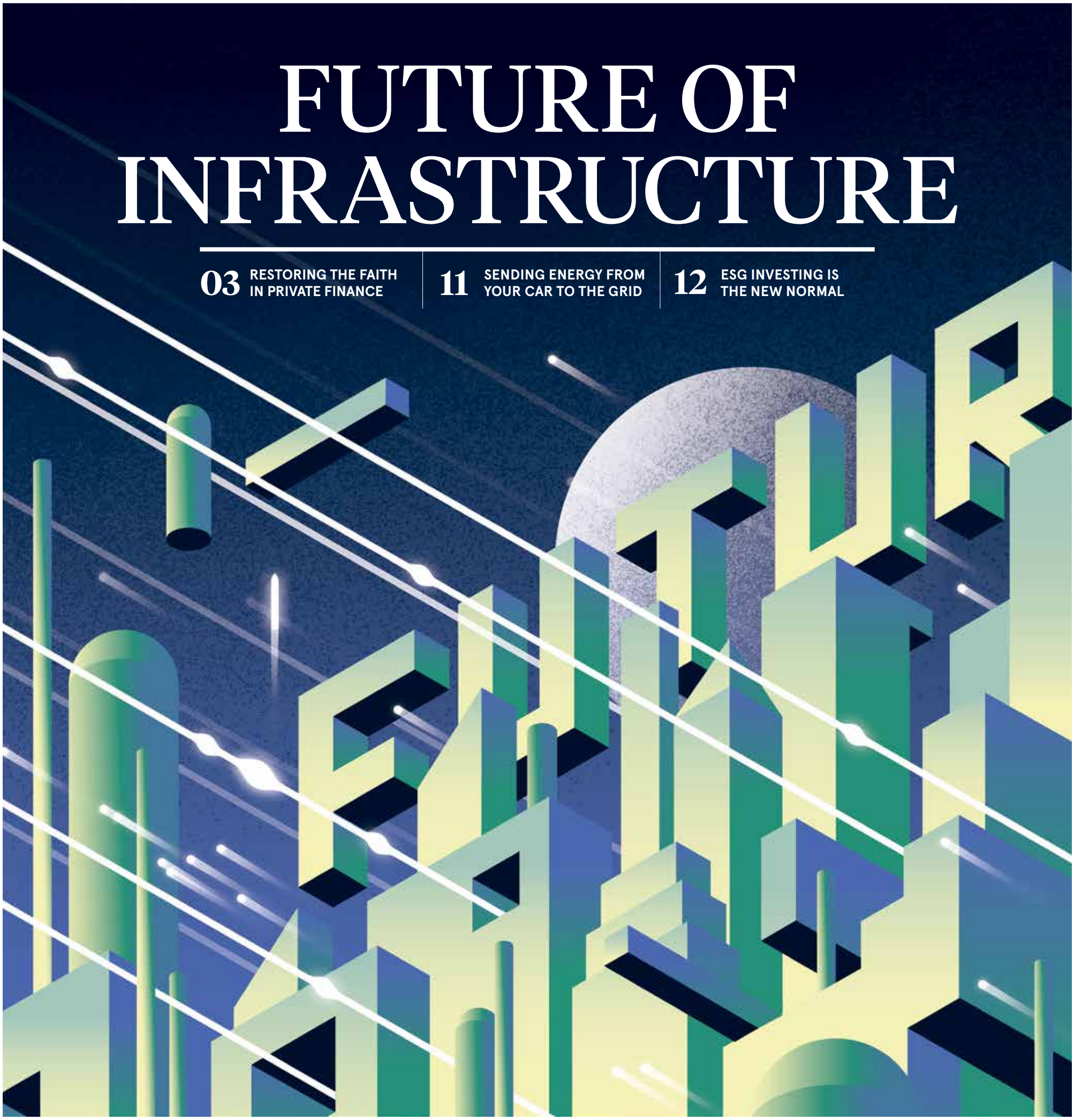
FUTURE OF INFRASTRUCTURE

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FUTURE OF INFRASTRUCTURE

Distributed in
THE TIMES

Published in association with
Global Infrastructure Investor Association
Promoting Private Investment in Infrastructure

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UK INFRASTRUCTURE

Restoring the faith in private finance

Concern over investing in regulated sectors is damaging UK infrastructure, but private finance is essential to meet future needs

Brian Groom

The UK hopes to invest £600 billion over the next ten years to rekindle a "Victorian spirit" by renewing overcrowded railways, roads and airports, building resilience against climate change and improving digital networks.

It expects half to come from the private sector, yet the political and regulatory climate has turned distinctly chilly towards private financing of infrastructure.

Policy announcements from both the government and opposition are sending negative messages to investors, reflecting public concern about whether private provision of public services represents value for money.

Some investors are reluctant to invest further in regulated sectors such as water and energy, though not enough so far to threaten the UK's dominance of Europe's infrastructure market for private capital, an area it has pioneered since the 1980s. Meanwhile Brexit heightens the UK's need to remain attractive to investors across the economy.

"The private sector needs to respond to the challenge of restoring public confidence. It needs to demonstrate its commitment and value for money," says Darryl Murphy, head of infrastructure debt at Aviva Investors, which has more than £5 billion invested in UK infrastructure.

The Labour Party has threatened to renationalise energy, rail and water companies, halt the use of private finance initiative (PFI) contracts and bring some existing schemes back in-house. Opinion polls have shown a large majority in favour of reversing privatisation of utilities.

Chancellor Philip Hammond announced in last autumn's Budget that he is scrapping PFI, used widely in the past to build hospitals and schools, though he held open the prospect of using other means of private finance for infrastructure projects where "it delivers value and transfers risk".

Regulators are getting tougher, notably in water, where Ofwat is attempting in the latest five-year regulatory period to curb bills, which have risen 40 per cent in real terms since privatisation, and press companies to fix more leaks, while restraining them from taking on too much debt and paying large dividends.

The collapse last year of Carillion, the construction company, in part because of project delays in three substantial UK public-private partnerships, further undermined confidence. The problems of Interserve, another contractor, stem in part from a disastrous venture into energy-from-waste plants.


Jason Hawkes/Getty Images

Planned spend on Heathrow's third runway currently stands at £14 billion

Few doubt the need to renew the UK's infrastructure. Since the 1980s, the UK has spent less on this than the United States, France, Canada and Switzerland, according to the Organisation for Economic Co-operation and Development. Think tank McKinsey Global Institute calculates the UK needs to spend an extra 0.5 per cent of gross domestic product a year until 2035 to meet its needs.

The government is raising its capital spending, but also needs private finance. Private sector projects include the £2.8-billion Hornsea One, the world's largest offshore windfarm, being built by Danish developer Ørsted off the Yorkshire coast. Heathrow Airport, owned by global investors led by infrastructure specialist Ferrovial, plans to spend £14 billion on a third runway.

Unless utilities are renationalised, much of the planned investment must come from companies in regulated sectors, including energy and telecoms where the cost is met through consumers' bills. The National Infrastructure Commission is reviewing regulation of the energy, telecom and water industries.

Infrastructure investors are mostly pension funds, life insurers and sovereign wealth funds looking for long-term investments that provide a steady income stream. They have significant holdings in UK water companies, airports, ports, telecoms, renewable energy and energy distribution.

"There is no question that some investors who have traditionally invested in core infrastructure, the regulated assets, feel the environment is no longer one they want to invest in," says Andy Rose, chief executive of the Global Infrastructure Investor Association. He insists, though, there is no blanket ban across the sector on investing in the UK.

Mr Murphy points to a surplus of liquidity in the infrastructure debt and equity markets, and relatively limited supply. "Asset prices remain high and borrowers have a wide array of financing options," he says. Infrastructure remains an attractive asset class in a low interest rate environment for those seeking a premium over government bonds.

Liz Jenkins, partner at law firm Clyde & Co, sees Brexit uncertainty as a problem. "Ministerial time and focus is taken up with this huge issue, and therefore there is not enough focus on infrastructure," she says. "For investors, you need some certainty and there is nothing but uncertainty currently," adding that global investors need a consistent pipeline of projects to justify the expense of bidding.

The Infrastructure Forum, a network of investors, contractors, consultants and other vested parties, complains that only 8 per cent of projects listed in the National Infrastructure and Construction Pipeline are sufficiently certain for contractors to prepare to deliver them.

The Treasury has yet to say what form of public-private partnership it favours after scrapping PFI, which had dwindled to a few projects. Alternatives include the model used for the £4.2-billion super sewer being built under London, which is off the government's balance sheet, though taxpayers act as a backstop.

Iain Scouller, managing director of investment funds research at broker Stifel, expects some post-PFI mechanism to emerge, but adds: "I suspect the potential returns going forward will be somewhat lower than they were historically."

Mr Scouller says investors in UK-listed infrastructure funds would like to invest in new projects, but there is nervousness about nationalisation risk. "If they can get returns from infrastructure projects of 5, 6 or 7 per cent per annum, that's a lot more attractive than very low gilts' yields," he says.

Mr Rose concludes that for the private sector to provide £300 billion of investment over ten years, the government must be clearer about the procurement models it will support. But he acknowledges: "The industry needs to have a better narrative about how private finance has delivered benefits for society."

2.5%
of UK GDP was spent on infrastructure between 2010 and 2015

0.5%
extra of UK GDP needed to finance the UK's infrastructure between 2017 and 2035

McKinsey 2017

Commercial feature

Q&A

Pension-controlled capital: the perfect partner for infrastructure projects

Pension-controlled capital is increasingly a major player in global infrastructure investment. But what makes it different to other types of finance? **David Cooper**, regional head of EMEA, debt investments, and **Irini Kalamakis**, global head of investor relations, at IFM Investors, an Australian investment manager owned by 27 pension funds, with £65 billion assets under management as at December 31, 2018, explain the advantages

Q How do pension funds differ from other private-sector infrastructure investors?

A David Cooper: Major infrastructure projects are, by their very nature, long-term assets which need to be matched with access to funding over the long term. The modern-day responsible infrastructure investor should not expect their managers to realise a core infrastructure asset every seven years to crystallise returns; in fact, some investors have even shorter tenures. Instead, pension-controlled capital brings an opportunity to take a long-term approach, often a decades-long horizon, and importantly allows investors to be a more attractive, trusted partner to the public sector, whether governments or local authorities. We take care to remember that any of the 15 million members we serve may be the ones using the infrastructure on which we invest in on their behalf. Responsible infrastructure investing is here to stay, and partnerships between the private sector, regulators and end-users can ensure it works for everyone.

Q Do pension funds take into account the views of the individuals they invest for?

A Mr Cooper: Absolutely. It is not unusual for me to hear from a client at a pension fund passing on feedback from end-members. In fact, we often hear constructive commentary from pensioners concerned about the dangers of fracking, for example, or those who don't want any exposure to coal investments. We invite robust discussion and it is important to note that IFM Investors invests through open-ended vehicles, which we believe gives our institutional investors the option to hold us to account in relation to our investment decisions. In addition, our infrastructure equity products all have investor advisory committees, which meet quarterly. Investors are not shy at expressing their views, and those of the people they represent, all of which helps shape our ethical principles.

Q What are your ethical principles?

A Irini Kalamakis: We are signatories to the United Nations-supported Principles for Responsible Investment and our investment decisions are guided by three core beliefs. We demand our investments contribute to a healthy environment, a stronger and more inclusive society, and be regulated by strong governance. We also publish a detailed report on our infrastructure carbon footprint each year, with pathways to improving emissions and energy consumption.

Q Can you give an example of infrastructure investing that reflects this ethical approach?

A Mr Cooper: We are a major investor in Manchester Airports Group (MAG), which is the largest UK-owned airport operator. It comprises Manchester, East Midlands and London Stansted airports, serving 58 million passengers a year. We co-own MAG with the ten metropolitan borough councils of the Greater Manchester area. Manchester Airport became one of the first in the UK to become carbon neutral following a £7.5-million investment in energy efficiency by purchasing clean electricity and offsetting emissions. It installed 25,000 low-energy LED lights, including the first on any UK runway. Overall, we are investing £1 billion in MAG to ensure it is fit for the 21st century, and our long-term commitment has helped to create 22,500 jobs for the local economy and increase apprenticeships and educational opportunities. MAG is a strong example of a well-aligned partnership, demonstrating how pension-controlled capital can contribute to essential infrastructure with really great outcomes.

Q There is talk of an "infrastructure gap" globally, so can pension funds help bridge that gap over the next 20 years?

A Ms Kalamakis: We believe so and there are many studies to support this, such as the World Bank and McKinsey pointing to a big deficit in the amount of money economies are spending on infrastructure. In more developed economies, such as the UK and United States, there is a mismatch between what the economy needs and what politicians want to do to win elections. Often minor upgrades to roads can deliver economic benefits, but aren't vote winners. Where pension funds can really contribute is where there is a partnership and alignment between government and investor. Pension funds think long term and in the UK we've seen partnerships result in projects, which create jobs, apprenticeships and opportunities in education.

Q There is a reputational issue in the UK around private sector investment in public projects. How can pension-controlled capital improve the situation?

A Mr Cooper: Private sector participation in public infrastructure projects has become highly politicised in the UK. However, there is no doubt the industry has been slow to respond, partly because it is fragmented, but also because no one has stood up and really made the case for the advantages. I would point to the success of projects in Europe, where private finance routinely invests in infrastructure alongside the state to deliver significant benefits to the public sector, the economy and, of course, the end-users. The fundamental difference is that in Europe there is normally cross-party support for private capital investment. As an industry, we need to be better at pointing to the track record of pension-controlled capital investing in a long-term, ethical way, structured around regulation and strong governance, and why and how it benefits millions of end-users and members, driving global economic growth. Examples of this are IFM Investors' collaboration with MAG, but also our ownership of Indiana Toll Road in America, where we have committed $200 million to improve the quality of a 156-mile road and completed this major construction project in a boost to local employment, while seeing a reduction in accidents across the workforce.

Q What difference can pension-controlled capital make to infrastructure in the UK?

A Ms Kalamakis: The UK is well placed to take advantage of pension-public partnerships by long-term, responsible owners and the benefits of asset recycling. Unlike many traditional suppliers of infrastructure capital, pension funds are uniquely placed to sustain relatively illiquid investments such as infrastructure. Their members' long-term investment time horizon aligns with the long-term life cycle of such investments, and are therefore much better aligned with both community and government expectations. In the end, it is the pensioners we represent who are going to be using the assets we build, from airports to roads and telecoms to ports. Our interests are all genuinely aligned for the long term and that is what makes a real difference.

For more information please visit ifminvestors.com/Infrastructure

ifm investors

MANCHESTER AIRPORTS GROUP AT A GLANCE

58.8m total passengers

£7.8bn economic activity generated in FY18

100% airport energy needs met via renewable energy

45k people employed locally

£1bn cost of Manchester Airport redevelopment

43% reduction in gross carbon emissions per traffic unit over five years

MAG Corporate Social Responsibility Report 2018

DIGITISATION

Changing the game with spatial analysis

Digitisation is revolutionising the way infrastructure is built and maintained, giving organisations the ability to track a dazzling variety of datasets to better inform decisions

Michael H/Getty Images

Charles Orton-Jones

On the face of it, Network Rail is a nightmare to run. The state-owned body operates 20,000 miles of track, 40,000 bridges, viaducts, tunnels and crossing points. How on earth do managers keep track of such a tangle of rail and assets?

To draw up a forensic image of everything it owns, Network Rail found a radical answer. It commissioned helicopters equipped with laser radar, known as lidar, to fly the entire length of the rail network, at a height of 250 metres, to scan everything in. The result is a detailed 3D digital model, featuring every tree, hill, sleeper and building to an accuracy of 4 centimetres.

Network Rail can use this 3D model to identify potential flood points by looking at the soil type and gradient. Engineers can see where trees are growing too close to the track. Storage buildings can be classified and noted for future use.

The 3D map is a base around which more data layers can be introduced. If needed, Network Rail can overlay 4G mobile signal strength maps, land ownership boundaries and 140 other data layers.

The Network Rail story is an example of how a discipline called spatial analysis is changing the way infrastructure is built and maintained.

At the heart of spatial analysis is data. Lots and lots of it. A basic map is adorned with dozens or hundreds of interactive data layers. Platforms such as Esri, Caci and Alteryx offer libraries of proprietary and open source data from Experian, Dun & Bradstreet, the Ordnance Survey, census data, satellite imagery, Met Office weather data and hundreds more to be woven in with the client's own information. Spatial analysis takes the guesswork out of infrastructure planning, by integrating every known source of data into a single working model.

> **The old method of guessing where infrastructure needs to be located is over; the data crunchers are changing the game**

Here's another example. Local authorities want to install charging points for electric vehicles across the UK. The money is there as the government funds 75 per cent of the cost. The question is where to put the chargers?

Rather than randomly sprinkle charging points, Emu Analytics, a consultancy with expertise in spatial analysis, created a UK-wide digital map identifying the location of all current electric chargers, plotted against residential density, and car and electric vehicle (EV) ownership. The result was a rich analysis of where new charging points ought to be located.

This approach gives local councils all the facts they need to make decisions. For example, Emu Analytics is able to state that Newcastle has the best EV charger ratio to cars, with 1.45 chargers per car, while Peterborough has the worst at 485 cars to every charger. The lack of rapid chargers highlights why consumers might be reluctant to buy. With just 1,500 rapid chargers and 3,400 connectors as of May 2018, there was only one rapid charging connection in the UK per 43 cars: not good enough.

Councils can use spatial analysis to find sites with good parking, demographic data to forecast where EV ownership is likely to be strongest and local authority data to find streetlights suitably located for conversion to charging points.

The demographic angle is particularly enticing. Infrastructure planners can make use of a dazzling variety of datasets about citizens such as where they live, incomes, buying habits, family sizes and travel routes. The mobility app Moovit anonymously aggregates travel data to track how commuters make their journey to work. The city of Boston used data from Moovit to unearth the fact that many commuters avoided using the train as they had nowhere to park at the station. It became clear that increasing bus routes along the commuter belt could ease the bottleneck.

Benefits of spatial analysis bring rigour to decisions on infrastructure. A vast number of factors can be modelled together, using an intuitive drag-and-drop interface. Staff across multiple sites can take part as most platforms are on the cloud and even accessible via smartphones.

The old method of guessing where infrastructure needs to be located is over; the data crunchers are changing the game. When we need a charging point for our cars or a bus to get to work, spatial analysis means they will be exactly where we need them.

How TfL runs its road team

Transport for London, or TfL, operates one of the most extravagantly complicated road networks anywhere in the world. Keeping track of where work is needed and where staff need to be is a formidable task. So TfL built the Surface Playbook to co-ordinate everything.

Built using Esri ArcGIS, a spatial analytics platform, the Surface Playbook works on a desktop, mobile and tablet. It maps out the road network, and where maintenance projects are needed, under way and planned for the future.

Staff use the app to view work schedules. The playbook prevents clashes: two teams inadvertently turning up at the same site can cause mayhem. Planners can draw down more than 400 data layers into interactive street maps to build a picture of what is needed. A simple time-slider function makes it easy to see how work is scheduled at an asset over time.

"Surface Playbook provides a comprehensive picture of our road network, assets, current works and projects in one place, giving employees the best information from which to make important planning and operational decisions," says Fiona Clowes, who helped build the playbook as TfL geographic information system lead.

STRANDED ASSETS

What happens when assets become obsolete?

With policies shifting towards cleaner sources of energy, stranded assets associated with fossil fuels can represent a huge risk to company balance sheets

Olivia Gagan

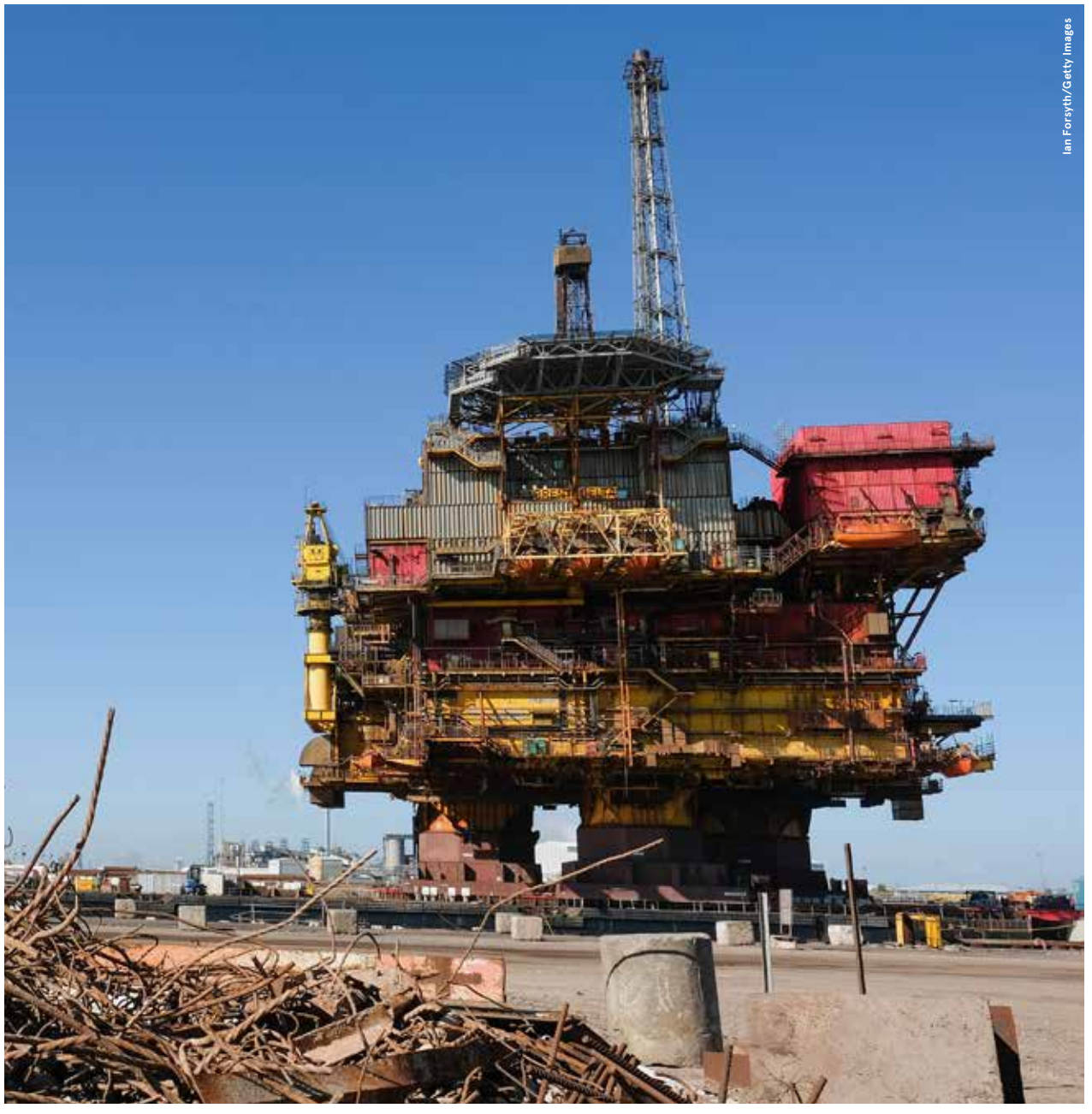
Owning stakes in major energy assets, such as oil fields, coal plants or gas pipelines, is typically a hugely expensive, long-term investment. It's a commitment that has historically paid off for both energy companies and their backers, who have collectively reaped the profits from decades of exponential leaps in global energy consumption.

But what happens when those assets become a growing liability, as policies shift towards curbing fossil fuels, rather than supporting them? This is when assets can become stranded.

A stranded asset – one that experiences an early write-down in its valuation or becomes obsolete – represents a significant risk to the balance sheets of companies invested in the energy sector.

The Paris Agreement saw 185 states commit to cull carbon emissions progressively from 2020, which sets a rising cost to owning assets that emit high levels of carbon. The International Energy Agency has warned that $1.3 trillion of oil and gas assets could be left stranded by 2050, if the fossil fuel industry does not adapt to greener climate policies. But is the growing risk of stranded assets being reflected in investors' behaviour and in the value of their investments?

Alex Harrison, a partner specialising in energy policy at law firm Hogan Lovells, believes that investors are more worried about the reputational damage of being associated with fossil fuels than the risk of their investments becoming stranded. "My sense is that the threat of a physical or legal prohibition on being able to exploit their reserves isn't chief in investors' minds," he says. "Their bigger concern seems to be the threat to their social licence to operate that comes from being active in the fossil fuel sector."



Ian Forsyth/Getty Images

Decommissioned 24,000-tonne Brent Delta Topside oil platform, pictured before it was scrapped in Hartlepool in 2017

But Giuseppe Corona, who manages global investor AMP Capital's $284-million Global Listed Infrastructure Fund, says far from just being an image problem, shifts are already happening in the perceived value of fossil fuel-based assets. "I can see changes in the equity markets. The cost of capital for assets at risk of being stranded is getting higher," he says. Lenders are requiring a higher level of returns on assets at risk of being stranded in the mid to long term.

Mr Corona says: "Coal assets are most at risk of becoming stranded. Oil assets are probably second in line. Gas is the one that is tricky; of all the conventional energy sources, it's possibly the cleanest."

When it comes to predicting which energy assets are in especially high danger of being written off or devalued, it is also a question of geography. Mr Corona's fund managers have to make an assessment on a country-by-country basis. He says: "The United States, for example, has seen a lot of coal being decommissioned. In China, too, policy is switching from coal to gas. So the impact of decarbonisation on coal investments in those countries is already undeniable. But with significant investment in gas, the risk of stranded gas assets is probably very far down the road."

Clampdowns on spending in the coal industry have also produced a knock-on effect of creating stranded assets in other sectors. Policies designed to avert climate change have led to stranded assets in transportation, such as rail tracks which were dedicated to taking coal to power plants. "When investing in rail, you now need to look at energy policy and ask whether those tracks are still going to be needed in 20 years," says Mr Corona.

Investors must, therefore, juggle multiple timelines when assessing which assets in their portfolios could become stranded. "By our estimation, it's a multi-decade process," he says. "For example, oil demand is rising in developing countries. Therefore, the chance of stranded assets in the oil sector is more likely from 2030 onwards."

Mr Harrison agrees that in the long term it will be the oil majors which own as-yet untapped reserves that could face the most risk of obsolete assets. "The most exposure to risk is going be on the balance sheets of the majors," he says. "There seems to be a recognition of fundamental inconsistency between decarbonising and exploiting those reserves. However, I don't think we've yet reached the point where anyone is thinking they are going to have to leave assets in the ground."

Mr Corona says whether an investor in the energy sector is an oil and gas giant, an activist shareholder or a major fund such as his own, being able to predict and outpace the rapid technological, political and social evolution regarding carbon is now one of the biggest challenges. He concludes: "The tricky part of our job is that we deal in very long-term assets. For the investment to work, you need to be able to rely on long-term cash flows. But things are changing so fast."

> **When investing in rail, you now need to look at energy policy and ask whether those tracks are still going to be needed in 20 years**

ENVIRONMENT-RELATED RISKS THAT MAY LEAD TO STRANDED ASSETS

Physical

- Environmental change
- Resource landscapes

Social

- Technological change
- Government regulations
- Societal norms and consumer behaviour change
- Litigation and statutory interpretation

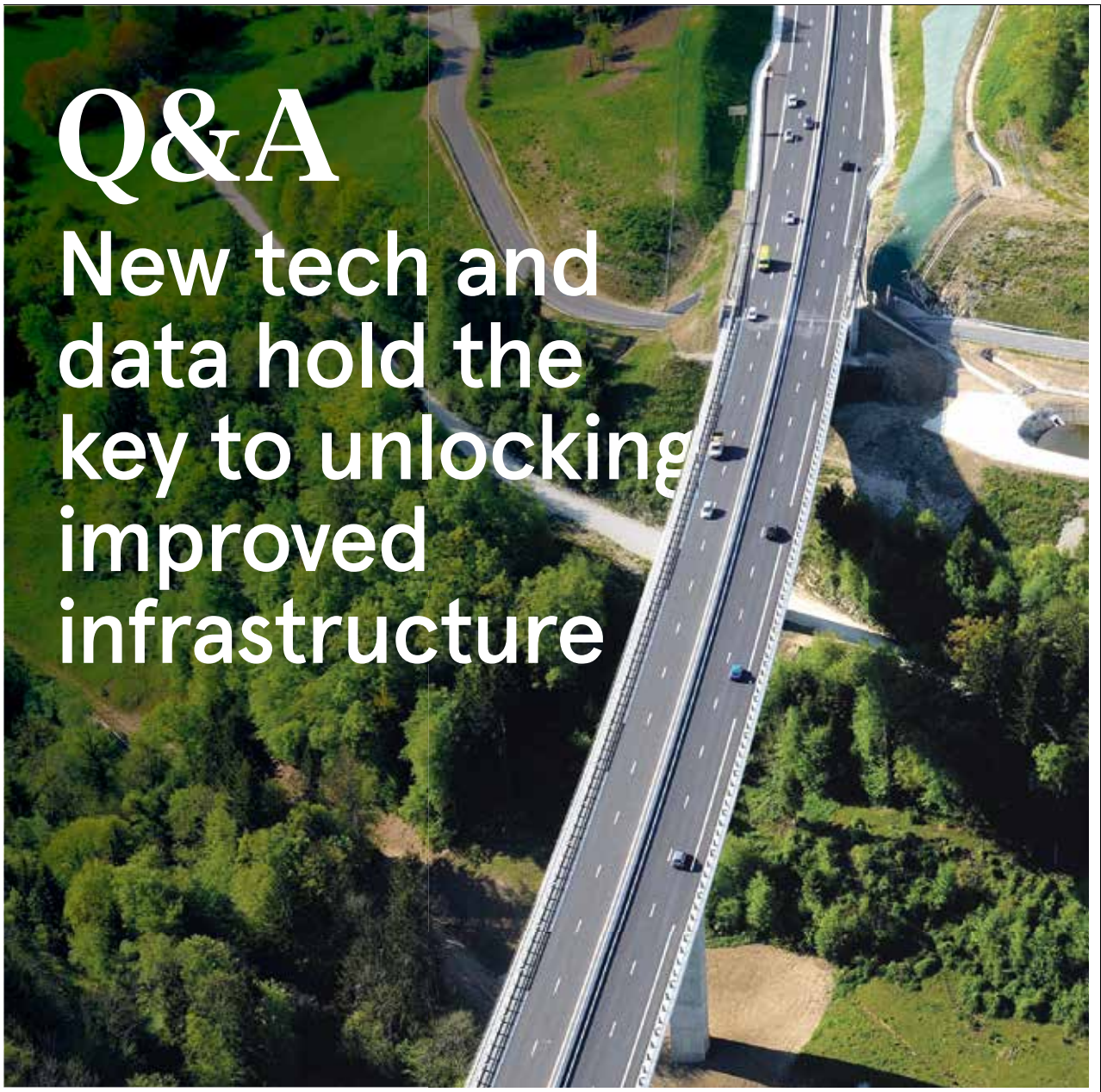
Lloyd's 2017

$1.3trn

of oil and gas assets could be left stranded by 2050 if the fossil fuel industry does not adapt to greener climate policies

International Energy Agency 2017

Commercial feature



Q&A

New tech and data hold the key to unlocking improved infrastructure

Macquarie Infrastructure and Real Assets' **Leigh Harrison**, head of Europe, Middle East and Africa, and **Peter Durante**, global technology and innovation lead, share insights into the role of investment in infrastructure

Q How will data analysis technologies impact infrastructure investments in the future? What problems are they solving and what potential do they have?

A Leigh Harrison: We're already seeing data collection and analysis having a growing and positive impact on the infrastructure assets in which we invest. More data is being collected, particularly as these assets become increasingly interconnected. Management teams and investors are using that data to improve the quality and efficiency of operations. For example, as part of the transport revolution, cars and other road infrastructure will become increasingly connected. We expect this will generate a host of useful data, which then helps to improve scheduling of maintenance on assets such as roads so problems are identified and fixed before they occur. This has the potential to improve the operational performance of infrastructure to the benefit of end-users and investors, while also driving improvements in health and safety outcomes for employees. Meanwhile, the move towards greater data gathering and analysis is also likely to increase the need for investment in new infrastructure that can collect and monitor it all.

Q What other opportunities will the transport revolution bring?

A Peter Durante: The electrification and automation of vehicles will require a significant investment in infrastructure, such as the installation of charging points and upgrades to the local electricity grid. Some estimates suggest that electrifying passenger cars and other vehicles may increase the electricity demand of a country by 10 to 30 per cent.[1] This is likely to require greater investment, particularly in renewable energy production. Fortunately, that creates a virtuous circle because electric vehicles have a greater incentive to use the clean, efficient electricity as it becomes more cost effective. In our view, the growth of the electric vehicle market is also driving down the price of battery storage, further increasing the potential share of electricity that can come from green energy sources.

> As part of the transport revolution, cars and other road infrastructure will become increasingly connected

Q What role will data have in household energy usage and what opportunities will that create for investors?

A Leigh Harrison: The data revolution is already playing a role in household energy through technologies such as smart meters. By providing enhanced visibility over energy prices, smart meters can help consumers make more informed decisions around their usage, for example shifting electricity demand to times when prices or emissions are lower. Smart meter businesses in some countries are highly desirable. In Germany there are some large metering businesses that are part of this ecosystem. But it does depend on the country, the regulatory environment and the nature of those businesses.

Q How can infrastructure companies use sensors and the internet of things to boost their value?

A Peter Durante: We manage a number of assets that integrate these technologies. Sensors and internet of things applications can, for example, assess in real time the health and performance of infrastructure. Instead of sending a crew of technicians to climb a wind turbine or dig up a pipe buried underground, you can now use sensors to more reliably inform you about the condition of materials and what is impacting their performance. Sensors also have a wide range of applications beyond maintenance, monitoring everything from physical data to transactions and even movement. For example, sensors are being used to track footfall, traffic and flow through an airport. They can also be used on bridges and roads, enabling operators to switch lanes and make them bi-directional, depending on the time of day and traffic patterns.

A Leigh Harrison: We are seeing infrastructure managers increasingly using technologies like this to enhance performance. In addition to the efficiencies they should generate for operators, they can also improve outcomes for communities as assets are less likely to break down unexpectedly and require repair. Ultimately, we think the end-user is the winner.

> These technologies are already making infrastructure assets much more efficient for end-users, safer for employees and better for the environment

Q What effect will the use of drones have on infrastructure investments?

A Leigh Harrison: We are seeing more companies using drones and we expect this to continue. They can be very effective as a means of reducing the labour time and cost of certain activities, such as maintenance and inspection. Drones can also make some activities safer, reducing the need to physically inspect assets such as telecommunications towers and large offshore wind farms. A drone can be a far safer way of doing the same inspection, and so can be more efficient and better for employees.

A Peter Durante: Drones can enable more regular inspection because the cost is driven down. The more you inspect something, the quicker you can identify and fix a problem before it happens. They are also generating a lot of new data, and we see integration and analysis of this data as key. We are starting to see providers' back-end platforms improve to allow this technology to become more useful across lots of different industries, ranging from energy to agriculture and transport.

Q How will data interact with research and development operations in infrastructure?

A Leigh Harrison: We believe data collection and analysis is making technology better, both in operation and during the research and development (R&D) phase. By helping researchers better understand how technology operates, data can be used to fix design faults. This is reducing the long-term cost of technologies, from solar photovoltaic cells to battery storage. We see this as an exciting trend and it gives us confidence that the infrastructure sector can help make economies more sustainable.

Q What are the challenges for the infrastructure sector in collecting and using all this data?

A Leigh Harrison: Traditionally, these types of businesses have not focused on the collection or analysis of data. We are starting to see this change, however we believe data collection is only the starting point. As the amount of data grows, we expect infrastructure operators will need to invest in their analysis capability. Using machine-learning and smart algorithms, insights from data can be better understood and integrated into decisions that improve the performance of assets.

A Peter Durante: It is also about improving the user experience. People generally expect technology will deliver improved services and operations over time. We see this in the infrastructure sector too, for example in contactless payments for public transport, automated payment for tolls and electronic boarding passes on phones. These improvements to the way we interact with infrastructure are underpinned by data.

A Leigh Harrison: In addition, we need to remain vigilant to cybersecurity risks. These assets are relied on by the communities in which they operate and can often be strategically important nationally too. Therefore, cybersecurity vigilance needs to remain at the forefront of infrastructure management.

Overall, we believe these technologies are already making infrastructure assets much more efficient for end-users, safer for employees and better for the environment. As they advance further and become even more embedded in the infrastructure we rely on every day, we're excited to see the increasingly positive impact they'll make for communities and economies around the world.

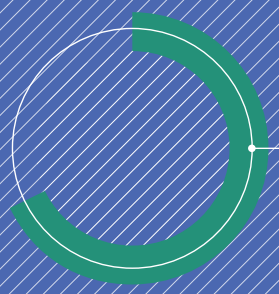
For more information please visit www.macquarie.com

1. MIRA calculation based on information from *BP Statistical Review of World Energy 2018*, Royal Automobile Club, US Department of Energy

MACQUARIE

THE FUTURE OF UK INFRASTRUCTURE

Investment in energy and transportation is driving UK infrastructure over the next decade as public demand for improved services grows



64%

of the public think the UK should spend money on infrastructure to improve public services

YouGov 2019

UK INFRASTRUCTURE PIPELINE IN NUMBERS

£413bn

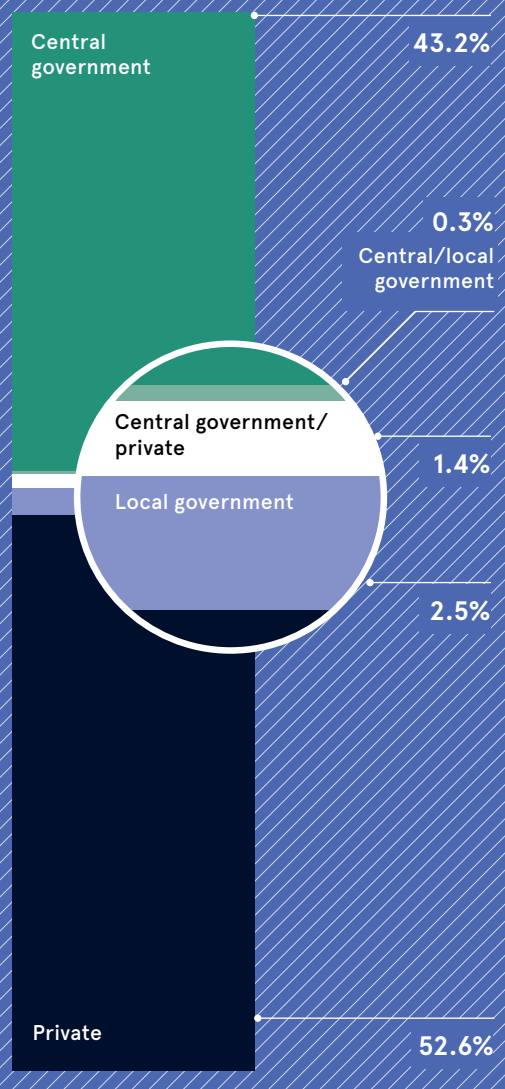
of capital expenditure investment

£329m

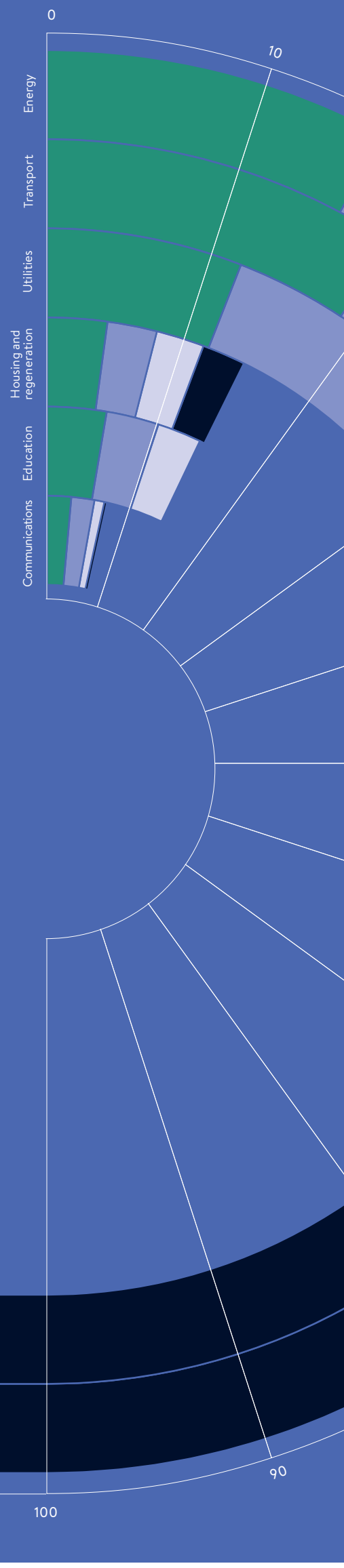
average project size

Infrastructure and Projects Authority 2018

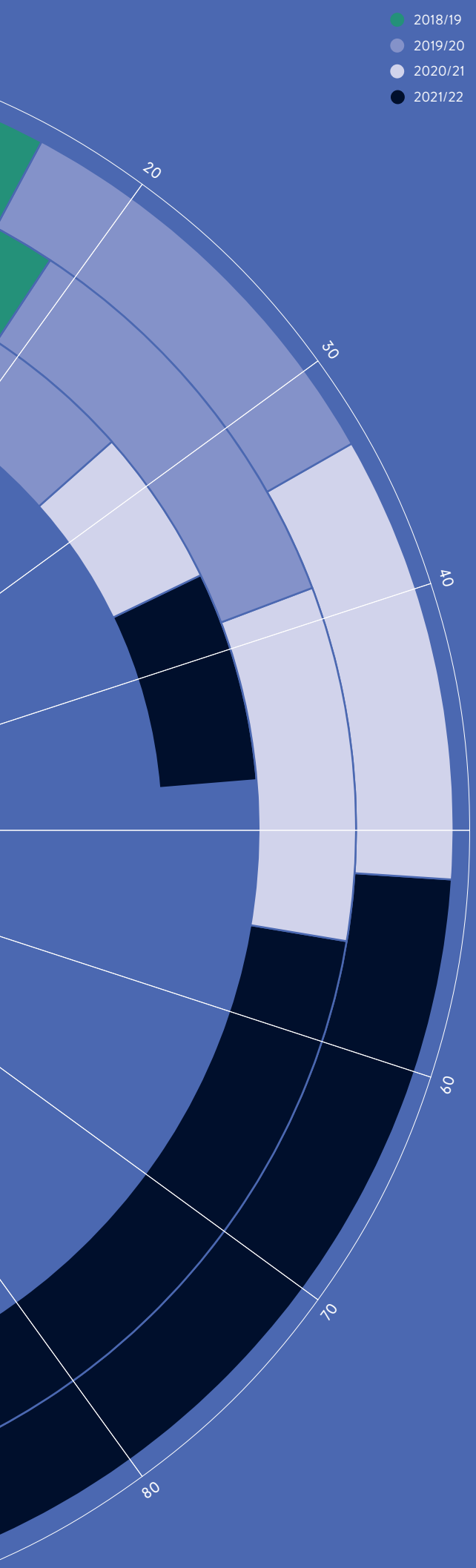
FUNDING SOURCE FOR INFRASTRUCTURE INVESTMENT OVER NEXT TEN YEARS



PROJECTED UK INFRASTRUCTURE IN



IVESTMENT IN THE PIPELINE (£BN)



Does not account for all infrastructure spending in Scotland, Wales and Northern Ireland as responsibility is devolved to respective administrations

Infrastructure and Projects Authority 2018

TOP TEN UK INFRASTRUCTURE PROJECTS IN PIPELINE BY CAPITAL EXPENDITURE

Capital expenditure (£bn) · Start of works/ construction (projected) · Date in service (projected) · Sector · Funding source · Status

01 HS2
ENGLAND

North to South high-speed railway connecting eight of the ten biggest cities in the UK

£55.7bn
2017
2033
Transport
Central government
Planning and consents

HS2 2019

02 HINKLEY POINT C
SOUTH WEST

3,260MW nuclear power station

£19.6bn
2019
2027
Energy
Private
Consents approved

EDF Energy 2019

03 CROSSRAIL
LONDON

60-mile high-frequency rail service to raise Central London rail capacity by 10 per cent

£17.6bn
2009
2019
Transport
Central/local government
In construction

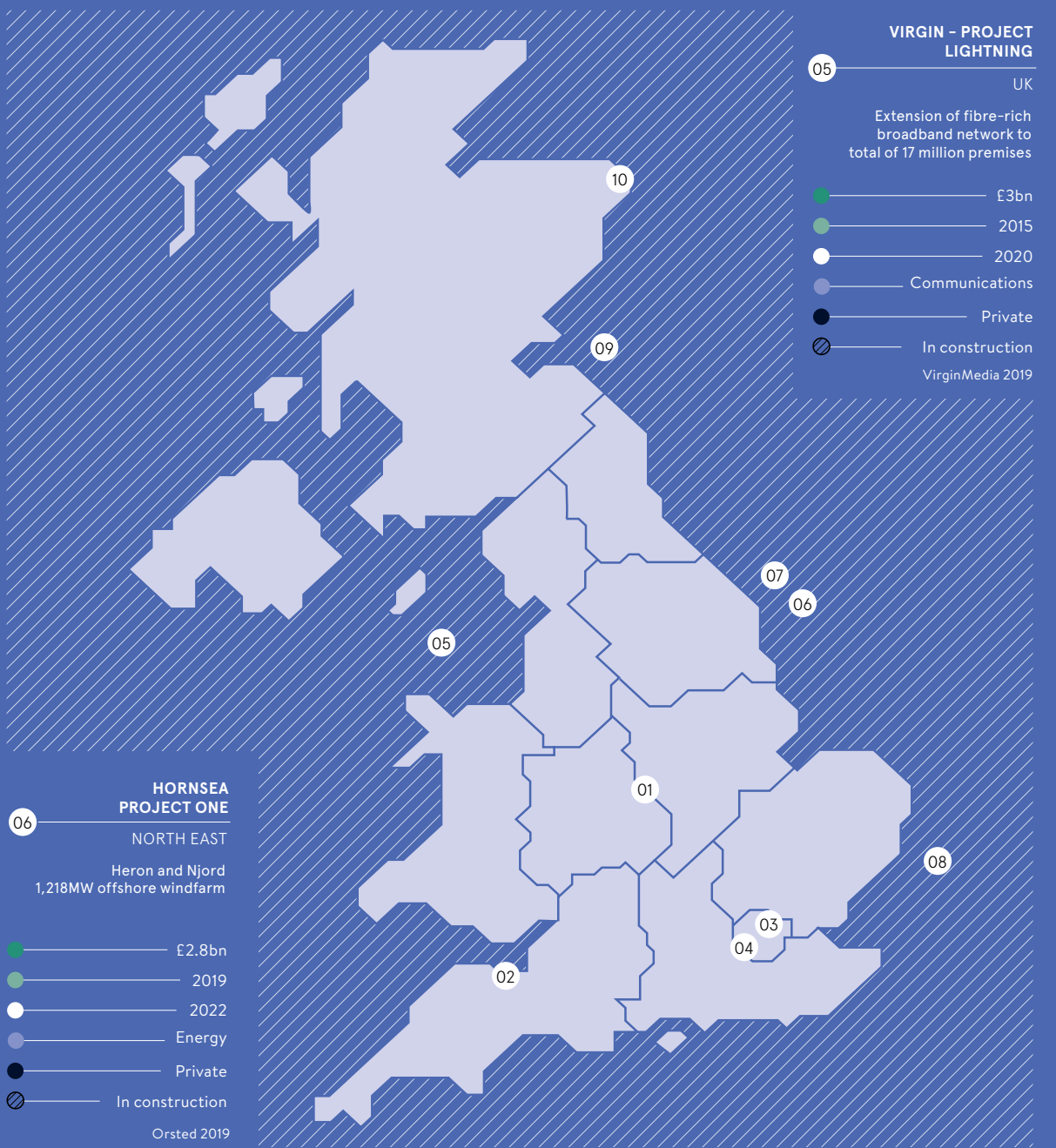
Crossrail 2019/DfT 2018

04 THAMES TIDEWAY TUNNEL
LONDON

25km super sewer

£4.2bn
2016
2023
Utilities
Private
In construction

Tideway 2019



05 VIRGIN – PROJECT LIGHTNING
UK

Extension of fibre-rich broadband network to total of 17 million premises

£3bn
2015
2020
Communications
Private
In construction

VirginMedia 2019

06 HORNSEA PROJECT ONE
NORTH EAST

Heron and Njord 1,218MW offshore windfarm

£2.8bn
2019
2022
Energy
Private
In construction

Orsted 2019

07 HORNSEA PROJECT TWO
YORKSHIRE AND HUMBER

Optimus and Breesea 1,386MW offshore windfarm

£2.6bn
2019
2023
Energy
Private
Consents approved

Orsted 2019

08 EAST ANGLIA 1
EAST OF ENGLAND

800MW offshore windfarm

£2bn
2018
2021
Energy
Private
In construction

ScottishPower Renewables 2019

09 NEART NA GAOITHE
SCOTLAND

450MW offshore windfarm

£2bn
2020
2023
Energy
Private
Consents approved

EDF Energy 2019

10 NORTHCONNECT INTERCONNECTOR
SCOTLAND

1.4GW capacity subsea cable between Scotland and Norway

£1.8bn
2020
2022
Utilities
Private
Scoping

Ofgem 2018

Commercial feature

Infratech set to transform sector

Emerging technologies, or infratech, are set to transform the infrastructure sector, creating opportunities for smart investors to achieve higher returns

A combination of stability and growth has helped to make infrastructure one of the world's fastest-growing asset classes in recent decades. Now further, tech-driven changes are forecast.

"I think the whole area is going to change dramatically," says Boe Pahari, managing partner and global head of infrastructure at AMP Capital, an investment firm with tens of billions of dollars placed in the asset class.

"The use, collection and interpretation of data, connectivity through the internet of things, artificial intelligence and automation in terms of robotics, these are areas that I can see really affecting us. We will see a huge change in the way we operate in the next ten years."

AMP Capital has equity investments in four sectors in the United States, Europe and Australia: transport, such as airports and trains; energy, including power generation and industrial infrastructure; communications, such as fibre-optic networks; and health, with areas such as primary and social care.

Airports, where AMP Capital's portfolio includes investments in London Luton, Leeds Bradford and Newcastle in the UK, and Melbourne in Australia, are likely to see some of the most eye-catching changes.

"Airports already have electronic passport control and facial recognition. You can take that to another level with imaging technology and artificial intelligence to look at bone structures for identifying people on suspect lists who are trying to enter the country," says Mr Pahari. Other potential applications include smarter baggage-handling systems and more fuel-efficient aero-engines that enable aircraft to fly further non-stop.

Other sectors set to benefit include education, where ways of providing online content are rapidly expanding. In logistics, the use of robotics in operations such as food storage is becoming more sophisticated. Mr Pahari adds: "You have artificial intelligence and augmented learning to be able to create maximum optimisation of power and space in buildings."

In health, there is scope to improve information systems, provide consumer applications and for specialists to treat patients on the other side of the world using the internet. In care of the elderly, there is opportunity for early-stage penetration of technologies, for example wearable devices to facilitate increased independence, mobility, communication and improved quality of life.

Drones have uses in infrastructure, for example surveillance in offshore rescue and recovery operations at wind farms and oil rigs, helping to deal with incidents without endangering human lives.

Mr Pahari sees three parts to AMP Capital's strategy. "First, we are always looking at what sort of technology gaps we have in our infrastructure portfolio, for instance the usage of cloud and internet technology to create online services, customer relationship systems and management information systems.

"The second thing is automation; what areas can be automated, whether in airports or other parts of logistics? Third, we are looking for investment opportunities that form part of the infratech environment, for example cloud-based services which have become so essential to business and the digital economy they possess infrastructure characteristics. Should we be thinking about extending our investment criteria to include these companies because they will become an integral part of infrastructure?"

> **Infrastructure starts with an invention, someone's imagination. By the time it becomes something we're used to, we call it infrastructure and it becomes essential to urban living**

He says AMP Capital will continue to look at opportunities adjacent to its current global infrastructure strategy and is likely at some point to create opportunities for investors to back infratech providers with applications in various sectors. For example, these could include companies supplying passport control technology or ground-handling equipment for airports.

Mr Pahari explains the way infrastructure investment evolves. "It starts with an invention, someone's imagination. By the time it becomes something we're used to, we call it infrastructure and it becomes essential to urban living. Aircraft and airports 50 or 60 years ago were on the borderline of the infrastructure model, but today we take them for granted and they are essential," he says.

Many core infrastructure assets were privatised 20 or 25 years ago, when investors took risks on regulations, performance and refinancing. In time, the asset class became derisked and returns became lower, or commoditised, as the "alpha", or active return on investment, was released to the investor.

"The same thing will happen to these new opportunities. Over a period of time, they will become derisked and commoditised," Mr Pahari says.

"It's a question of when, as an infrastructure investor, you want to enter the cycle of value creation. Ideally you want to be able to spot the trends and move into things as they become commercialised. As an infrastructure investor, I would not necessarily want to be in early-stage or venture capital, but I would want to be in growth or opportunity capital. I think at that point, with something which has basically been commercialised and has worldwide application, that is an attractive space to enter."

Mr Pahari describes AMP Capital as "bringing a private equity rigour and style to infrastructure". It does not invest in core areas such as toll roads, utilities and bridges, but in emerging areas such as regional airports that are being internationalised or privatised.

Recent investments include a 49 per cent stake in London Luton Airport, a 50-50 partnership with Invenergy Clean Power to develop gas-fired power generation facilities across America, Canada and Mexico, and acquisition of two UK businesses providing services for people with learning difficulties, Care Management Group and The Regard Group.

AMP Capital has more than 70 investment professionals in its infrastructure business located in offices across Europe, North America, India, Australia and New Zealand. Mr Pahari says the firm has the expertise to "really capture upside and assume the risks" in the sectors in which it operates and in the technologies that affect them.

He concludes: "We are always looking to be able to sustain returns. As derisking happens, the returns that early investors enjoyed are going to keep going down for late investors. If we can create growth opportunities using technology to cut costs, then we will be able to sustain that growth. Progressive and enterprising private sector players are going to continue to look at different ways of using technology in our business."

For more information please visit www.ampcapital.com

AMP CAPITAL

BATTERY STORAGE

Sending energy from your car to the grid

The potential environmental benefits of vehicle-to-grid technology are huge, but the economics to roll out the tech at scale remain uncertain

James Gordon

It may look like an ordinary building, but Aston University's European Bioenergy Research Institute is extraordinary. For it is one of just a handful of buildings in Europe to use vehicle-to-building (V2B) technology. Owners of battery electric vehicles (BEVs), who work on the site can not only charge their cars, but can redirect any spare electricity into the institute when needed.

Vehicle-to-building and vehicle-to-home (V2H) concepts are variants of the vehicle-to-grid (V2G) model, which sends the energy stored in an electric vehicle battery back into the grid. The hope is that in the future V2G could help to balance demand and supply of energy to and from the national grid.

So far Innovate UK, part of UK Research and Innovation, a government-funded agency, has invested £30 million in 20 V2G projects, while Cenex, the UK's first centre of excellence for low-carbon and fuel-cell technologies, is involved in delivering several large-scale V2G trials, with the first V2G units installed earlier this year.

According to a study by the British Parking Association, there are several barriers to entry. One is that manufacturers still need to agree standards. The report also highlights a number of uncertainties, including battery degradation from V2G units and the attitude of vehicle owners. Another concern is infrastructure. The majority of charging points being installed are one directional, but V2G points must be bi-directional.

For these reasons, Alex Harrison, energy partner at law firm Hogan Lovells, says investor appetite for V2G and V2B remains unclear.

"The economics of V2G and V2B are largely unproven, especially at scale," he says. "Investors will need to assess the stability of potential revenue streams, which may be based on power price arbitrage, selling balancing services, such as frequency response, to the grid or grid-system cost avoidance."

Based on the data already coming out of V2G trials, Chris Cox, Cenex's head of energy systems and infrastructure, does not think any of these obstacles "have to be a show-stopper for the commercial application of V2G".

He says: "While the economic case for V2G is still being refined, the potential environmental benefits are huge. Based on the current pipeline for V2G products, we could see V2G charging establish itself as a valuable option alongside other charging solutions between 2025 and 2030. It will initially be a niche product, but as V2G hardware prices fall, it could be used more widely in a variety of applications, with a number of different use-cases emerging."

Mr Cox thinks that in addition to BEVs, key industries have a role to play in helping V2G to reduce the strain on the over-worked national grid.

"The economic benefits of V2G are greatest when there is a long and predictable dwell time," he says. "So airports, train stations or workplace car parks are very promising locations for V2G and could really support the transition to a low-carbon electricity network."

> **Airports, train stations or workplace car parks could really support the transition to a low-carbon electricity network**

At the end of 2016, energy consultant Adam Mitchell published a case study testing the validity of a V2G business model for Heathrow, Europe's busiest airport.

Working on a ten-year projection, Mr Mitchell's consultancy StrategicFit revealed that each V2G charger at Heathrow's long-stay parking could generate between £1,400 and £2,200 every year.

"National Grid (NG) operates a dynamic firm frequency response balancing service. To maintain a reliable service to customers, NG must keep frequency to 50Hz. But often there are events, such as people switching on their kettles at half time in an important football match, that upset this fine balance. To address the shortfall, NG runs a daily auction. In the future, if Heathrow has V2G-intelligent chargers, it can sell that capacity back to the grid on a second-by-second basis," says Mr Mitchell.

But, if and when the technology is introduced, could it ever be used to help power Heathrow's five passenger terminals?

"V2G could certainly provide Heathrow Airport with a greater level of energy security because it will be able to use the thousands of vehicle to balance out its own supply," he says. "It may also reduce reliance on diesel generators, which although not used very often, are costly to service and test to ensure that critical IT systems, lighting and fire defences can keep working if the grid trips. That would be a huge cost-saving.

"However, I don't think it is at all realistic to expect V2G to power a terminal for long periods. That said, in the future, V2G might be able to do so for a short period of time if a grid goes down."

But what of V2B and V2H? Marco Landi, Innovate UK's V2G innovation lead, says: "If the UK already has a V2G infrastructure and value chain, it will be easier to implement V2B and V2H specific use-cases, with seamless transition between V2G and V2B. But, at the same time, V2B and V2H installations aren't wholly dependent on V2G."

However, Maria Bengtsson at EY thinks that making the case for V2H is vitally important if V2G is to thrive. She says: "The British Parking Association's report on car parking indicates that a car is parked 80 per cent of its time at home, 14 per cent at destinations with rest in transit. This demonstrates that for any business model around V2G to be successful, it will have to consider what role homes will play in the model."

RESPONSIBLE INVESTMENT

ESG is the new normal for infrastructure

Growing awareness of responsible investing, which considers environmental, social and governance factors, has transformed the conversation in the infrastructure sector

Jim McClelland

Environmental, social and governance (ESG) factors exist to make the job of the responsible investor easy, in theory. The reality, for infrastructure, is less simple.

Rising uptake of ESG means infrastructure is increasingly required to consider the context in which it operates, says Professor David Hart, director of sustainable energy specialists E4tech. "The sector is having to take account of its own ESG priorities, as well as those of others, as it provides infrastructure to support initiatives which meet wider goals," he says.

Investment is also gearing up, says Tim Clare, ESG director at Anthesis Group. "As with wider private equity, infrastructure funds are starting to put in place internal ESG teams, policies and procedures, set meaningful management and improvement key performance indicators at asset level, and beginning to report. GRESB [global real estate sustainability benchmark], in particular, is driving action," he says.

GRESB assesses ESG performance. Its data and analytical tools are used by more than 75 institutional investors, collectively representing over $18 trillion in capital. In 2018, GRESB assessed 903 real estate funds and property companies, 75 infrastructure funds, 280 infrastructure assets and 25 debt portfolios.

ESG is effectively the new normal, says Marissa Szczepaniak, investment director at Vantage Infrastructure. "Growing awareness has completely changed the conversation in the infrastructure community," she says. "Nowadays, investors expect integration of ESG."

For the responsible investor, infrastructure is particularly attractive to pension funds, with long-term liabilities. There is a natural fit with ESG factors, focused on returns over time, as well as alignment on reputational risk.

So a nationally critical infrastructure asset that scored poorly on ESG might still secure funding, but come with conditions attached, says Ms Szczepaniak. "The responsible investor would need to have a clear ESG turnaround plan, to optimise it for current and future customers," she says. "Continued poor performance would attract public scrutiny and lead to ever-increasing fines, decreased subsidies, early retirement or even public ownership."

The consequences of getting it wrong can be serious, even fatal, says Emma Arnold, technical director of environmental due diligence at WYG. "Poor management of ESG in capital projects is a major reputational and financial risk. It can mean projects getting delayed or even not getting off the ground," she says.

The responsible investor also makes demands of fund managers, adds Mr Clare. "Poorly performing funds are going to have to work harder, although ultimately there is still a lot of cash needing a home," he says. "Vital infrastructure will get funding, but marginal schemes, particularly in democracies with heightened environmental and social concerns, will increasingly struggle."

The responsible investor is not short of infrastructure options. The World Bank *Beyond the Gap* report estimates investments of 4.5 per cent of gross domestic product will enable developing countries to achieve their infrastructure-related sustainable development goals. Identifying a huge global infrastructure gap, the bank issues the stark reminder that 940 million people still live without electricity, 663 million lack improved drinking water, 2.4 billion need improved sanitation, one billion live more than two kilometres from an all-season road and four billion have no internet.

Development finance institutions can, however, lend concessional capital to infrastructure projects in non-Organisation for Economic Co-operation Development countries at interest rates well below the usual. Such cut-rate financing has potential to substantially speed renewable-energy transition in developing economies, for instance, according to Bloomberg New Energy Finance, reporting for the $5.4-billion Clean Technology Fund.

On environmental issues, of course, the carrots and sticks of policy, regulation and standards are nothing new for infrastructure players.

In 2013, the UK Treasury published an *Infrastructure Carbon Review*, recognising the opportunity for value-chain participants to co-operate on low-carbon development. To help turn aspiration into reality, the PAS 2080:2016 standard, a consultative document based on the British Standard model, was then commissioned, explains Guy Thompson, head of architecture, housing and sustainability at MPA (Mineral Products Association) The Concrete Centre.

> **ESG is not a number, it is a living, breathing process to influence tangible change for the better, while reducing risk and achieving sustainable financial gains**

"This PAS promotes reduced carbon, reduced-cost infrastructure delivery, more collaborative ways of working and a culture of challenge essential for innovation. It includes requirements for all value-chain members to show leadership and establish effective governance systems for reducing whole-life carbon," he says.

With the social dimension coming more to the fore, though, ESG is emerging in a new light, beyond mere compliance, as a value-generative way to win projects. The primary reasons are twofold, argues Adrian Walker, infrastructure partner at law firm Hogan Lovells and head of its Business Integrity Group. "On the one hand, you have public sector procurement law focused on social value and ESG, which is going to cross-fertilise by jurisdiction and into the private sector," he says.

"Then you also have the multi-trillion-dollar flight of private equity and funds to ESG, which is lowering the cost of capital with a deeper liquidity pool. So ESG is going to be key in price competition, too."

The issue for infrastructure, however, is understanding what actually constitutes ESG in practice, argues Ms Arnold. "There is still very little awareness and much confusion about ESG across the sector," she says. "Asset managers are continually asked for conflicting sets of data from investors and ratings agencies are increasingly trying to shoehorn ESG into a metric."

Ultimately, ESG must not become a tick-box exercise or greenwash. Ms Arnold concludes: "ESG is not a number, it is a living, breathing process to influence tangible change for the better, while reducing risk and achieving sustainable financial gains."

Infrastructure needs in low and middle-income countries

Estimated annual cost to develop infrastructure between 2015 and 2030; preferred scenario

Electricity	Transport	Water/sanitation	Flood protection	Irrigation	Total
$778bn	$417bn	$198bn	$103bn	$50bn	$1.5trn
Invest now in renewable energy and energy efficiency; gradually ramp up access to electricity in poorest areas	Increase the utilisation rate of rail and public transport; densify cities; promote electric mobility	Provide safe water and sanitation using high-cost technology in cities and low-cost technology in rural areas	Adopt Dutch standards of coastal flood protection for cities; accept increased risks from river floods based on cost-benefit analysis	Invest now in renewable energy and energy efficiency; gradually ramp up access to electricity in poorest areas	equating to... 4% of total GDP

OPINION

‘Future generations will judge us on the infrastructure we leave them and we must make the right choices now’

As a global association representing infrastructure investors, the UK is an important focus for us. Of our members’ $500 billion of infrastructure assets worldwide, roughly 30 per cent is currently invested in the UK. This makes the UK the largest home for this domestic and international capital.

However, while many countries look to the UK as a pioneer of the innovative use of private finance in the delivery of infrastructure, the UK itself appears to be increasingly facing a crisis of confidence. The current narrative here is illustrated by the recent abolition of the private finance initiative, a model much copied around the world, and even calls for renationalisation of certain industries.

The Global Infrastructure Investor Association (GIIA) is clearly not impartial in this debate and we have a duty to reflect on the criticisms as well as promoting the sector and recommending an appropriate response. Our view, however, is a lot of the commentary is based on myths that play well in the current political environment, but are too readily accepted without challenge.

In the recent Budget, the Chancellor stated there is compelling evidence that the private finance initiative does not genuinely transfer risk to the private sector. The reality is that private sector contractors absorbed massive amounts of risk by delivering projects on time and to budget, and absorbing cost overruns. Many leading contractors have exited the market or even ceased to exist as a result; you can’t get much stronger evidence of risk transfer than that.

The water sector has attracted public criticism and the regulator has made much of the need for the utilities to rebuild trust. In fact, trust in the water companies remains comparatively strong and in 2017 an independent Ipsos MORI survey showed the UK came top of 28 countries when citizens were asked to rate their satisfaction with water infrastructure. This is not surprising when the quality of water from our taps is among the highest in the world at an average cost of £1 a day per household.

The popular narrative would have us all believe that the profits from the privatised utilities end up simply lining the pockets of the bankers. In reality, the dividends paid out often go to pension funds that provide a return on investment for people saving for their retirement. In our own research, GIIA has identified that 118 UK pension funds, representing nearly nine million individual pension pots, are currently invested in UK infrastructure. Much of our infrastructure is part-owned by local authority, retail, manufacturing and other pension funds whose members are relying on a satisfactory return on their investment in their later years.

Societies around the world are facing unprecedented challenges of climate change, ageing population, urbanisation, digitalisation and artificial intelligence when planning their future infrastructure needs. Many of them have incredibly stretched public finances where short-term political decision-making will often trump longer-term sustainable investment in the competition for finite public funds.

Now is the time for the private sector to demonstrate its value and for policymakers to prioritise the long term over the short term. There are some encouraging signs such as HM Treasury’s recently announced infrastructure finance review and the National Infrastructure Commission’s review of economic regulation.

It is the private sector that has the skills to bring the financial discipline and efficiency of building and operating infrastructure, and the expertise and investment appetite to innovate. But we need to do better at supporting this narrative with data and demonstrating the social benefits that investors bring.

Future generations will judge us on the infrastructure we leave them and we must make the right choices now. ●

Andy Rose
Chief executive, Global Infrastructure Investor Association

Driving performance in public sector infrastructure projects

Nigel Brannan, partner at strategy and transformation consultants Curzon & Company, stresses the importance of mastering the basics for a performance-focused infrastructure organisation

Public sector organisations have long recognised the need to be more outcome and performance focused. While signalling the right intent, many struggle to translate desired outcomes into tangible outputs from their employees and suppliers.

A general ethos of reducing cost above all else compounds this challenge. Furthermore, the organisations often outsource the problem to a supply chain that is increasingly fragmented and under pressure to bid for contracts at very low margins. Suppliers then hope to make money from variations to the original contract that either were not or could not be specified up front, often taking advantage of their client’s poor planning, organisation or decision-making.

Partnerships and alliances are touted as mechanisms for delivery assurance and improved performance, but there are still significant inconsistencies in their effectiveness and practicality. The biggest challenge is usually to align organisations around incentives, which often involves increasing risk in exchange for higher profit, and ensuring all parties are focused and organised around a common outcome. This is easier said than done.

For major, complex infrastructure projects, it extends beyond the physical construction effort to incorporate the planning and design phases. The public and political outcry at the spiralling cost of many high-profile programmes, or fear that they will overspend significantly, comes from a perceived inability to nail critical decisions, and plan and design in a reasonable timeframe. There are many political reasons why champions of the HS2 rail link, Hinckley Point C nuclear power station and Heathrow Airport’s third runway continue to say those projects will deliver for the quoted costs, but the odds are they will not.

> None of this is rocket science, but it is remarkable how many organisations struggle to put it into practice

Innovation and digitisation play important roles in improving the performance of infrastructure organisations. Much of our work involves implementing innovation and digital strategies, but we do it through the lens of following the money. This means mastering the basics of productivity and performance, which starts with knowing what your core success measures are and how you are performing. In infrastructure delivery you need right-to-left planning, which means working backwards from the answer of what needs to be in place and by when to hit key milestones and performance outcomes.

Curzon & Company is currently partnering with a major public sector infrastructure client to move the organisation towards a performance management culture. There are three stages in addressing the performance challenge: scan, focus and act.

The scan phase establishes the baseline, trajectory and key drivers of performance. One critical output is a single version of the truth across scope, activity, cost and risk. Focus is about prioritisation and channelling effort to where it has most impact. Major wins often come from an emphasis on looking forwards and addressing future risks rather than reporting historical performance.

The third stage is act, which means actually doing things differently. It involves engaging the organisation and their partners at programme and project level to adopt new ways of working. Common measures, good information and “heartbeat” disciplines get results.

None of this is rocket science, but it is remarkable how many organisations struggle to put it into practice.

Our client now has transparency of previously hidden efficiencies, providing them and their regulator with the confidence they are meeting their commitments. They can manage the affordability of the programme proactively, a key benefit where scope requirements evolve over time.

They are offsetting build cost risks by focusing on high-cost elements with standardised product design and productivity benchmarks. Most importantly, they are deploying tools and disciplines at project-site level where success, or failure, is delivered.

For more information please visit curzoncompany.com

CURZON & COMPANY
STRATEGY AND TRANSFORMATION

URBANISATION

Three ways infrastructure investment can tackle urbanisation

With nearly 70 per cent of the world's population expected to live in towns and cities by 2050, rapid urbanisation is one of the biggest challenges of our time, putting unprecedented pressure on transportation systems, utilities and the environment. But emerging technologies are affording new, smarter ways to maintain, build and interact with infrastructure in an effort to make urbanisation more manageable

Heidi Vella

Jonathan Mitchell Images/Shutterstock

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Using existing infrastructure better

So-called smart infrastructure technology uses sophisticated sensors, data analytics, artificial intelligence, machine-learning and cloud computing to better understand the technical and financial performance of infrastructure to determine new insights for its improved use and maintenance in urbanised areas.

Last year, the UK government announced it is developing a digital twin – an online replica of a system or place which through real-time sensor data mimics its behaviour – of key infrastructure across the country. The governmental Digital Framework Task Group believes such data-capturing and sharing could release an additional £7 billion a year of benefits across the UK infrastructure sector.

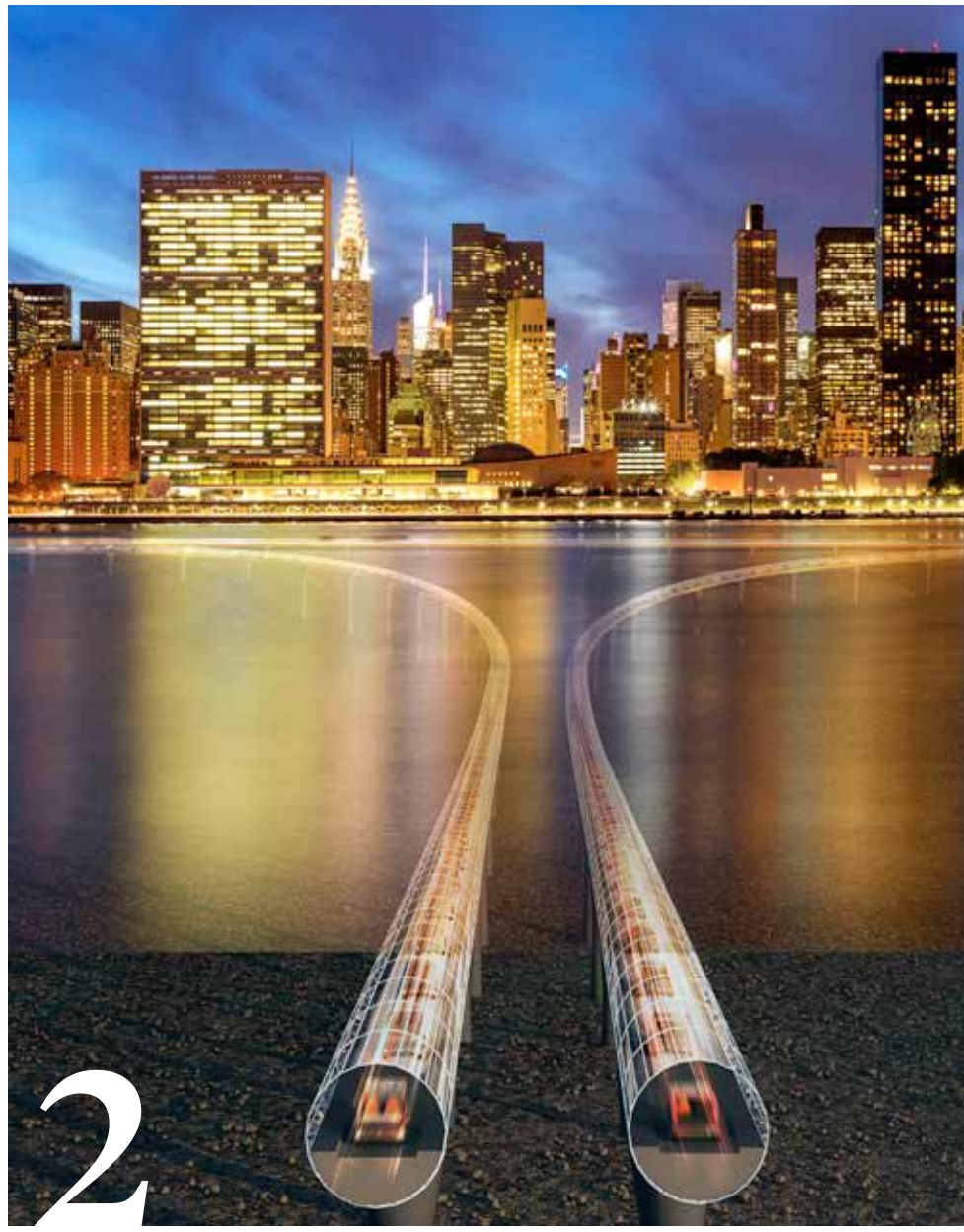
"Every asset owner is sitting on a goldmine of data," says Oliver Hawes, head of smart infrastructure at Mott MacDonald, a London-based management, engineering and development consultancy. "Smart infrastructure is about improving efficiency, making better managerial and operational decisions, and pin-pointing errors before they happen."

> **One of the most important areas is utilising emerging technologies for better, more efficient mobility systems**

Other cities are already using this technology to great effect. Mott MacDonald is working with Auckland City Council in New Zealand on a project called Safe Swim. The programme improves the accuracy of water quality predictions for 84 local beaches and swimming spots from less than 20 per cent to more than 80 per cent.

Through the initiative, the company, which has just announced a new partnership with Microsoft to create a cloud-based smart infrastructure platform, collects billions of datapoints from strategically placed sensors, creating a digital twin that can monitor atmospheric conditions, urban stormwater and wastewater networks, and the marine environment in real time.

According to Mr Hawes, the technology will enable the municipality to better understand its wastewater networks when considering future investments, as well as improve public health.



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Transforming urban mobility

One of the most important areas for future infrastructure investment and transformation amid growing urbanisation around the world is utilising emerging technologies for better, more efficient mobility systems for increasingly congested cities.

London-based PLP Labs, co-funded by the Swedish government, has just launched a futuristic proposal for an "exhaust-free, non-stop and high-capacity mobility system".

Called NuMo, for new mobility, the concept features a platoon of autonomous electric vehicles that travel through a dedicated labyrinth of underground, overhead or river-water tunnels, transporting individuals and families non-stop from one place to another.

In the system, cars are controlled by artificial intelligence, connected to the internet of things and unhindered by other traffic or pedestrians, so they can travel at steady speeds, within milliseconds of one another, in a continuous flow.

According to the researchers, the average speed in large cities is decreasing every year, down to 21 km/h in Stockholm inner city, for example. However, with a speed of 30 km/h, each NuMo lane could take 3,600 vehicles an hour, which means theoretically a four-passenger car with one-second headway would offer twice the lane capacity of a 24-metre bus with 120 passengers each minute.

"It's like a motorway that never stops, but because the cars are autonomous and controlled digitally, they can drive much closer and much more safely, which is the key," explains Lars Hesselgren, director of research at PLP Architecture. His team are currently creating an economic case study for the project.

Though clearly a future-forward concept, many transport companies are making investments in similar digitally controlled, free-following transport systems that utilise emerging technologies.

Last year, Volkswagen AG announced its intention to develop a "supercomputer to rule the roads" that can "augment the entire mobility system [of a city] and control it with intelligent algorithms which constantly interact with moving objects – a car, a bike, people – to give predictive optimised routing information".

> **Smart infrastructure is about improving efficiency, making better managerial and operational decisions, and pin-pointing errors before they happen**


NuMo

PLP Labs' NuMo concept (illustrative example in New York) features a `platoon' of autonomous electric vehicles that travel through a labyrinth of underground, overhead or under-water tunnels

Renovating subterranean systems

A city's sewer system operates unseen, but its workings are fundamental to a healthy urban population. London's was originally built in the mid to late-1800s, when the city's population was growing rapidly to more than six million by 1900. Today the population is approaching nine million and the Victorian subterranean sewer is overwhelmed, frequently overflowing into the River Thames.

Thames Tideway is an epic expansion project currently underway to divert this excess sewage to a wastewater treatment plant. When finished it will reduce the river pollution by 94 per cent.

The 25-kilometre giant underground pipeline is routed through the heart of London at depths of between 30 and 60 metres, using gravity to transfer waste eastwards.

"This project is both unique in both size and scale," says Andrew Cox, head of infrastructure asset management at Allianz Capital Partners. Along with its co-investors, Allianz provided part of the £1.3 billion of private equity for the £4-billion project.

"Compared to now, this will be a vast improvement. The Thames is an asset we don't appreciate, and this project will provide recreational, environmental and social benefits for Londoners," says Mr Cox.

Though boring underground holes isn't new, updating such critical infrastructure with limited disruption is no easy feat. The mega-project is minimising public disruption by using the river for transport to reduce the estimated 506,600 two-way heavy goods vehicle movements thought to be necessary to 140,000, greatly reducing road traffic.


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