power don't lose revenue because of embedded generation. "The idea of consumers producing power is a new thing in South Africa," says Spencer. "As we address these issues, other economies that work on a similar model will be able to learn from the experiences here. But for the moment we are still in our infancy and still learning ourselves."

1. Droogfontein Solar © Droogfontein Solar Power
2. Botterkloof mini-hydro © James Hampton
3. Dorper Wind © Arup
4. Megawatt park rooftop PV © Arup

Advising on the future of South African renewables

Including due diligence work, Arup's team in South Africa is currently working on 1,800MW of renewable energy projects – equivalent to the Western Cape's Koeberg nuclear power station. Some of the projects we're helping to realise include:

- Nobelsfontein wind farm – a 73.8MW, 41-turbine wind farm being constructed near the border between the Western and Northern Cape
- The 75MW Kalkbult solar PV facility in the Northern Cape, which consists of over 300,000 PV modules and is expected to produce 135GWh of electricity annually
- The Linde and Drenberg solar projects under construction in the Northern and Eastern Cape
- Eskom's programme for 150MW of PV facilities at its power stations
- The 4.2MW Stormemelk hydro project at the Botterkloof Dam near Clarens in the Free State
- Droogfontein 50MW fixed-tilt PV plant just north of Kimberly in the Northern Cape.

Big data

Any data that current tools can't handle - whether it's because of size, speed, or its messiness. The reason "big data" has become such a buzzword is that we now have a lot more raw data suddenly being produced (e.g. from sensors, computer systems, and internet activity), and at the same time have much better and more scalable tools to handle it (e.g. Hadoop ecosystem of tools). This opens up major new business opportunities across many industries.

Big data, big opportunity

What data analytics can do for the built environment

There may have been a lot of hype over big data but the benefits are real. Today, it's possible to collect and analyse unprecedented amounts of data from the built environment – something that opens up a world of possibilities.

“Buildings, vehicles and mobile phones all have sensors in them that produce lots of data about what's going on in the physical environment,” says Francine Bennett, CEO and co-founder of big data specialists Mastodon C. “Where you've got lots of data, you can find ways to make things work better – whether that's personalising environments or finding efficiencies in the way you use resources.”

Volker Buscher, leader of Arup's Digital business, is excited by the possibilities. “The ability to give our clients new insight into their business problems or on their project issues is a fantastic opportunity to explore,” he says. “I've been doing digital work in Arup for 20 years and from a client's point of view I don't think it has ever been as exciting as it is now.”

“Big data allows you to answer interesting questions,” says Arup data and information specialist Ilka May. “You can ask things like: Where do we have free capacity? Where do we have a need? Where can energy flow from one building to another or into transport? When different parts of the built environment start to

communicate with each other, data can reveal some fascinating insights.”

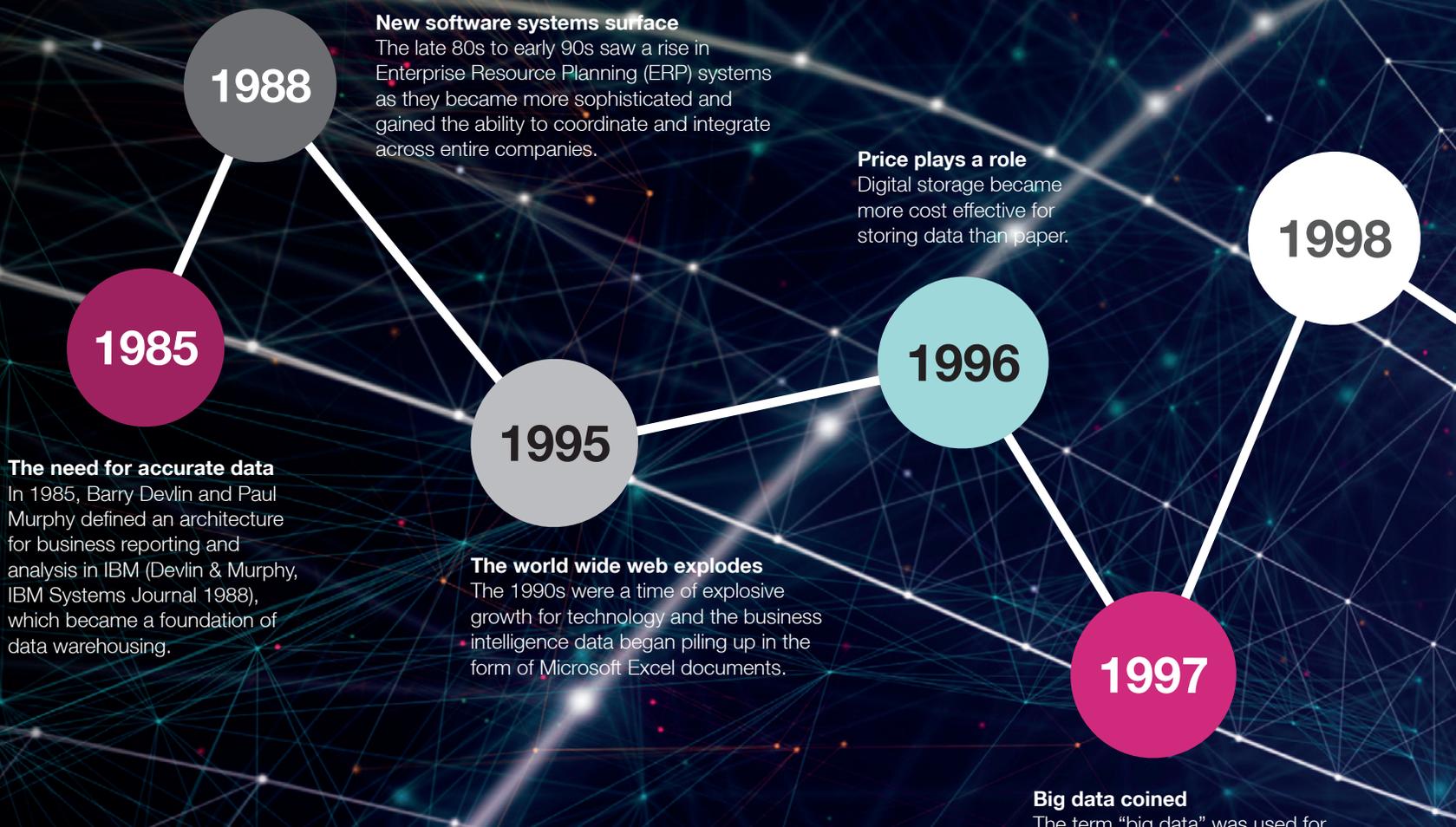
“Big data can help us create tools that can deliver specific insight into a particular client need,” Buscher continues. “We can also use it to provide multiple insights at once. For example, in an airport you could combine in-flight data, mobile operator data, real-time data from the baggage system and CCTV data to positively impact both operations and the passenger experience. Analytics can help to reduce operational costs and increase revenues.”

Using mobile phone data to understand mobility

The Welsh Government in the UK commissioned Arup to create mobile phone matrices to support two projects in Swansea and Newport – a scheme appraisal and local development plan. We were able to use the data to track footfall and journeys through the study area, using big data analysis to provide deeper insights into how people use the spaces. Using mobile phone tracking data enabled the use of a significantly larger sample size than normal road side interviews, which in turn created greater confidence in decision making. Following this work, the Welsh Government has asked us to create mobile phone matrices for the whole country.

Cloud computing

The computing resources like servers that we can access and control remotely. Cloud computing can be very useful in big data applications because it's a flexible way to 'rent' a set of virtual servers for a few hours to do a big calculation, rather than having physical infrastructure always there.



Internet of Things (or IoT)

The network of sensors and other 'sensing things', which interoperate with each other and send data to users over the Internet.

For this approach to have the widest possible benefit, Buscher and May believe that big data should be supported by open data standards in order to enable interoperability. "At Arup we want to support the development of open industry standards," says May. "We see a huge risk to the emerging markets in the development of proprietary systems, especially for small and medium enterprises."

"As we create insights, we will be working out where we can publish data or make it available for the greater good," says Buscher. "We think big data can help our clients, their businesses and their projects, but we also think it can help shape a better world. That feels genuinely exciting."

Sensing a city to boost an economy

Arup is advising a world-first big data project in Christchurch, New Zealand. To improve how the city functions, Sensing City installs sensors to collect real-time information on a range of variables including pedestrian and vehicle traffic flow, water and air pollution. By integrating and making the data from a variety of sources openly available, Sensing City will encourage the development of information-based solutions that improve quality of life in Christchurch and create expertise that the city can export. The pilot project gave students the opportunity to measure the water quality along Christchurch's waterways using kits created by the Massachusetts Institute of Technology. Subsequent projects have looked at things such as real-time traffic information and how environmental factors affect chronic obstructive pulmonary disease (COPD).

Predictive analytics

The statistical techniques which use data to make predictions or to prioritise risks. This type of analytics can help us to assign resources more intelligently - for example, to assess which support ticket an engineer should attend to first, based on a prediction of which is likely to be the most infrastructure-critical.

Google launched

Google is launched and will soon become the world's dominant search engine.

1999**Launch of Wi-Fi**

The Wi-Fi Alliance formed as a trade association to hold the Wi-Fi trademark under which most products are sold.

Enterprise web application

Top ERP vendors like SAP, PeopleSoft, Oracle and JD Edwards begin aggressively focusing on using Web services to link their own suites.

2002**2005****An open source solution to the big data explosion**

Hadoop was created in 2005 out of the necessity for new systems to handle the explosion of data from the web.

Data continues to explode

Bret Swanson and George Gilder projected that U.S. IP traffic could reach one zettabyte by 2015 and that the U.S. Internet of 2015 will be at least 50 times larger than it was in 2006.

2008**2010****Google CEO Eric Schmidt announces**

that "There were 5 exabytes of information created by the entire world between the dawn of civilization and 2003. Now that same amount is created every two days."

Where you've got lots of data, you can find ways to make things work better – whether that's personalising environments or finding efficiencies in the way you use resources.

Arup is embracing data analytics, but is the rest of the industry as keen? Bennett believes that not everyone has woken up to its potential. "I think that the main barriers to making better use of data analytics in the built environment are actually cultural and organisational," she says. "The hardware technologies and the analytical technologies you need are already there. But the industry is not currently data driven – it needs to look across to sectors such as manufacturing to see just what an extensive role data can play."

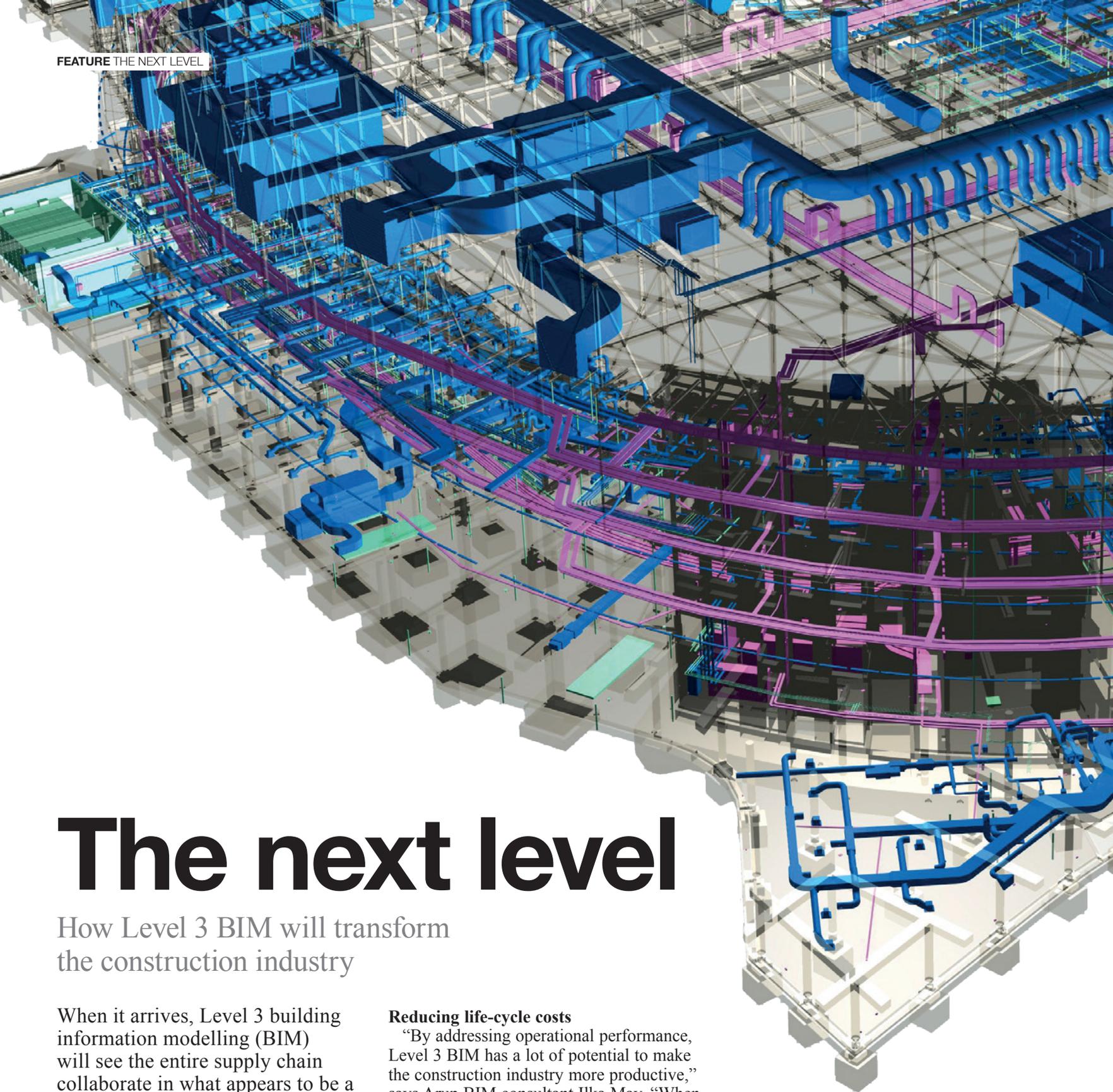
Bennett's company, Mastodon C, is a big data specialist that Arup has partnered

with as it launches its new Digital business. Arup is ensuring the development of the skills needed to effectively combine its range of built environment expertise with data science. In addition, it's investing in research and partnering with universities to understand more about how data analytics, along with other trends, will shape the future of the built environment.

For Buscher, such a focus on big data is vital: "To do the best work in the built environment, you really need to know big data. Then you can do things that would otherwise be impossible."

Sensors

Small pieces of hardware which detect something about their environments - often embedded in other devices (e.g. a mobile phone contains many kinds of sensors). Sensors are one way to collect real time data about the built environment or about infrastructure.



The next level

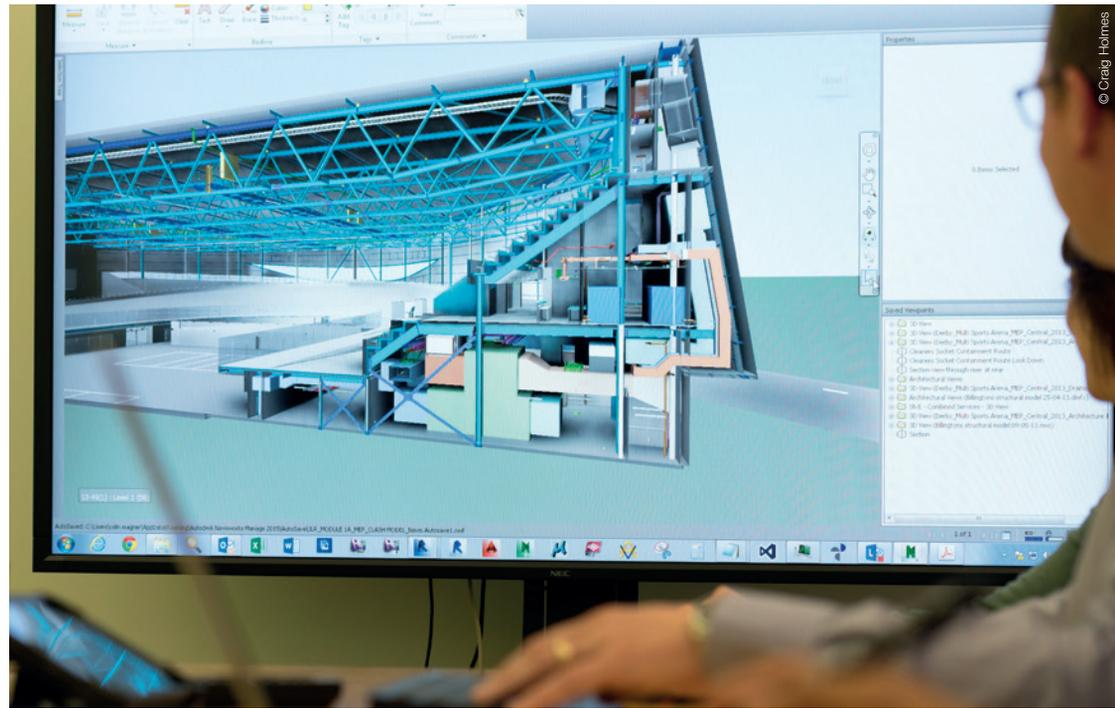
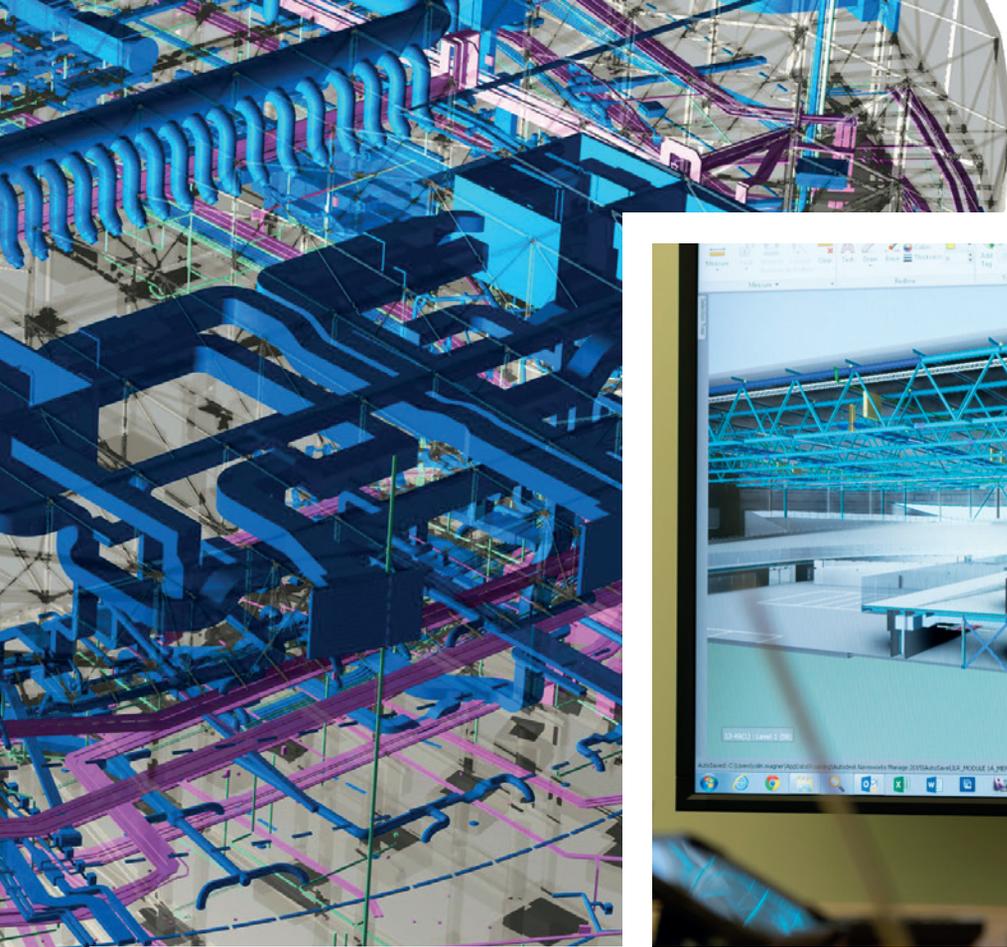
How Level 3 BIM will transform the construction industry

When it arrives, Level 3 building information modelling (BIM) will see the entire supply chain collaborate in what appears to be a single shared model. It will extend into the operation and performance of assets over their lifetimes, where the majority of costs arise. So what effect will it have on an industry that's currently grappling with Level 2 BIM?

Reducing life-cycle costs

“By addressing operational performance, Level 3 BIM has a lot of potential to make the construction industry more productive,” says Arup BIM consultant Ilka May. “When the UK government’s BIM Task Force looked at the public spend across the life-cycle of an asset, they estimated that just 20% goes on the design and build phase with operation accounting for the rest.”

This gives designers a tremendous opportunity to influence operations early in the design process, explains Paul Hill, a BIM specialist at Arup: “With BIM Level 3 you can really work out how the building would be used and managed as part of the



data modelling. You can bring in facilities managers or asset managers to influence that at a stage in the project when it's still cheap to do so – the later the changes, the more expensive they are.”

Hill imagines that the ultimate result will be a much smarter approach to city design: “With BIM Level 3 you can use data from smart city sensors to fine-tune buildings for specific locations. For example, you could consider factors such as how adjoining buildings affect light levels or wind. If you maintain the data set you’ll be able to model what would happen if those buildings are demolished and ensure your own building keeps performing optimally.”

A key role for clients

Clients have a vital role to play in realising these benefits, says Mark Bew, chair of the UK government’s BIM Task Force: “Clients are the most important thing. If a client specifies something that will result in a poorly performing hospital, school, highway or other asset, that asset will perform badly – BIM or no BIM. You know that before the project starts.

“This isn’t a new thing. Clients have always had to be good at understanding what they need. What we’re doing in the UK is reminding them of this and giving them smarter tools to help them specify what data they need easily. They will be able to create digital employers’ information requirements online for free.”

May argues that until now the

construction industry has been slow to embrace such digitisation – with a knock-on effect on productivity. “Processes in construction have not changed to keep up with technology,” she says. “For example, before we had email, printing plans and shipping them to clients meant we knew who owned the last version and where it was. It also provided time to think. When email arrived, we didn’t change our processes and people were able to disseminate gigabytes of data to an infinite number of people and recipients.

“What that meant is we lost control. Now, in a complex project where hundreds of people and so many different players are involved, it takes us an awfully long time to figure out who has the latest proofed version of any piece of information. There’s duplication, there’s waste everywhere. We need to streamline that and bring our processes back in line with new technology. This is what BIM enables.”

New data skills

As well as having the right processes, the industry needs the right people. “We will need people who understand systems engineering and data modelling,” says Hill. “Because it will be possible to interact directly with the data structure, people who can deal with data and data structures rather than drawings will come to the fore. Drawings will simply be an output, a report, a different way of visualising the data.”

Of course, training costs money and Bew

By addressing operational performance, Level 3 BIM has a lot of potential to make the construction industry more productive.

is often asked about the financial burden of BIM on the industry. He points to the fact that in the UK the government has covered the cost of much of the groundwork, down to making the documentation available for free. Besides, he says, investing in training, support and development is something every business should do as a matter of course.

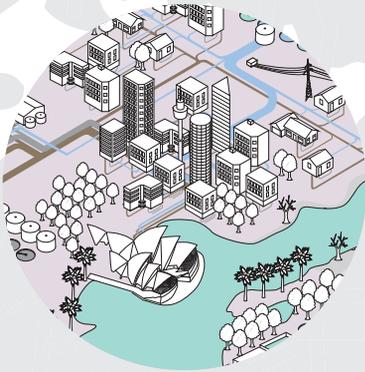
Ultimately, Bew argues that the best preparation for Level 3 is excelling at Level 2. “In the UK we have £10bn of public spend going through Level 2 BIM right now, with savings of over £840m last year. These are proper, life-changing savings that we’re making, which mean that more kids get schools and we build more motorways.”

He also cautions against neglecting the industry’s core competencies: “This is not an excuse not to train or not to be good at the old skills like project management, commercial management, design management and existing disciplines. You cannot stop doing those otherwise BIM won’t work. But if we get everything right then Level 3 BIM can create a true digital economy for construction and the built environment.”

The future of urban water

What your city's water supply could look like in 2040





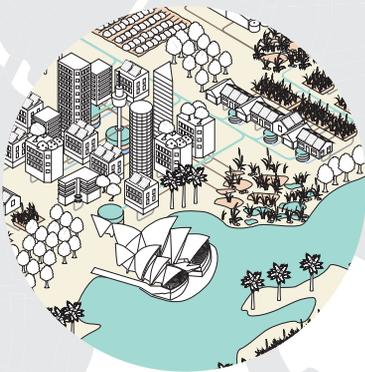
SCENARIO ONE incremental improvements

This describes a world with little change to existing assets and operations. Water services are user-centric and provide greater personal choice and control over service levels and pricing. This requires increased deployment of digital infrastructures and data analytics to cope with system peaks and fluctuating demand patterns.



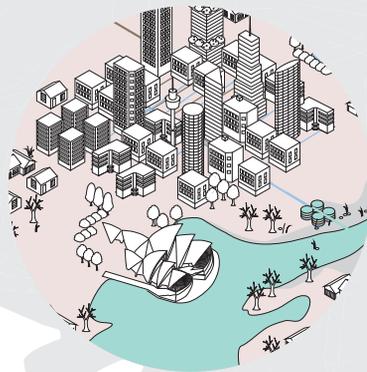
SCENARIO TWO better together

A scenario where industry and utilities better collaborate across a centralised water supply system with an integrated provision of utilities. Customers enjoy a seamless experience across multiple, integrated utilities – including shared billing, pricing and customer services. This demands better cooperation between urban utilities through collaborative planning, shared protocols and open data.



SCENARIO THREE autonomous communities

A world in which households, communities and industries develop independence in water collection, processing and distribution. Services enable customers to manage and maintain autonomous water systems at building, community or industry cluster levels. Cooperatives, virtual networks and community platforms govern and operate autonomous systems and small-scale water networks.



SCENARIO FOUR survival of the fittest

A scenario with greater competition for limited resources and restrictions to supply with high disparities in usage behaviour and access. Applications provide customers with real-time data and information about water consumption, availability and pricing. This requires differential water pricing and services according to availability of supply, service plans and customer behaviour.

How will cities around the world use and manage their water by 2040? This is the question Arup worked with Sydney Water to investigate in a recently launched report, *The Future of Urban Water*. Using Sydney as a reference, the report explores how social, technological, economic, environmental and political trends could shape our urban water future.

The study outlines how cities could manage their water and how consumers might access and pay for it in four possible scenarios.

“These scenarios reflect a range of fundamental challenges facing the global water industry,” explains Mark Fletcher, the leader of Arup’s global water business. “The biggest issue is variable supply. Cities generally have either too much water or too little, depending on the region and the time of year. They also face shock changes such as more intense storms and incremental changes such as rising sea levels.”

“Water is about supporting our cities’ resilience to shocks and change. It’s about the ability of water resource management to support a city’s growth,” says Kaia Hodge, manager of Liveable City Programs at Sydney Water. “The scenarios we examined suggest that we cannot simply assume centralised planning, delivery and management of water services to achieve the best outcomes.”

“Each scenario is very different,” says Daniel Lambert, Arup’s water business leader for Australasia. “But what they all have in common is that technology will have a huge impact on the way we use and manage water, both for individual households and for water authorities.”

Water is about supporting our cities’ resilience to shocks and change. It’s about the ability of water resource management to support a city’s growth.



Taking the plunge

The benefits of swimmable urban rivers

From New York to Sydney, more and more cities have plans to make their rivers swimmable. What's behind this growing movement?

"This is about more than just a nice place to have a dip on a hot day," says Michael O'Neill, a senior environmental consultant at Arup. "If a city has got its urban waterways up to a swimmable standard then it's a sign that they've put in place all the elements needed to sustainably manage water running through the city."

"It means that they have stopped pumping water out of the river for industrial and other uses and stopped, or are successfully managing, the discharge of wastewater into the river," he says. "It means they're using parkland and trees to capture and recycle storm water instead of channelling it straight into the river. And it means that any upstream dams are releasing enough water for the river to flow as naturally as possible."

It's perhaps no wonder that the idea is gaining traction. In O'Neill's home country of Australia, the idea of making the Yarra River in Melbourne swimmable is attracting interest. Things are a little more advanced on the Parramatta River, where the Parramatta River Catchment Group of 12 local councils want residents to be able to swim in the river by 2025.

But, warns O'Neill, a couple of things need to happen before we can all go jumping into our urban waterways. "This requires a vision plus the political will and funding to make it happen, fundamentally it's a land use and planning issue" he says. "Also, the public perception that urban rivers are dirty is deeply rooted and it'll take some effort to change that."

If these hurdles can be overcome, there are different options depending on the river's water quality and access requirements. The proposed filtering Plus Pool in the Hudson River in New York, on which Arup advised, aims to clean the river little by little while providing a spectacular place to swim.

Whether or not cities are able to make their rivers swimmable, O'Neill believes it's an aim worth pursuing because they'll be better off just for having tried. "To me, safe and free access to public land and public waterways is a no-brainer and a basic right of all citizens. It will make our cities much better places to be."



Real-time monitoring will mean you can see how much water you're using and when you're using it.

Lambert expects technology to help people manage their water use by giving them more information about their water bills. "Real-time monitoring will mean you can see how much water you're using and when you're using it," he says. "Real-time monitoring could also enable water companies to adopt peak and off-peak billing models to influence customers' behaviour." Hodge also points to the importance of utilising effective insight: "To understand and anticipate customer trends we need to become very sophisticated in our understanding of customer values and preferences."

Lambert envisages that technology advances will continue to drive new innovations in how water authorities utilise data to spot leaks, minimise their energy costs by pumping off-peak, consider ways to automate their systems and reduce overall operational expenditure. "Technology will help us learn from one another about how to better manage water," he predicts.

Fletcher believes the industry can also learn from natural systems as part of a multidisciplinary approach to design: "We now recognise that green infrastructure is often better than grey infrastructure or centralised solutions," he says. "Green infrastructure makes cities more liveable, and improves their response to risks like climate change, biodiversity loss and urban air quality."



Arup has put this approach into practice in projects such as developing the vision for the transformation of Melbourne Water's redundant main outfall sewer into a 27km long green corridor. This vision provides an amenity for the city as well as benefits such as harvesting water and managing stormwater run-off. Other recent work for the firm includes helping Sydney Water create a demand management decision framework for prioritising both technical and behavioural demand-management options.

For Hodge, collaboration is key to coping effectively with future scenarios. "For Sydney Water, we believe that we have an important leadership role to play in identifying and facilitating broader community outcomes through collaboration with other agencies, the private sector, and community groups."

"The scenarios help us understand possible pathways into the future and enable conversations about how we can influence and shape that future," says Fletcher. "By understanding trends and planning for the future, water utilities can get more out of their current and future assets, improve customer experience and enhance the liveability of urban areas."

You can download a copy of **The Future of Urban Water** at http://publications.arup.com/Publications/F/Future_of_Urban_Water.aspx

Lighting 24/7 cities

How smarter lighting can support night-time economies

Modern cities no longer sleep – they're on the go 24 hours a day. Yet all too often, experts argue, cities only plan for daytime. They neglect the potential of night-time lighting to shape urban life after dark and support local businesses.





The right night-time lighting can make shift workers feel safe on after-dark commutes. It can make you more likely to walk or take public transport. It can encourage you to gather outdoors to socialise at night, contributing to a city's night-time economy.

Arup's new report Cities Alive: **Light and Life in the Urban Night-time** is out now. Download your copy at arup.com/night_time

With darkness accounting for 50% of the world's time, that potential is huge. Arup's night-time design specialists believe that well-designed lighting can influence the way you use and enjoy a city, the way you move around its streets and even the way you feel.

Shaping the urban experience

"Have you ever stopped to wonder why you take a certain route home at night, or why you feel safe here but not there?" asks Florence Lam, global practice leader for lighting design at Arup. The chances are it has to do with how different spaces are lit.

"The right night-time lighting can make shift workers feel safe on after-dark commutes. It can make you more likely to walk or take public transport. It can encourage you to gather outdoors to socialise at night, contributing to a city's night-time economy."

So what makes effective night-time lighting? Answering this question involves understanding things like how people want to use city spaces, how light affects our bodies and our behaviours, and why we need darkness too.

"The thing that is most important to

the night-time economy is understanding who uses these spaces," says Don Slater, a sociologist at the London School of Economics and co-founder of its Configuring Light research group, whose work focuses on the relationships between culture, technology and the economy. "You also have to understand the conflicting ways different groups such as young people and older people use the spaces."

Applying smart technology

When you have this understanding, new lighting technology can certainly help bring the night-time to life, or make people feel safer. Glasgow, in the UK is trialling intelligent street lighting that responds to factors such as noise to combat anti-social behaviour. But new systems have to be planned carefully.

For example, Lam points out that urban lighting is not the end in itself; but is a means to activate and deliver improved community and economic outcomes. "We should not aim to simply recreate the day at night, but instead, we need to carefully consider the role of night-time. New technologies have opened up a realm of new



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opportunities for lighting. Despite groundbreaking innovations such as LEDs, we believe the most exciting future development will be about how lighting responds to the changing nightscape. We will see our cities lights change depending on the time of night and the different usage patterns of the public realm after dark – articulating the many different shades of night.”

Community involvement

This is why it’s important to consider lighting as part of wider night-time design, says artist and Arup lighting designer Leni Schwendinger: “Cities need lighting committees in the same way they have planning committees,” she argues. “These would build an understanding of an area – including of planned development, of how people will use the public space and therefore of how it should be lit.”

Schwendinger also believes it’s essential to involve communities in this process and points to Arup’s work in Cartagena, Colombia, as an example. Here her team has worked to create high-quality night-time public spaces. As part of the project, districts are invited to explore their after-

dark hours, highlight dark spots – those that are unsafe or unwelcoming – and influence design decisions.

Slater carried out social research for the project. “If you want to really understand how people use the public realm, you need a really rich understanding of city life,” he says. “That means qualitative research with a lot of interviews, a lot of observation, and a lot of photographic and video work that helps you tease out everything you need to know about a city.”

Collaborative design

Ultimately, a new approach is required, says Schwendinger: “Night-time is fundamentally different from daytime. In many hotter climates, it provides the best conditions for people to use outdoor urban spaces. So it deserves its own design approach that combines expertise in lighting design, urban planning and sociology.”

Slater describes such an approach as a creative dialogue. He and the team at Arup believe that by combining expertise in this way, cities can use night-time lighting to become more enjoyable, more sociable, safer, healthier and easier to get around.

1. Berlin Kantstrasse

Artist Hans Peter Kuhn’s playful lighting design concept turned rail bridges into night-time works of art. © ESA / NASA

2. City Park, Bradford, UK

Carefully balanced lighting provides a flexible, fun and functional night-time setting for the park. © Giles Rocholl

3. 82nd Street Partnership, New York

Community involvement helped develop a night-time lighting strategy that enabled people to enjoy the streets at night. © Arup

4. Leicester Square, London

Better lighting at night turned spaces that felt uncomfortable into places that people wanted to gather. © James Newton

5. Central Park, Songdo

Sculpting light around the bridges’ key features created a soft glow to guide pedestrians at night. © Joon-Hyuk Lee

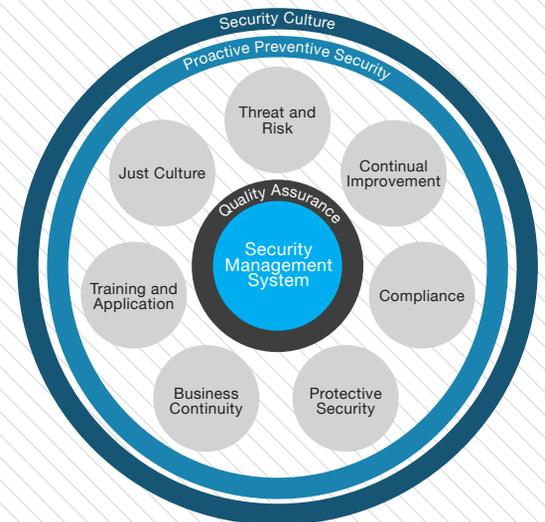


Security should be seen as the job of everyone in the aviation community, not just those people with designated security responsibilities.

Revolutionising aviation security

The system that integrates security into aviation business management

How can the aviation industry best tackle the constantly evolving threat of terrorism, whilst minimising inconvenience to passengers? Specialists believe that an important part of the answer lies in Security Management Systems (SeMS), which Arup helps industry partners such as airports to develop and implement.



Security Management Systems (SeMS) framework

Although SeMS have been an audited industry requirement for airlines since 2007, it is not required elsewhere in the aviation industry and hasn't been used widely by other aviation organisations such as airports. However, that looks set to change as the UK's aviation security regulator, the Civil Aviation Authority (CAA), recently launched its SeMS framework as a precursor to extending its performance-based approach to aviation security regulation.

Stacey Peel, an aviation security specialist at Arup explains the thinking behind SeMS: "It is a mechanism for integrating security into the management of the broader aviation business," she says. "It is about establishing an organisation-wide security culture so that preventive rather than protective security becomes the focus. This in turn strengthens the business's security and resilience."

What does a security culture look like? "Security should be seen as the job of everyone in the aviation community, not just those people with designated security responsibilities," says Peel. "Everyone – from retail to check-in staff – should be aware of security issues and feel empowered to do something about a problem they see. This creates an environment that's hostile to terrorism."

"You can compare it to the way the construction industry has improved its safety record on construction sites by developing a safety culture," says Simon Brimble, an associate director in Arup's security, resilience and risk team. "It's all about making everyone part of the process and empowering people, through ownership and meaningful metrics."

So SeMS aims to do for security what other management systems do for issues such as safety, quality or the environment. And to succeed they need to include similar key components – including board-level backing, having a person accountable for security standards and performance monitoring, assessment and reporting.

"SeMS can involve very straightforward metrics such as how many passengers were subjected to certain types of screening," says Brimble. "You can also have softer metrics – saying that senior management should go on a refresher course every two years, for example. The important thing is to make certain the metrics are measurable and that the systems that are in place are able to support them. The metrics must provide relevant evidence and shouldn't just



be measuring for the sake of measuring."

In fact, much of the information required by SeMS already exists in an organisation, as the CAA Director of Aviation Security Peter Drissell points out. "Stansted Airport, in the UK, was one of our pathfinders for SeMS," he explains. "They found that 70% of the information they needed existed already, it just wasn't collated and analysed in a clear and consistent way."

"This is where digitisation can help," as Drissell explains. "If you want to be sure there are no holes in perimeter fences, you might have to sit down and go through volumes and volumes of patrol reports. But if security patrols captured that information on tablet computers as they went, it would be very, very easy to translate that into a systemic capture of assurance. Manchester Airport is doing this sort of thing with a commercial off-the-shelf (COTS) software management system."

Drissell stresses that this doesn't mean that small organisations need a large and complex SeMS: "The industry we regulate ranges from large airports like Heathrow down to one-man-and-a-van cargo operators. If you're a very small operator, you don't want a SeMS regime that is so bureaucratic it stifles what you do. So proportionality is an absolutely key requisite for this."

By encouraging organisations to adopt SeMS, the CAA hopes to move away from

a 'direct-inspect' regime, where inspections only really give the regulator a snapshot of an organisation's performance at a particular time. Instead, it wants to embed quality assurance in organisations so it can refocus its own efforts to where they can have the best effect.

Although SeMS isn't mandatory for the aviation industry in the UK or elsewhere, Brimble believes it's in organisations' best interests to adopt this approach: "With SeMS, organisations can see the level of exposure that they have, and address their risks in ways that are proportionate, measurable, and more transparent to their managers and Board members."

He cautions that SeMS isn't a silver bullet, but says: "Once in place it has wide-ranging benefits for an organisation. For example, you could expect ensuring that staff always have the right training to create a more productive, more satisfied workforce."

The best way to amplify such benefits, says Drissell, is for the industry to adopt SeMS globally: "It would be much, much stronger if there was a consensus across the world, and particularly a consensus within Europe, as to what a SeMS-driven environment might look like."

With such a consensus in place, airports and other aviation businesses around the world could maximise the benefits of integrating security into their wider management.

All aboard

Why cities are turning to electric buses

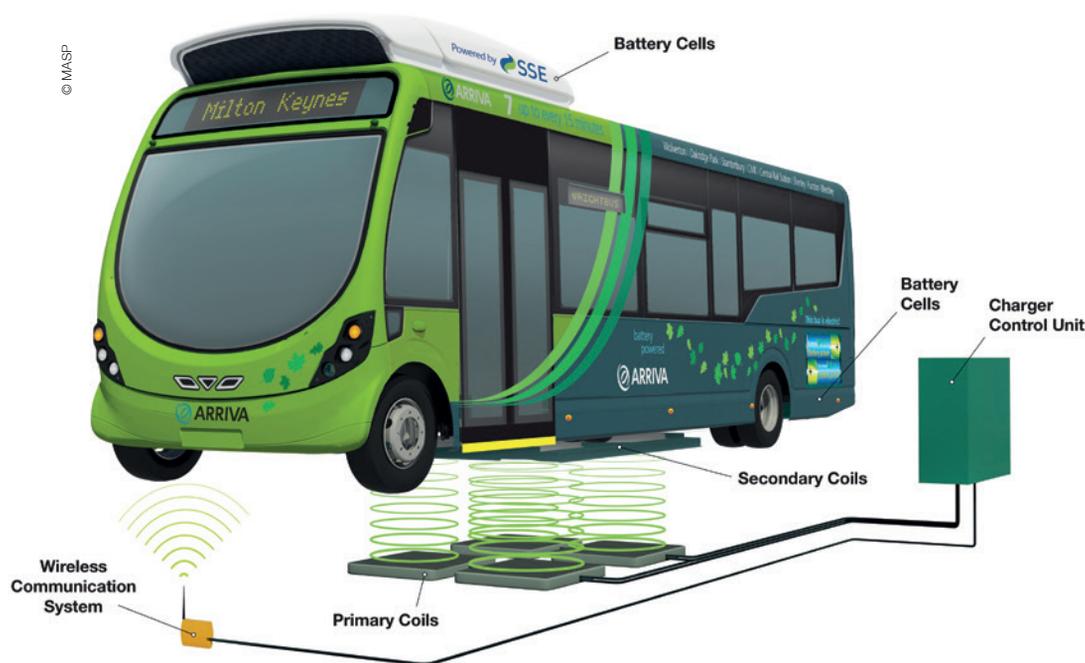
Advances in technology combined with wide-ranging benefits mean low-carbon electric buses are an increasingly attractive option for cities seeking to decarbonise their public transport.

Improving air quality in York

Arup helped to identify short and long-term opportunities for using electric buses in the UK city of York and to introduce the vehicles on key routes.

City of York Council (CYC) wanted to improve air quality in York by reducing emissions from its bus fleet. With over 300 large diesel buses travelling through the city centre an average of ten times each day, buses currently have a disproportionate impact on air quality. So the city has set an ambitious target for 80% of its bus traffic to have zero emissions by the end of 2017.

We produced a roadmap to identify how their challenging target can be achieved within the constraints of a historic city and provided a summary of the technology currently available. The study outlined which services would need to be converted to which technology and how the strategy should be delivered. We also helped to deliver York's successful bid to the Green Bus Fund for six of the vehicles, which are now in service – helping to reduce air pollution in the city centre.



Milton Keynes electric bus

Demonstrating wireless charging in Milton Keynes

The city of Milton Keynes in the UK is now one year into a five-year electric bus demonstration programme that's been planned and managed by a Mitsui-Arup joint venture MBK Arup Sustainable Projects (MASP).

Eight electric buses have taken over a route that even diesel buses find demanding: running 17 hours a day, seven days a week, each bus covers over 56,000 miles a year. However, the Milton Keynes buses have a special technological advantage to help them meet the rigours of their route: wireless charging from plates set into the road.

In just 10 minutes, a bus parked over a charging point can replenish two-thirds of the energy consumed on its 15-mile route. Only two wireless charging points are needed to service all eight buses, which charges in the time scheduled for driver breaks.

The buses have already logged over a quarter of a million miles, showing other cities around the world that low-carbon public transport is achievable.

"I think the technology has reached a stage where we're sure low-carbon urban public transport can be done," says John Miles, an Arup consultant and Professor of Transitional Energy Strategies at the University of Cambridge. "The only question is: will cities do it?"

For Mark Watts, the executive director of the C40 Cities Climate Leadership Group, it's not so much a question of whether cities will do it but when. "In terms of climate change, there is no plan B," he says. "You cannot tackle climate change unless you decarbonise urban transport."

But both Watts and Miles argue that electric buses can help solve an even more pressing problem for cities: air pollution. "Cities like Rio, Shanghai, Hong Kong and others all have air quality problems that electric buses could dramatically improve because as well as being low-carbon they are zero-emission," says Miles.

The fact that electric buses don't emit pollutants such as nitrogen dioxide or particulate matter is one reason why cities around the world are already buying them. Watts points out that in China, Beijing has just ordered 700 electric buses, Shenzhen already has 1,000 on the road and Nanjing has about 900. In Norway, Oslo's mayor wants 100% of the city's public transport

to be zero-carbon by 2020. In the UK, London, which lacks the advantage of a hydro-electric power supply, is aiming to hit 20% by the same date.

There is demand in the market and Miles argues that once you factor in development costs, it's already possible to manufacture electric buses for close to the price of their fossil fuel counterparts. To help boost the market further, 20 C40 cities issued a declaration on 27 March calling on manufacturers to deliver the low-carbon vehicles they want to buy at competitive prices.

As electric bus technology becomes more affordable, the good ride quality of the vehicles mean they also offer an alternative to more costly modes of low-carbon transport. "Light rail and tram systems are incredibly expensive to build – typically £30m per mile," says Miles. "An advanced electric bus provides very nearly the same quality of ride and service as a tram at a much cheaper price. You could create an electric bus service on a segregated pathway for less than £10m per mile."

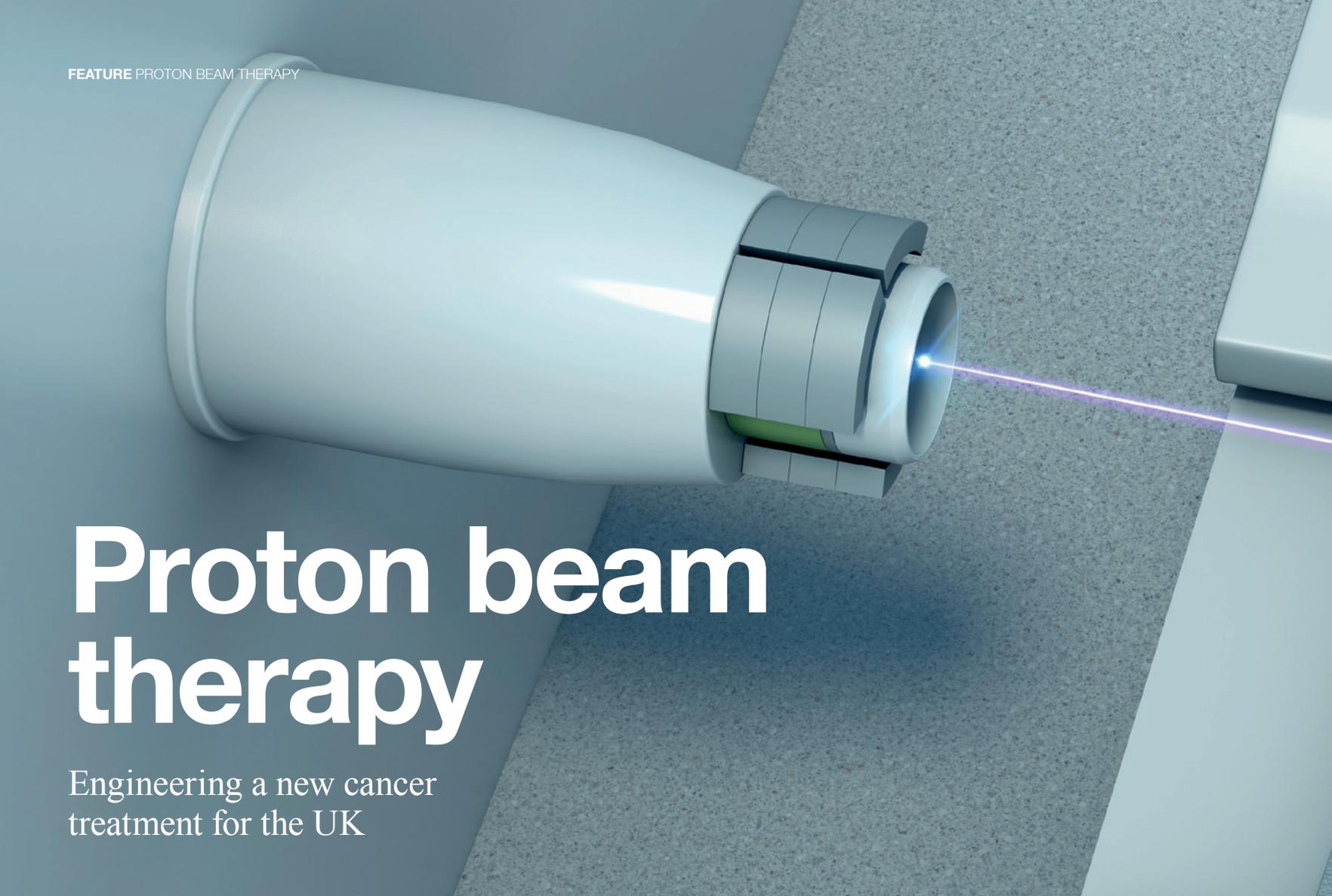
This is why cities around the world have already made extensive use of cost-effective bus rapid transit systems using conventional diesel vehicles. Watts agrees that electric buses could extend

those benefits because they reduce carbon emissions and air pollution too. He also says that city leaders should take account of the much wider economic and social value of low-carbon vehicles, which includes everything from reducing ill health caused by pollution to reducing stress caused by vehicle noise.

In terms of economic benefits, Watts points to the fact that cities which adopt electric buses as part of a low-carbon transport network can save money. He highlights the recent New Climate Economy report showing that Copenhagen, which has invested in prioritising public transport, cycling and walking spends only about 4% of its GDP each year on urban transport while sprawling car-centric Houston spends as much as 14%.

And he points to the fact that Rio, the current chair of the C40, estimates it loses 2.5% of its GDP to congestion. "Some of the estimates from the World Bank for East Asian cities put this figure closer to 5%," he adds.

"There is a huge cost saving – a macroeconomic saving – for a city in having a low-carbon transport system," concludes Watts. "Electric buses are part of an approach that can make cities more prosperous and liveable."



Proton beam therapy

Engineering a new cancer treatment for the UK

Proton beam therapy uses high energy beams of radiation to destroy cancerous cells and results in less damage to surrounding healthy cells than conventional radiotherapy. The beam of protons stops once it ‘hits’ the cancerous cells, making it useful for treating cancers in critical areas, particularly in the case of young children.

But if you have a cancer that is suitable for treatment by proton beam therapy, you can’t currently receive that treatment in the UK. Two new National Health Service (NHS) centres that Arup is helping to engineer will change that. From 2018, these state-of-the-art facilities in London and Manchester, funded by a £250m Government investment, will treat up to 1,500 patients a year.

“Since the NHS Proton Overseas Programme began in 2008, a total of 541 patients have been referred overseas at an average cost of £75,000 per patient,” explains Sam Shooter, an associate in Arup’s building engineering team. “So over

their lifetime the new UK facilities will be much more cost-effective, and they’ll also provide a much better experience for patients and their families.”

Richard Amos is the operational lead for proton beam therapy physics at University College London Hospitals (UCLH), where one of the new centres will be based. He points out that the new facilities will pay for themselves in other ways too.

“If you treat children using conventional radiotherapy and cure them of their cancer, there’s a higher risk that they’ll need treating in later life for conditions relating to that radiotherapy – things such as secondary cancers,” Amos explains. “So using proton beam therapy today will save the NHS money in 20 or 30 years’ time.”

Healthcare on an industrial scale

However, making this life-saving treatment a reality on the two sites at UCLH and The Christie in Manchester was far from easy. “This was something much more akin to industrial engineering than a typical healthcare environment,” says Shooter.

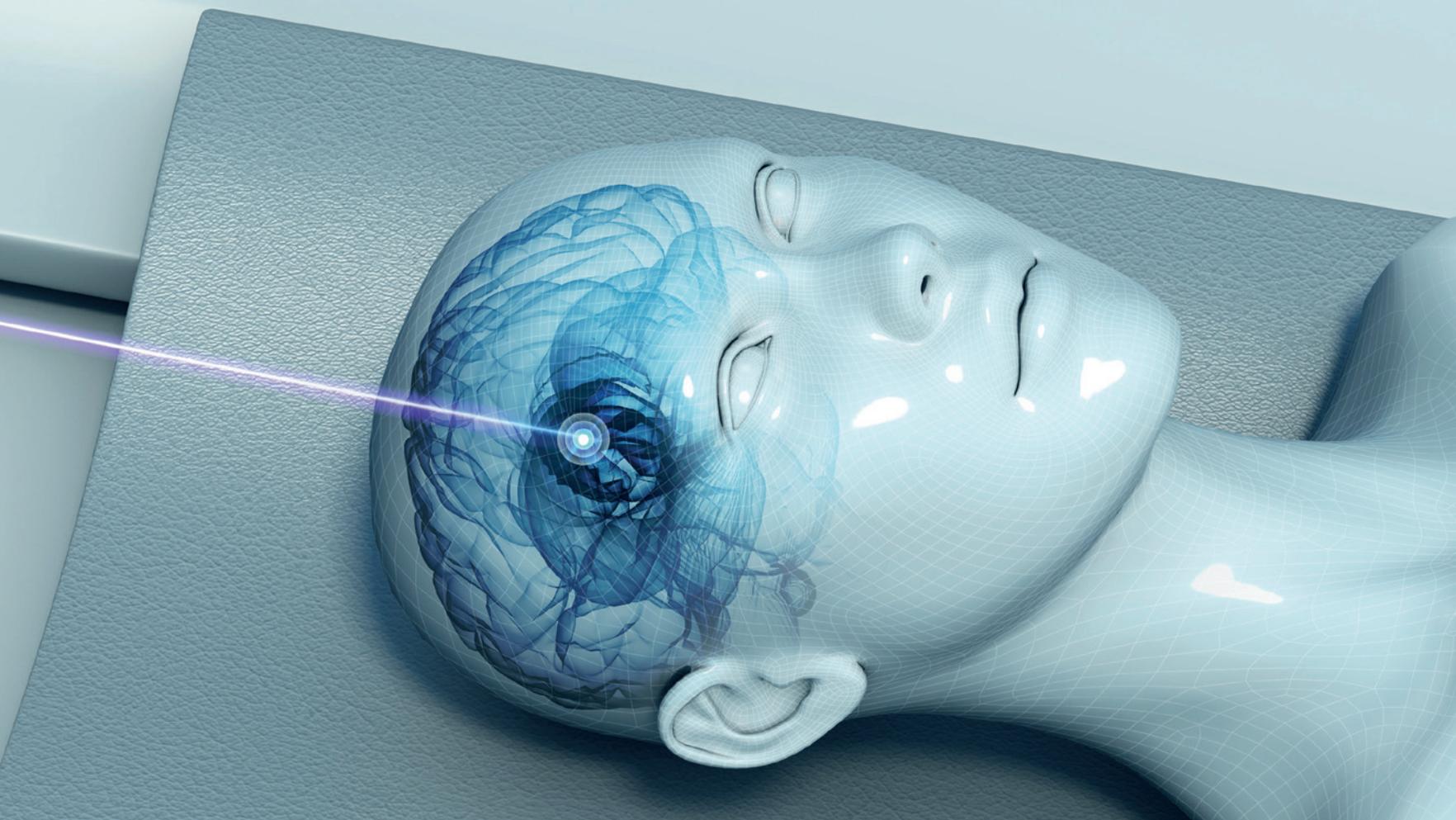
“Accommodating these buildings on existing sites is quite a challenge,”

he continues. “These are energy-hungry buildings that need 1MW for their equipment and require their own substations. This also means they have significant cooling requirements.”

Although the buildings are inherently and unavoidably energy-intensive, our engineers still tried to reduce consumption where possible. “We looked for ways to reuse the heat generated from cooling the magnets and systems,” says Shooter. “It’s reclaimed and supplied to the ventilation systems.”

In addition, our team had to ensure the building could accommodate the 90-tonne cyclotron particle accelerator needed to speed up the protons before they are beamed into the cancerous cells. The associated treatment gantries also weigh 200 tonnes. And the concrete walls need to be up to 4m thick to provide shielding from the radiation.

On top of this, Shooter and his colleagues had to plan around equipment that hadn’t yet been procured. “We had to design a building to work with whichever machine was selected as part of the procurement process,” explains Dave Pitman, Arup’s UKMEA healthcare business leader. “There



are subtle variations in things like size and energy consumption between different manufacturers' equipment."

Amos argues that, from a patient's point of view, the challenges of building on operational sites were certainly worth it. "At UCLH, the new proton beam facility connects directly to the hospital's existing radiotherapy department via a tunnel that's already in place," he explains. "You wouldn't have thought that would be possible in a place like central London and it's something that really improves the experience for patients."

Learning from global experience

As the centres are the first to deliver high energy proton beam therapy for the UK, Arup's global experience with similar facilities proved valuable. The team that engineered the complex phased project at the Bronowice Cyclotron Centre in Krakow flew to the UK to advise on the NHS centres. We also took the contractor working with us on the project at The Christie to see the Polish facility in action.

Pitman explains how the team took every opportunity to share the benefits of their

experience: "We'd previously worked on the Hong Kong Sanatorium Hospital, where a private client asked us to see how proton beam therapy could be done in an existing building of more than 30 storeys. When this client happened to be passing through London on holiday, we arranged for him to meet up with team from UCLH to share the benefits of his experience with the NHS team."

The NHS also benefits from having Arup working on the buildings in both London and Manchester. "Being involved in both schemes means we can act as a conduit for collaboration," says Shooter. "If we find an issue with one, we can help solve it in the other. Because although the buildings will be different, they will need to accommodate the same equipment."

Shooter and Pitman say it wasn't difficult to find engineers willing to put in the hours on projects that will benefit so many people: "In the UK, we're all shareholders in the NHS and we all demand the best possible outcomes from the NHS. The proton beam therapy centres in Manchester and London will improve lots of people's lives."



Proposed new UCLH cancer therapy centre

Since the NHS Proton Overseas Programme began in 2008, a total of 541 patients have been referred overseas at an average cost of £75,000 per patient.

