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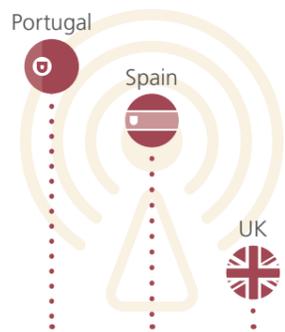
Law. Tax

Global infrastructure report

Connected Future



Digital



UK lags behind in full fibre use: **90%** in Portugal, **71%** in Spain, **4%** in UK.



Altnets continue to expand, providing promising investment opportunities.



5G set to deliver long-term opportunities.

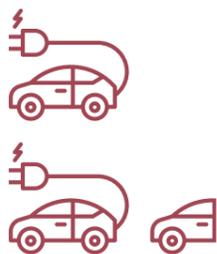


Cross-industry partnerships set to dramatically increase: telecommunications, health, transport and financial services.

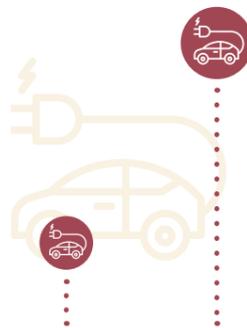
Countries to watch



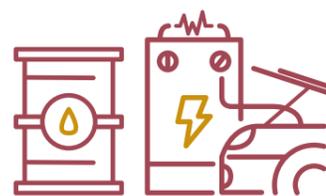
Electric vehicles



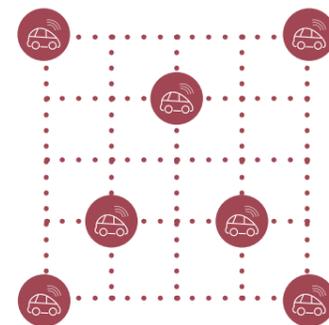
54% year-on-year increase in global sales of EVs making the case for new infrastructure.



UK market expected to grow from **135,000** in 2017 to **12m** by 2040.



Oil majors turning to EVs, recognising their future role.



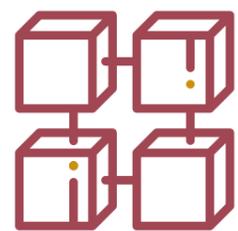
Smart charging and vehicle-to-grid models present massive opportunities.



Energy storage



Projects are moving from contracted to merchant revenue streams.



Blockchain and energy storage are transforming the transactional landscape of supply and demand.



Decreasing risks opens doors for debt financing.



Lithium-ion batteries facing competition from new technologies.



Smart mobility



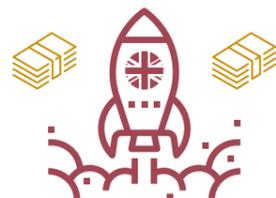
Use of Big Data brings cyber security concerns and requirements.

USD 45bn



2016-2018 – combined value of M&A deals in the Mobility-as-a-Service sector was **USD 45bn**.

GBP 3.8bn



UK government calculates spaceports could generate around **GBP 3.8bn** revenue over the next decade.



Rapid growth between 2018 and 2050 in global passenger mobility (**200% – 300%**) and freight activity (**150% - 250%**) will play a defining role in driving smart railway growth.



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Connected Future

Technology-driven transformations are not only disrupting our everyday lives, but are also radically transforming the infrastructure sector. On the one hand, innovation is driving an upgrade of existing infrastructure, such as digital; on the other hand, it is determining the emergence of new asset classes like charging points for electric vehicles.

One of the key themes of our 2017 CMS Infrastructure Index was that the more competitive the traditional infrastructure market becomes, the more investors will seek alternative propositions. And, given the fact there is still plenty of capital available, the hunt for yields is increasingly leading investors into new territory.

The ongoing revolution across the infrastructure landscape is already having significant repercussions for market participants, driving increasing demand and opening up a range of new opportunities. In this report, we focus on four sectors that, according to our analysis and experience, represent promising investment propositions in the world of infrastructure.

The starting point of our journey will be digital, which is providing the backbone for digitalisation of the economy. While 4G – the fourth generation of mobile phone technology – has already witnessed robust deal flow, the advent of 5G is set to lay the foundations for a huge range of innovation.

Moving to energy, storage technologies, particularly batteries, are providing a wide range of flexible services required in our increasingly decentralised, distributed and intermittent electricity systems.

Meanwhile in the transport sector, long held as a cornerstone of infrastructure investment, the smart mobility revolution gathers pace. The rise of electrified,

connected and autonomous vehicles is likely to represent the most significant transformation of transport since the invention of steam locomotives and internal combustion engines in the 19th century. On top of that, new applications of technology are blossoming, creating efficiencies in public transport, both for users and operators in the form of mobility-as-a-service and digital railways, respectively.

Governments, organisations and investors who understand the interaction between digital, EVs, energy storage and smart mobility, will be the ones to capitalise on the opportunities presented by our connected future.

As our report examines in detail, not all countries are receptive to technology innovations to the same degree, thereby offering fewer opportunities. In Europe the UK is firmly securing its role as a global hotbed of infrastructure innovation, thanks to its forward-looking regulatory framework. While in Asia, Singapore is already becoming a testing ground for new technologies, given its thriving start-up ecosystem and its conducive legislation.

This report is supplemented by four sub-sector reports, expanding on the findings of our 2017 CMS Infrastructure Index and providing a bridge towards our upcoming 2019 Index.

Kristy Duane
*Partner, Co-head of Infrastructure
& Project Finance, UK*

t. +44 20 7524 6568
e. kristy.duane@cms-cmno.com



Paul Smith
*Partner, Co-head of Infrastructure
& Project Finance, UK*

t. +44 20 7367 3475
e. paul.smith@cms-cmno.com



Digital

The use of digital infrastructure to provide vital connectivity at high speeds for residents and businesses around the world is nothing new, but its fast-evolving market landscape promises extensive openings for the infrastructure community over the coming years. While concession-based public-private partnerships (PPPs) rolled out by certain procurement authorities have provided a sleek transition to a new asset class, the full potential of the market goes far beyond these projects.

We have identified the following future key trends within the market:

Infrastructure investors finding opportunities in alternative network providers

The volume of transactions for broadband deals featuring infrastructure investors/players has been growing, particularly in the M&A market. A large proportion involve infrastructure funds buying into alternative networks (altnets), both active and passive networks, that are building up dark and lit fibre coverage to challenge the position of current incumbent groups.

In May this year, Antin and Goldman Sachs-managed funds bought CityFibre – the largest altnet currently operating in the UK – joining Amber, Arcus, Aviva, DIF, Cube, Infracapital and 3i in investing in the space. While these ventures are almost exclusively commercial, operating outside concession-based frameworks, long-term partnerships with existing internet service providers (ISPs) can also provide opportunities for investors. Vodafone and TalkTalk are among the groups who either partner with altnets or are actively seeking to do so.

Scale of capital committed to altnets to grow as they gain greater market share

More investors see altnets as an attractive area of investment as they scale up to create more comprehensive networks, covering larger areas. This will attract more players into the market, particularly as there is a lot of competition in traditional asset classes, making it harder for investors to deploy capital. While equity has already made moves into the area, debt providers are now beginning to follow, exemplified by Hyperoptic's recent GBP250m debt raised from a syndicate of banks including BNP Paribas, ING, RBS, Société Générale and Barclays. Partnerships with ISPs or signing up large-scale commercial customers on long-term contracts will also aid this process.

5G promises to provide continued projects in which to deploy capital over the longer term

While much of the focus is centred on rolling out fixed fibre last mile connections to customers, 5G is poised to move to centre stage over the coming years. The next generation of wireless connectivity will necessitate significant backing. A fleet of telecoms transmitters will need to be built to fully densify coverage. This process has already begun, with Wireless Infrastructure Group (WIG) among the early movers following its GBP 220m debt raise in August to finance investment in 5G-ready infrastructure.

Certain markets around the world will offer particularly enticing opportunities

Internet penetration has progressed in an uneven fashion globally, with some countries closing in on comprehensive full-fibre networks while others fall behind. Those countries which have been slower to adopt new technologies now provide a host of exciting opportunities, particularly those where demand for innovation is high, such as Romania or Italy. Singapore is at a far higher level of digital development, but its progression to the next stage of connectivity opens up vast opportunities too. Its government's Smart Nation initiative capitalises on their already advanced internet services by encouraging projects in the Internet of Things (IoT) and smart mobility fields. Mexico has also recently launched a massive nationwide initiative by tendering out a wholesale mobile network that will provide a 4G and 5G-ready service to 92% of Mexicans.



euNetworks

Jennifer Smith,
Chief Financial Officer



Richard Taylor,
General Counsel

euNetworks has seen strong growth over recent years. It is a Western European bandwidth infrastructure provider, owning and operating fibre-based networks across the region. It owns and operates 14 densely fibred metropolitan networks in key cities and also a long haul fibre network that spans 49 cities in 15 countries. It is a company that has expanded its network at pace over the last three years, and by year-end, will have lit over 25,000km of fibre in the long haul since 2015. This investment in the network is driven by the ever-growing bandwidth needs of its customers. Stonepeak Infrastructure Partners acquired a majority stake in the company in early 2018 and as part of this transaction funding was secured for increased expansion in these areas.

"Data centre to data centre traffic continues to grow, and given the footprint we own and how we develop our networks, it's an opportunity we are well placed to both serve and benefit from," says the group's CFO Jennifer Smith. "More than 80% of our revenue has connectivity to a data centre at some point in the solution."

Increased activity in this portion of the market has been observed by infrastructure players from all corners of the industry, from banks and investors to advisers and construction groups, so it is unsurprising to hear a connectivity specialist noting the same.

"We're upgrading some paths and doing route overbuilds as the bandwidth demand between some 'hyperscale' data aggregation sites continues to grow. We're also extending our network, digging new routes to new locations that are near our existing metro footprints. We're fortunate to have a network that enables us to do that and when you own the duct or sub-duct, you have more control over the economics of how you shape and develop your network," said Richard Taylor, euNetworks' general counsel.

So what impact will 5G have on a company such as euNetworks? Ultimately it's thought this will drive more data, which will be transmitted and stored around networks. But it also opens up more demand for fibre to connect up different mobile-related sites.

"The architecture towards small cells – the proliferation of a higher number of cells with a lower radius of coverage – those will need to be connected to a fibre backbone and we see that as a potentially promising area of growth," says Smith.

"Fibre is the only scalable economic solution to accommodate the multiple requirements for 5G & small cell roll-out," adds Taylor. "As fibre is agnostic of technology, operators can easily and efficiently switch and mix between fronthaul, midhaul, and

backhaul designs as 5G traffic grows. In addition 5G requires high accuracy - traffic needs to be highly synchronised at higher speed. Fibre technology allows this accuracy especially in high traffic or dense areas, in comparison with wireless technology."

The company is also bullish on how it could withstand any disruption from newer technology that may emerge over the coming years.

"Fibre is and will remain the crucial underlying foundation of the internet, catering to an increasingly connected and bandwidth hungry world," says Smith. "We're pulling new cable through parts of our network with greater fibre count – so more capacity. Continued developments in the optronics and hardware that sits on top of the fibre allows further bandwidth scale. That gives us continued growth opportunity into the future with our fibre assets."

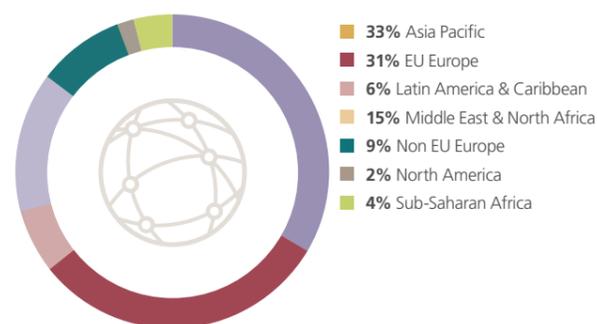
"So in terms of tech changes, we do not see anything competing with fibre as the basic building block of data connectivity. Our business is capital intensive and with various macroeconomic challenges, we could potentially face an issue at some point to feed an increase of bandwidth demand."

In the spotlight: countries to watch

The smartphone and the digital economy have made the internet an essential part of everyday life, generating a demand for instant, constant and ubiquitous connectivity. However, more needs to be invested in digital infrastructure to improve broadband access and speed, and many countries are falling behind development goals, with rural areas often experiencing the poorest connectivity levels.

Global broadband penetration rates have been identified below:

Regional penetration rate



Source: FTTH Council EU, 2018

The EU has set an objective to achieve broadband speeds of 30 Mbps for all European households and ultrafast speeds of 100Mbps for 50% of households by 2020. However, many EU member states are not on track to meet this goal, although others such as Portugal and Spain have made huge progress.

We have singled out five key jurisdictions that we think pose the greatest opportunities for investors based on past deals, local incentives and predicted future investment activity:



A rise in government and private investment

The UK has seen significant changes in recent years due to the providers in M&A activity. The leading fixed broadband providers in the UK are BT (36%), Sky (24%), Virgin Media (20%) and Talk Talk (12%).

The UK is also making progress following the launch of its GBP 400m Digital Infrastructure Investment Fund to boost full fibre networks across the country, aiming to provide access to 15m premises by 2025.

With fibre infrastructure still significantly lacking, there is a demand for improved services. Only around 4% of homes and businesses in the UK have a full fibre offering, compared to much higher rates in other EU countries where full fibre is enjoyed by 90% of homes and businesses in Portugal and 71% in Spain.

Within this market, CityFibre, Hyperoptic, Gigaclear and others have emerged strongly onto the scene. It is here that infrastructure investors have found opportunity in the UK, highlighted by the takeover of CityFibre by Antin Infrastructure and West Street Infrastructure Partners in June 2018. The wider altnet market is currently largely an equity market characterised by small, high-risk entrepreneurs.

Homes and businesses with a full fibre offering



High adoption and demand

Deregulated in 2016 and largely characterised by platform-based competition, Romania's broadband market is one of the most promising in the CEE. Despite it being ranked last for overall performance in the EC's 2018 Digital Economy and Society Index, 44% of Romanian households subscribe to ultrafast broadband according to the survey; outperforming the EU's average of 15.4%. While its broadband access rate marginally lags behind other countries, its high ultrafast adoption rate suggests it is a market that is swiftly developing, promising tangible investment opportunities over the coming years.

Broadband network owner Electrogrou Infrastructure has judged now to be the right time to conduct an IPO, with a flotation on the Bucharest Stock Exchange expected before the end of 2018.

Orange is conducting tests with Samsung and Cisco on high-speed home internet access to improve Romania's fibre-optic networks for 5G expansion. RCS & RDS (Digi Mobil) has also partnered with Ericsson to launch enhanced broadband services across its network in preparation for 5G and IoT developments.



A favourable regulatory regime to encourage investment

Although showing a low penetration of digital, the potential of the Italian market is significant. In 2015 Italy launched its strategy for high-speed broadband which has simplified its regulatory framework and incorporates investments into future-proof infrastructure.

This summer the Italian government sought to create a single company for the roll out of fibre. This solution aims to avoid costly overbuild of infrastructure as rival networks are built out by Italy's incumbent phone operator Telecom Italia and the competing broadband operator Open Fiber, in both of which the government holds stakes.

Open Fiber, the first wholesale operator in Italy owned by Enel and state lender CDP, obtained EUR 3.5bn in April 2018 from a consortium of banks for its Fibre to the home (FTTH) push, making it the largest structured finance broadband initiative in Europe, Middle East and Africa (EMEA).

Open Fiber has also partnered with Cisco Network Services Orchestrator and a consortium of operators led by Maticmind, to automate its networks for retail service providers.

TIM (Telecom Italia) has the lion's share of Italy's broadband market, occupying a 45% share.



A nation with a plan

Bahrain has been a leader in the telecommunications sector in the Middle East since its market liberalisation in 2002. Baltelco, Zain Bahrain and Viva Bahrain are the market leaders.

In June 2018, Viva Bahrain launched its first 5G network public showcase, which achieved gigabit speeds of up to 1.5 Gbps. This follows its system/network transformation contract with Huawei earlier in January to improve IT infrastructure and introduce wireless radio technologies as part of its 5G readiness strategy.



Delivering the smart nation

High wired and wireless broadband penetration rates are driven by the city's 'smart nation' ambitions to integrate digital technology across households, businesses and public services, making the country a global broadband pioneer. Singtel, Starhub, M1 and TPG Telecom are market leaders.

In 2017, Singtel entered a 5G Centre of Excellence partnership with Ericsson to develop a 5G pilot network in Singapore's science, business and IT hub. The pilot network, launching in Q4 2018, aims to deliver 5G coverage with enhanced mobile broadband speed. M1 similarly announced a partnership with Huawei in June 2018 to embark on 5G trials.



Aviva Investors

Sean McLachlan,
Senior Director

When asked about the challenge altnets face in the UK's monopolistic market Sean McLachlan, senior director at Aviva Investors, says "I think in the UK, just by the nature of how altnets have come to be, you're looking at a different business model than most of the other European countries.

"For example, the procurement of fibre infrastructure is being done with very different models such as the 4th utility approach, very similar to regulated gas, water and electricity or PPP structures bringing private and public sectors together"

"Fibre broadband infrastructure is a real economic driver from a country perspective and rural communities are an important part of this.

"Many people are increasingly looking to work more at or closer to home but for many living in rural areas that's almost an impossibility," says Aviva Investor's Sean McLachlan.

"So, if you're working in London and living somewhere in say West Sussex, you may have to come into London because you can't do your work at home. Then there's a number of clear economic benefits when you look at connecting up smaller villages and rural areas and so the demand case is very compelling, from our perspective."

With this in mind, investors need to get comfortable with long-term risks, especially when putting fibre into premises.

"People talk about future-proofing and nothing is completely future-proof of course, but in terms of speed, fibre operates at the speed of light with excellent reliability and can be highly cost-effective", says McLachlan.

"Fibre is a great technology for providing a pretty long-term solution to connectivity. It's also very complementary to some of the other technologies that you see out there such as 5G."



CityFibre

Oliver Bradley,
Corporate Finance Director

In just a few short years since its foundation in 2011, CityFibre has grown to lead the pack of altnets in the UK bidding to challenge the incumbent operators in the fibre broadband sector. That growth and a tie-up with Vodafone ultimately drew the interest of infrastructure investors, with funds managed by Goldman Sachs and Antin swooping to acquire the company in April 2018.

Vodafone will at first have exclusivity to offer its services over the networks CityFibre builds out. After a set period other ISPs will then be able to use the lines laid down by CityFibre.

"So the proposition to the other ISPs then becomes, why wouldn't you come onto our network because it is a much better network than Openreach's," says Bradley.

"It's cheaper than what you'll be paying for a far inferior product, as we price competitively with the through the cabinet products that are available to them on Openreach."

It is this competitive pricing that Bradley hopes will entice even more retail business towards CityFibre's networks, as any ISP that takes advantage will accrue higher profit margins compared to similarly priced products hosted on the incumbent's hardware.

Bradley also states that there will likely be an opportunity for bank debt as part of the overall funding mix, opening up a new corner of the market to this type of capital. Leveraging the equity within the business could very well help the network expand over the next few years.

"The key for us to really increase our throughput is to be building multiple towns at a time. Once we've got going in the twelve towns and cities that make up our first million, we'll then be able to move to twelve more towns and cities to make up the next million and so on. We would hope to be in five million premises by the mid-2020s."

The altnets that have emerged in the UK over the past few years have not only brought more competition into infrastructure provision, as well as more choice for consumers, but have also sped up the development of fibre broadband all across the country. This is a key argument for the existence of the altnets, according to Bradley.

Investment opportunities in digital

Neutral host infrastructure could unlock investment

The utility-like model of neutral host infrastructure will do away with the vertically integrated model used by the UK's larger fixed and mobile broadband providers and introduce shared infrastructure which retailers would have equal access to. The UK government's recent telecoms review concluded that neutral host infrastructure could unlock investment, address 5G deployment challenges, improve rural connectivity and reduce barriers to entry for retail service providers.

Edmond de Rothschild Asset Management's Ada Cerne highlights that technology risk is something that infrastructure lenders are keen to manage, with the pace of change in the sector potentially leading to redundancy of existing technology in a relatively short space of time. She states: "Although some of the concessions can be up to 30 years, usually the debt facilities for private initiatives are effectively much shorter at below 10 years. Even the facilities within concessions have incentives for the borrower to refinance after 10-12 years, so it's quite rare we have a real 30 year technology risk in terms of the debt that is issued today."

Another way to safeguard an outlay on a transaction is to choose wisely exactly which projects to get involved in. Rural areas are likely to be later targets for disruptive technologies due to their smaller and less dense consumer markets, according to Cerne, whilst at the same time being the areas in which most investment is currently needed.

Transport for London is currently running a tender process to find a neutral host operator to provide a 4G network to the London Underground.

Wireless Infrastructure Group (WIG) has participated in the development of neutral host distributed antenna systems in the UK, Spain and Portugal.

Airspan Networks, a small cell equipment supplier, has created the wholesale network carrier Dense Air to provide much the same service in European markets, including Ireland and Belgium.

"Technology risk is something that infrastructure lenders are keen to manage, with the pace of change in the sector potentially leading to redundancy of existing technology in a relatively short space of time."

Ada Cerne
Senior Investment Director,
Edmond de Rothschild Asset Management

Rural community involvement

Widespread internet access has tremendous benefits for rural areas. However, due to low population density and a smaller customer user base, rural areas are less commercially attractive, often requiring some sort of government subsidy for infrastructure.

The UK government estimates around GBP 3-5bn of funding is needed to bring full fibre to these areas. In its 2018 Autumn Budget, the UK government pledged GBP 200m would be invested to fund the installation of full-fibre broadband in rural areas, starting with replacing aging copper lines in primary schools. This budget has been allocated from the National Productivity Infrastructure Fund.

Some countries rely on competitive bidding processes. France has the most established broadband PPP programme, largely focused on rural developments. The Grand Est project of 2017 with a capex of USD 1.3bn, involved the procurement of a FTTH network via a publicly owned fibre broadband network. The scheme drew wide interest from both equity and debt, with a selection of banks, financial institutions, telecoms groups and infrastructure funds all contributing to the financing package. France has continued to roll out further projects under its PPP programme since.

"Fibre broadband infrastructure is a real economic driver from a country perspective and rural communities are an important part of this," says Aviva Investor's Sean McLachlan. "Many people are increasingly looking to work more at or closer to home, but for many living in rural areas that's almost an impossibility,"



What does the future hold for digital?

Given the current and predicted growth in data traffic, the rapid expansion of IoT devices, and the emergence of new technologies, such as machine learning and AVs, the rapid evolution of broadband networks is inevitable. The anticipated capabilities of 5G will allow new technologies to break through and become mainstream. 5G networks are expected to bring improvements to the wireless space: lower costs of transmitting data, substantially higher data speeds and low latency.

5G and small cell densification

UK authorities aspire to put the nation at the front of the pack when it comes to 5G. Outdoor small cell networks will form a crucial backbone for this offering.

With more communication towers and small cell base stations required to support 5G, there are many opportunities for both construction and asset operation. With 5G expected to operate at higher frequencies of between 28GHz and 39GHz, small cells will allow greater coverage at this level due to the resulting weak signals being unable to sufficiently penetrate obstacles.

Ofcom recently auctioned off the 3.4GHz band to telecoms companies for 5G use and various government-backed research initiatives are underway to encourage investment, develop technology and prepare a regulatory framework. The GBP 1bn National Productivity Infrastructure Fund has provided a GBP 700m pool of funding split between local full fibre and 5G programmes. The government is also in the process of developing a pilot 5G city as part of the 5G Urban Connected Communities project.

WIG is among the early movers in this area following its GBP 220m debt raise in August to finance investments in 5G-ready infrastructure. WIG sealed loans from Barclays, Barings, Lloyds, MetLife, RBS and Vantage Infrastructure in a demonstration of the willingness of lenders to back projects in this area.

Inter-industry and cross-industry partnerships

Communication infrastructure development necessitates various inter-industry partnerships and cross-industry partnerships. System developers and mobile operators will collaborate to lead joint builds, and anchor tenants will be needed to provide long-term committed revenue streams.

To facilitate further development, government will need to cut red tape and mediate relationships and collaborations with utilities and landowners using property and existing infrastructure to build networks.

In September 2018, SSE's telecoms division signed an agreement with the UK mobile networks Three and O2 to accelerate fibre connectivity using space in Thames Water's sewer network to pave the way for future deployment of cell sites and masts for both 4G and 5G.

Cross-industry partnerships will emerge predominantly in telecommunications, health, transport and financial services. The healthcare sector is already exploring the potential of 5G advancements with remote, robotic surgery exploiting the step-change in the speed of data transfer.

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The healthcare sector is already exploring the potential of 5G advancements with remote, robotic surgery exploiting the step-change in the speed of data transfer.

Data centres

Data centres will become even more important as much of the data created and distributed across connected devices will be stored in the cloud. Significant updates may be needed to match the capabilities of fast networks. According to Next Generation Mobile Networks, 5G is predicted, compared with 4G, to reduce latency by 80% and improve reliability to near 100%, eliminating downtime.

Internet of Things (IoT)

As roll out and usage of IoT devices including wearables, smart homes and vehicles are growing, new 5G networks will become crucial to enable technology-driven infrastructure updates, given that they are capable of handling up to 100 times more connections per radio base station than 4G. This will support wider adoption of smart homes, smart cities and AV across the globe.

Autonomous vehicles

As cars capable of connecting to the internet for navigation and entertainment purposes become more widespread, the demand on mobile networks and satellites will increase. Data consumption by vehicles is likely to rise further, and new generation networks will have to satisfy that demand. As AVs and 5G networks are both in the early phases of development it is difficult to predict how these technologies will interact. However, it is safe to say that reliability and ultralow latency features of 5G could prove to be useful for vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) communication technologies helping AVs navigate in traffic.

The Pennsylvania Broadband Initiative seeks to equip the Pennsylvania Turnpike toll road that runs across the state with fibre-optic connectivity to assist in transmitting

tolling data, traffic management and potentially making it ready for connected and autonomous vehicles.

Smart nations

It is naturally more difficult to implement 'smart nation' strategies across countries with greater landmass due to the increased capital requirements of more infrastructure required per capita. Smart nations give greater advantages to modern 'city states' which, along with having fewer administrative layers to align before a project can begin, have the advantage of a lower population than an average country, so requiring less connecting infrastructure such as transmission cables and radio towers.

Singapore leads the field, but it seems unlikely to remain unchallenged as Hong Kong and Dubai look to make advances in smart mobility, healthcare, planning and finance.

As the cost of manufacturing the related infrastructure comes down, the implementation of these strategies across greater areas will be more realistic. Countries such as Estonia and South Korea are leading the way in this area, following the digitalisation of government services in Estonia and effective promotion of smart cities in South Korea.

Singapore leads the field, but it seems unlikely to remain unchallenged as Hong Kong and Dubai look to make advances in smart mobility, healthcare, planning and finance.

Electric vehicles and charging infrastructure

There has been a major leap towards full-scale adoption of electric vehicles (EVs) over recent years, driven by a combination of changing consumer desires, dramatic improvements in costs and reliability and support from governments across the world. As a result, many predict that the era of the internal combustion engine (ICE) car will soon be over.

EV infrastructure has become an increasingly popular asset class for institutional investors seeking to deploy capital.

Based on our findings we have identified the following future key trends within the market:

Growth in demand crucial for making the case for new infrastructure

While EVs are still regarded by many as a relatively niche area of an automotive industry where the ICE remains king, there is no questioning the direction of travel. In 2017, there was a 54% year-on-year increase in global sales, with EV ownership forecast to reach up to 228m by 2030, encouraging car manufacturers to dramatically ramp up production and development of EVs.

Oil majors turning towards EVs

Major oil & gas companies are now backing EV companies. These moves are a clear sign of where oil majors are heading over coming years, as well as a recognition that they must adapt to survive.

Smart infrastructure will be key

Smart charging models and vehicle-to-grid (V2G) have the potential to deliver huge benefits for grid operators facing up to demand curves that do not always match supply, as well as network constraint and system stability issues. There could also be benefits for consumers, since they can charge their vehicles at times of low power prices, or even sell their stored electricity back to the grid during peak periods.

Countries with strong regulatory support for EVs are spearheading the electric mobility revolution

Several jurisdictions are pioneering the roll-out of EVs and the required charging infrastructure. Norway and the UK have demonstrated the most vigour, the latter developing a GBP 400m Charging Infrastructure Investment Fund to catalyse investment in EV charging. Likewise, Germany is investing EUR 1bn into a package of measures to incentivise both hybrid and EV owners, of which EUR 200m will be made available to rapid charging infrastructure. Singapore's Land Transport Authority has actively partnered with private companies to deploy EV fleets, working towards a 'car-lite' society.



Octopus Investments

Daniel Saunders,
Specialist Investments – Transport and Energy Sector

Set up in 2000, Octopus is an investment company that operates across multiple sectors. Daniel Saunders, investment director at the company, focuses his work on zero and ultra-low emissions transport-as-a-service (TaaS) projects. TaaS provides smart solutions to deliver clean transport to fleet operators, using a pay as you use mechanism.

"We're approaching our work from a total investment solution standpoint and we are predominantly interested in fleet and commercial vehicles," says Saunders.

"Octopus is thus looking to accelerate the transition to zero emission vehicles in the areas that we can make the biggest impact: vans, buses, licensed taxis and chauffeur vehicles, the latter being key to our recent Heathrow contract."

That particular transaction involved Octopus financing the acquisition of new Jaguar I-Pace electric vehicles in October 2018, as part of its commitment to assist Heathrow airport with emissions reduction.

According to Saunders, EV represents a major disruption for people operating vehicles for financial and business purposes.

"Not only do they have to overcome the fact that this is a new technology to get to grips with which is also more expensive – but they also have to incorporate new energy infrastructure to support it."

Apart from increased costs, the necessary energy infrastructure also varies: it could be a charging point, or, for a hydrogen vehicle, it might be a hydrogen fuelling facility.

Reinforcing the grid is a third additional feature that needs to be taken into consideration.

"These main components need to be invested in, in a sensible format. We prefer working with the customer across all elements of the project and investing as required to provide a bundled solution," explains Saunders.

But investment in the EV sector nevertheless encompasses considerable risks, due to rapid shifts in infrastructure. "What we've seen now in terms of the vehicles that have been built and the infrastructure required will change in a decade's time. Once autonomous vehicles are with us, rather than on-street charging, we're likely to see large depots on the outskirts of major cities with very large charging capacity requirements."

Counterparty risk is another concern for investors, as all EV-related investments are considerably greater than what an operator is used to paying. Also the repayment needs to be made over a longer period to make the periodic payments manageable. "Before, they'd be paying for the vehicles over three to seven years depending on the vehicle, while now it could take five to ten years."

"There is also a technology risk, as batteries are relatively new, so no one truly knows how it's going to play out," continues Saunders.

However, he stresses the operational costs of EVs will be low, as electricity costs are much lower than fuel at the moment. That said, this may gradually change, "as more and more EVs go live, we expect the Government would start implementing higher tariffs for electricity consumed by drivers, as the Treasury cannot realistically lose that much money."

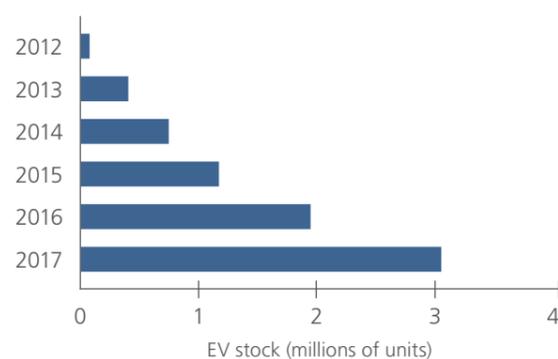
There are multiple types of EVs, thus Octopus believes investors have to be pragmatic. "If it makes sense for the customer and for the counterparty, then we'll look to deliver it," says Saunders. "The majority of requests that we have had are around battery electric and that's probably where the market will ultimately end up."

In the spotlight: countries to watch

Reducing air-quality pollutant emissions is increasingly one of the top priorities for governments across the globe.

The initial growth of the EV market has been supported by government subsidies in an effort to encourage their take-up, to rein in public dependence on fossil fuels and to reduce pollution. The sale of EVs has also been accelerated by extensive research into micro-technologies, which has made them both more cost and space-effective.

Annual growth of EV stock worldwide



Source: International Energy Agency (IEA)

The UK and France will ban the sale of ICE cars by 2040, India and Norway by 2030, and the Netherlands plans to make EVs the only option for new car buyers from 2025.

As EVs are rolled out, the charging infrastructure required to accommodate them also needs to be deployed. One of the principal issues in relation to EV take up is range anxiety. James McKemey, head of insights team at Pod Point tells us "60% of all energy will flow into the car at home, while at work another 30% charging is estimated. Between these two there's 90% of the energy going into an electric car and that's before covering any public charging infrastructure at all." He also highlights that there is a misconception of what a car is as people frequently see it as a mobile object. The car is actually stationary for the vast majority of the time and as a result, a 200 mile range is more than enough for most drivers.

Many countries are beginning to ramp up incentives and regulatory frameworks that should reduce the cost of capital for those involved in the sector.

As such, as well as encouraging the installation of charging points on private properties, especially in new-builds, governments need to promote the implementation of a range of publicly available charging points. These initiatives can include local councils leasing out kerb-side locations where charging infrastructure can be installed. Charging companies are also leasing spaces in the car parks of 'destination' locations, such as leisure facilities and supermarkets, creating more income for those companies.

Many countries are beginning to ramp up incentives and regulatory frameworks that should reduce the cost of capital for those involved in the sector. Other countries, like Norway, have already largely achieved these goals and are now learning to cope with the huge uptake of EVs by consumers, resulting in heightened investment opportunities in charging infrastructure to catch up with vehicle ownership trends.

We have singled out five key jurisdictions which we suggest pose the greatest opportunities for investors based on past deals, local incentives and predicted future investment activity:



Norway

Supporting infrastructure at all levels

Norway represents the world's most successful experiment in the mass adoption of EVs. According to the IEA Global EV Outlook, Norway has achieved the highest market share of EVs globally, reaching 39.2% in 2017. The Norwegian Public Roads Administration says the country's EV fleet increased from 3,347 units in 2010 to 251,702 in 2017.

Norway has created a favourable policy framework, with a set of measures that includes exemption from purchase tax, from 25% VAT on Battery Electric Vehicles (BEVs) and from circulation tax. Ownership and company taxes have also been reduced.

Besides government measures, the success of the Norwegian model is also based on local initiatives, such as free parking schemes for EVs, exemption from urban and highway tolls and the option to use bus lanes. Hence, cities such as Oslo and Bergen have an EV market share which is significantly higher than the national average.

Norway, however, suffers from a shortage of public charging points, and particularly fast charging points that facilitate long-distance trips. With the goal of phasing out petrol and diesel cars by 2025, the country is set to remain a beacon of electric mobility for the foreseeable future.



The Netherlands

Increase in charging points in six years demonstrates commitment

The Netherlands represents one of the most promising EV markets in the world. Second only to Norway for EV market share, the country boasts the highest share of publicly accessible slow chargers in Europe. The total number of charging points across the nation increased from 400 in 2010 to 113,630 in 2017, according to the Netherlands Enterprise Agency.

Unlike Norway, the Dutch market is characterised by a prevalence of plug-in hybrid electric vehicles (PHEVs) over BEVs. In 2017, out of a total of 119,332 electric vehicles registered in the Netherlands, 98,217 were PHEVs, while only 21,115 were BEVs. But as in the case of Norway, the Dutch success story is based on a mix of state and municipal policy initiatives.



Germany

Car manufacturers invest in mobility initiatives

The EU's largest economy, and biggest car manufacturer, represents an extremely promising market for EVs. According to Germany's National Platform for Electric Mobility (NPE), the goal is for the country to reach 1m EVs on the country's roads by 2020. German car manufacturers are increasingly investing in electric mobility initiatives. In 2019, Volkswagen will be launching its EV car-sharing service called We Share in Berlin, deploying 1,500 e-Golfs that will be followed by 500 e-up! models. Energy companies such as E.ON, Vattenfall, RWE and EnBW have a significant presence in the provision of EV charging infrastructure. According to the NPE, 70,000 public charging points and 7,100 fast charging points will be required in Germany by 2020.



China

Schemes to incentivise EV adoption

With a population of approximately 1.4bn people, China constitutes a potential EV market of massive proportions. The country currently ranks first globally for total EV stock, already hosting approximately one third of the world's total. According to the IEA Global EV Outlook, over 1m EVs were sold in 2017 with China accounting for more than half of global sales.

China offers a favourable policy environment for electric mobility, such as exemption from purchase and excise taxes. Local authorities are also proactive in incentivising EV adoption, with measures that include the restriction of licence plates for ICE cars. Thanks to these policy initiatives, China is already becoming a leading manufacturer of EVs, including commercial and public transport vehicles, and a leading producer of lithium batteries.



UK

Funding ambitions to be a global leader

The UK is ramping up its efforts to become a global EV leader by creating a favourable policy framework and by attracting private capital to fund the development of a cutting-edge infrastructure network. As part of this initiative, the government announced a GBP 400m EV Charging Infrastructure Investment Fund (CIIF) to provide funding to companies that install charging points. The road to zero strategy also includes the creation of a GBP 40m programme for the development of new wireless and on-street charging technology. These investments will also join over GBP 100m pledged by the government towards R&D for vehicles and batteries at the Zero Emission Vehicle Summit in Birmingham in September 2018. These commitments have led BP to predict that the UK EV market may see growth from 135,000 in 2017 to 12m by 2040.



Investment opportunities in EVs

Smart charging requirements

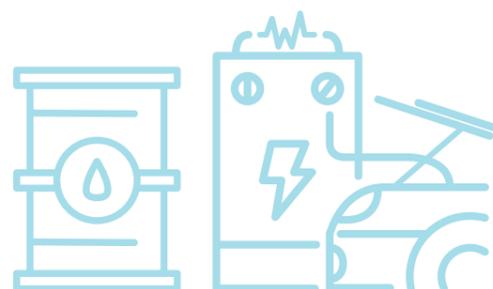
The introduction of EVs will change domestic power usage as consumers move from purely ICE to EVs. The UK's National Grid suggests it could see a 10% overall uptick in electricity consumption, with a 30% increase in peak time demand. This can, however, be countered by careful policy management regarding charging infrastructure, by specifying the inclusion of smart charging technology in public and new-build integrated chargers.

Vehicle to Grid (V2G) charging equipment will be key to help balance the grid during peak demand. Using advanced machine learning and artificial intelligence to manage bi-directional charging stations, V2G systems can be used as a congestion protocol to draw surplus power from plugged-in EVs and hybrids, while simultaneously controlling the timing of charging to limit strain on the local network. V2G technology is still in its piloting phase.

Pivot Power – developer and financier of large battery storage projects to enable greater grid flexibility and the EV roll-out – believes presenting a business model as a bundled package will reassure debt financiers of predictability and utilisation.

“We’re looking into highly predictable utilisation rates, which come from buses, taxis and corporate fleets. They are usually used in very predictable patterns which repeat over and over again. If the infrastructure for corporate fleets can also be used for public, personal charging, this is also definitely an opportunity as you can then think more of a 24-hour running profile for those charging depots.” says Matt Allen, CEO of Pivot Power.

“Infrastructure costs are not just about getting chargers in the ground, it’s actually also about the provision of the power that is required. So, if you look at utilisation, it’s got to be high and predictable. There will be an agreement with a corporate fleet that for the next 10-15 years they will be using that power. You’ll see that very much as a debt financeable product on the market,” Matt Allen continues.



Corporate fleets

Businesses of all sizes are feeling the pressure to switch to more eco-friendly transport solutions, due to corporate responsibility concerns and financial incentives that may be available for EVs. This is more prevalent for companies heavily reliant on vans and trucks, considering their contribution to poor air quality.

An alternative investment might come in the form of fleet funding as a means of ensuring long-term returns on investment. This structure offers multiple advantages, the first of which is the involvement of a creditworthy corporate counterparty, allowing for more sophisticated business models with lessened exposure to vehicle and chargepoint demand risk.

Debt financing will have a place in corporate fleet EVs and it will extend its reach to charging infrastructure, supporting these assets in scaling to critical mass.

Destinations

Some of the most obvious spaces in which to continue to deploy public EV charging points are car parks at consumer destinations such as shopping centres and hotels. This also provides investors with a similarly creditworthy corporate counterparty, in the form of corporate real estate landlords who own broad portfolios of destinations. The leasing structure itself can also be simplistic, with only one counterparty involved.

The idea of functional destinations also opens up opportunities for a variety of commercial property or real estate investors.

Different revenue models

With the EV charging market in its infancy, there is a debate about which revenue models would not only be most appropriate from a consumer perspective, but would also create healthy revenues for developers and investors. The traditional model, that of pay-per-kilowatt, is easily transferable to the consumer market, due to it replacing pay-per-litre of fuel. It would have the added benefit of being more likely to align with smart charging by showing peak time energy prices.

Another payment method, already in use by the US public EV charger provider Blink Network, is a subscription membership fee. While this system may work by defensively marketing the product and therefore protecting the customer base, it could also work against EV infrastructure providers by excluding the revenues available from spontaneous charging.

For now at least, EV charging often takes longer than petrol refuelling, due to the speed of charging points currently available, so another possible revenue model is pay-for-duration. This has the benefit of increasing time pressure on the consumer, which should help reduce the likelihood of queues at charging points.

“I think the world’s going to see costs, the ones required for charging, come down quite a bit. The inverters for solar projects and those for EV charging are not very different at all, but inverter costs are still for some reason remaining very high for charging, so I think we’re going to see capex cost on chargers come down quite a bit. This will help the bankability of charging infrastructure.” concludes Matt Allen, CEO of Pivot Power.

“Infrastructure costs are not just about getting chargers in the ground, it’s actually also about the provision of the power that is required. So, if you look at utilisation, it’s got to be high and predictable.”

Matt Allen
CEO, Pivot Power

What does the future hold for EVs and charging infrastructure?

According to the International Energy Agency (IEA), the current global EV policy scenario considers both the policies and measurements that governments already have in place. Under this scenario, the total number of EVs could reach over 125m by 2030. If the policies highlighted in the IEA's EV30@30 campaign were applied on a global scale, this scenario expects the number of EVs to surpass 228m by 2030.

Charging technology development

The current format of induction charging models, in which magnetic fields transfer energy to the battery of stationary EVs, is likely to evolve into mobile inductive charging. Car manufacturers, such as BMW and Vauxhall, have launched EV models that can be powered wirelessly, whilst the leading suppliers of such charging technology, in the form of 'power mats', are WiTricity and semiconductor giant Qualcomm. Both have contributed towards creating a common standard that automotive wireless charging systems will be based on.

Hydrogen fuel cell electric vehicles (FCEV)

Targets for hydrogen FCEVs pale in comparison to global battery EV roll-outs, with no expectation for scale until after 2030, according to the European Climate Foundation. Currently, numbers are low because the technology is not yet commercially mature, with global units only surpassing 7,200 in 2017. According to the European Climate Foundation, the share of FCEVs in the global market could reach 27% in 2050, competing solely with battery-powered EVs.

Under its new national Hydrogen Deployment Plan for Energy Transition, France aims to spend EUR 100m encouraging companies to buy 5,000 vans and 200 buses by 2023 to scale up the current 250 hydrogen-powered vehicles deployed nationwide. French train manufacturer Alstom produced the world's first hydrogen fuel cell passenger train, which is now approved to operate on a commuter line along the German North Sea coast.

In California, San Pedro Bay ports are testing the usability of long-range extenders on BAE Electric and Kenworth's hybrid and fuel cell electric trucks, whilst the port of Los Angeles is testing fuel-cell semi-trucks.

Developments in hydrogen refuelling technology are underway in California, China, Germany, Japan and South Korea according to the IEA's 2018 Global EV Outlook.

Energy storage

Storage technologies are at the forefront of the energy transition. Their ability to alleviate traditional grid balancing challenges and to foster a shift towards a more flexible and reliable decentralised energy system are some of the main reasons storage is seen as such a critical component of future power systems.

The energy storage market is transitioning from its early ancillary service contracts-based phase, and project developers are looking at opportunities on a merchant basis. The flexibility of services a storage asset can provide to customers is expected to decrease merchant risk and facilitate debt financing.

Based on our findings we have identified the following future key trends within the market:

Energy storage is critical to electricity system services

Electricity systems require a range of ancillary services that energy storage technologies are able to provide. Such services encompass frequency response, electric supply reserve capacity, balancing demand and black start. Utility-scale battery storage projects are already helping utilities deliver their obligations to keep the 'lights on' through short and long-term contracts.

Co-location offers a valuable proposition for energy producers

Co-location is an attractive proposition for both renewable and conventional energy projects. A number of initiatives are already in the pipeline, both for retrofitting existing grid-connected projects, as well as new projects, where energy arbitrage could make subsidy-free projects more attractive and diversify the revenue streams available.

Behind-the-meter offsets pricing risks

Large-scale energy consumers can now offset the risk of fluctuating energy prices with behind-the-meter opportunities. Such demand shifting offers a wealth of benefits, providing cost reductions in day-to-day operations by avoiding peak use of system charges, while simultaneously increasing revenues from the provision of system services, such as demand side

response, improving productivity and contributing to sustainability objectives. The storage-as-a-service business model can offer solutions on a service agreement basis, without consumers needing to invest in owning a system.

Competition and flexibility are set to increase

Increasing installed capacity will create competition between storage projects and other generation projects for various revenue streams. For example, the increased number of battery storage projects has been one of the contributing factors to the reducing prices for the provision of frequency response in the UK. Business models that seize rising merchant opportunities on short notice will be of most importance for the future of the storage market.

Blockchain will unlock consumer opportunities

Blockchain and energy storage have the potential to transform the transactional landscape of supply and demand. Energy giants are rallying together, forming high-level consortiums to launch systems that will shift the dynamics of the traditional market, enabling peer-to-peer trading and empowering 'community microgrids', which are already popping up in the US and Australia.

Decreasing risk opens the doors to debt financing

Regulatory acceptance, rapidly falling costs of batteries, the increasing need for flexibility services and increasing co-location opportunities have appeased many of the initial concerns of long-term investors, making debt financing more readily accessible. That said, low-risk projects are still currently favoured over those projects relying on merchant revenue, despite potential higher returns.



Eelpower

Mark Simon,
CEO

Since building the first ground-mounted solar farm in the UK in 2010, Mark Simon has run companies that build, operate and own renewable assets, most recently large-scale commercial energy storage infrastructure. With a project pipeline of 860MW, Eelpower Limited plans to build 1 GW of grid-connected storage by the end of 2021.

Simon believes that batteries will play a key role in accommodating the significant volume of renewables now featuring in the energy mix.

“The UK has done an amazing job in introducing renewables. Few are truly aware of the new world we are in. The assets we’re seeking to deploy deliver the services that make renewables sustainable. You cannot do this without a sustainable set of solutions in which batteries play a vital part,” he says.

In 2014, it installed the UK’s first commercial battery alongside a renewable power project (Slepe Solar Farm in Dorset), and in 2017 Simon and his team launched Eelpower, with the construction of its 10 MW energy storage barn at Leverton, near Lincoln. The company has since added more projects to its portfolio.

“We have won the two largest frequency response contracts awarded since August 2017 which have underpinned our first two projects: Leverton, and the 20MW Rock Farm scheme near Ludlow which went live in July [2018],” says Simon.

Since Rock Farm is in open air, the company is interested in performance differences between seasons. High temperatures during the very hot summer in 2018

had quite an interesting effect on the project’s use of power.

On the group’s ambitious capital raising plans, Simon explains, “We have a pipeline of 1 GW to build in the next few years. Building 100MW every quarter requires strong low cost capital providers. We will be very shortly announcing advisors to help us in this process.”

For Eelpower, 1GW is just the starting point. The company hopes it will reach its target sooner than the currently pencilled-in 2021. Funding for the projects will be highly diverse. “It will be a combination of debt, mezzanine of some sort and a small proportion of equity from multiple parties,” explains Simon.

Although there are evident changes in the attitudes of investors in the sector, information on investments and their correlation to prices offers more certainty. According to Simon, power prices are set to decrease and become more volatile. While the former will not reach zero, there will continue to be an increase in the frequency of negative pricing.

Considering the aforementioned dynamics of the market, Simon stresses, “traditional infrastructure investors are investing based on an appreciating price of power and are short volatility; Eelpower offers investment that is long volatility and is largely indifferent to the price of power. It doesn’t need to be low for us, because our battery assets are efficient and the costs are marginal versus the value of the revenues – we’re getting between 86% and 90% efficiency.”

While Eelpower is less concerned about the price of power, volatility will bring benefits for the business and is seen as an opportunity

for arbitrage. “Batteries are like solar: they are easy to deliver, and we don’t worry about delivery risk,” adds Simon.

On the other hand, there are also multiple risks to be addressed within this sector. Politicians not grasping technology issues represent one of the clear obstacles to further development of energy storage. “They understand prices, they understand keeping the lights on, but few understand the complexity.”

In addition, very few politicians actually show interest in technology, even though it is a critical component of the economy. The energy trilemma, which encompasses low carbon, low prices and energy security, is at the forefront of the political agenda.

Nonetheless, Simon asserts, “Energy security comes at a cost, low prices as well, therefore it’s really challenging for politicians to deliver this.”

Changes in technology models might also lead to high variation in costs. The mobile phone industry is a relevant example; in past years everyone worried about what was included in their plan, whereas nowadays the cost of using a mobile phone has become so low that few people fret over this anymore.

Simon reveals the aim of Eelpower is to develop a network of assets that provides services to the grid, making it ultimately able to make renewables sustainable across the nation. This is going to be highly necessary if the move towards a carbon-free power system is to become a reality.

In the spotlight: countries to watch

The changing energy landscape has triggered significant evolution within the energy storage market. Technological advances in battery storage and its intrinsic versatile nature are cementing the technology as a pivotal tool for offering the flexibility that future energy systems require to overcome obstacles from increasingly intermittent sources.

Reductions in costs have helped pivot battery storage’s financial attractiveness in the energy market. The average cost of grid-scale battery projects that came online in 2017 globally is estimated to be under USD 600 per kilowatt hour (kWh) for an average duration of four hours. Lithium-ion battery prices are also expected to drop considerably, with the IEA forecasting prices to reach USD 70 /kWh by 2030. Cost reductions have been one of the main enablers of battery storage deal flow.

We have singled out five key jurisdictions that we think pose the greatest opportunities for investors based on past deals, local incentives and predicted future investment activity:



Setting sights on merchant revenues

The emergence of readily available revenue streams for storage projects in the UK has sparked significant development over the last three years. The UK grid operator’s Enhanced Frequency Response (EFR) tender & Fast Frequency Response (FFR) service has offered considerable ground for battery storage projects to highlight their ability to contribute to National Grid’s legal obligation to balance supply and demand on the grid. 201MW of projects were awarded EFR contracts, and dozens of projects profit from FFR contracts. Statera Energy holds FFR contracts for its operational 49.99MW lithium-ion battery storage system, and the 48MW Creyke Beck Storage project currently under construction.

The Capacity Market, a key policy of the UK’s Electricity Market Reform programme, has also been a key facilitator of projects to date, however, the low clearing prices and de-rating applied in the 2017 auction resulted in fewer storage projects benefitting. The recent decision of the General Court of the European Union has resulted in the suspension of the Capacity Market until the European Commission undertakes a formal state aid investigation.

In 2018, the first battery storage assets will be used in the UK’s Balancing Mechanism (BM). Through BM, National Grid promises GBP 350m annual rewards to participants, potentially inaugurating a new era for the battery storage industry in the country.

Co-location opportunities and behind-the-meter deployment for large consumers are set to be the next big trends.

The Netherlands

Pioneering battery storage and grid support

The Netherlands has no specific legislation for energy storage, but has seen increasing investment in battery storage technologies. The 10MW AES Netherlands Advancion Energy Storage project was the first large battery-based energy storage facility to commence operations in 2016.

Dutch company Alfen has developed a 3MW renewable energy and battery storage co-location facility. Launched in 2017, the project integrated battery storage into Princess Alexia Windfarm to help smooth out peaks and troughs in power supply and better match the demand for energy. The system uses BMW car batteries to store the surplus energy. There are plans to expand the project to 12MW, making it the largest of its kind in the country.

Germany

Driving leadership through R&D

Increasing renewable capacities and the ongoing decommissioning of nuclear plants has put a focus on battery storage technologies. Although Germany’s grid is stable, and blackouts are virtually non-existent, researchers in the city of Schwerin have aspired to develop a battery park to ‘black start’ the grid, to recover from a shutdown. The project, named WEMAG, is led by Younicos – a smart energy and grid solution provider that bases its services on battery storage. The

Investment opportunities in energy storage

system can provide energy storage for renewables as well. Due to its easy installation, the software is expected to make its way into other jurisdictions where grid stability and blackouts are more of an issue.



China

1.6GW of electrochemical storage capacity planned or under construction

China boasts by far the largest renewable capacity in the world, opening a range of opportunities for new battery storage facilities. The central government extensively supports innovative energy solutions, and in 2017 the first national-level energy storage promotion policy was released. China currently has around 1.6GW of storage capacity planned or under construction. China Energy Storage Alliance has forecasted that, by 2020, the country's storage market will have a capacity of 67GW. The country enjoys a strong presence of more than 100 lithium-ion battery manufacturers and technology providers including BYD, China Aviation Lithium Battery, and Lishen.



Chile

Big ambitions for ancillary services and co-location

Chile's share of renewable energy has tripled in the past five years. The country's ambition to increase share of renewable energy supply to 20% by 2020 and the network's increased grid stability needs are among the main drivers behind energy storage deployment. Under the 20.571 law, which introduced a net-billing scheme for self-consumption, producers can sell the electricity they do not consume to the grid at wholesale energy prices. Through this mechanism, households have the incentive to optimise their production, raising hopes for a boost of behind-the-meter battery storage applications for small consumers.

AEG has showcased the benefits of co-locating battery storage projects with conventional power plants. AES Gener built the 12MW lithium-ion Andres BESS next to its Andres substation to provide frequency regulation and spinning reserve services, becoming the country's first battery storage project.

Statera Energy

Tom Vernon,
Managing Director

As a fully integrated developer, owner and operator of flexible infrastructure that focuses on energy storage and high efficiency gas reciprocating engines, London-headquartered Statera Energy aims to deliver enhanced flexibility for the UK electricity system and to assist in the transition to a low carbon economy.

"Unlike the approach historically prevalent in renewable investment, we believe it is important to focus on the commercial model just as much as the assets themselves when investing in the flexible generation and storage sector. Without doubt a differentiating factor is innovation on the business plan", says Tom Vernon, managing director at Statera Energy.

Focusing on the asset is no longer enough. It is necessary to look at the broader market and potentially at other assets, to reduce risk and add cash flow certainty.

"Contracted revenue offered by the UK capacity market and National Grid ancillary services is critical for investor certainty on project cashflows. The cuts we've seen to the capacity market derating factors and decreases in frequency response pricing are substantial. For the time being, it has undoubtedly reduced the attractiveness of storage as an investment proposition," Vernon says.

"Looking forward we believe successful delivery of utility scale storage requires innovation and optimisation across the whole supply chain. This ranges from site development and location, route to market and business plan, equipment procurement, and economies of scale. The market is competitive and we aim to optimise all these areas."

Balancing participation

Global grid-connected energy storage is expected to grow to USD 7bn by 2025. Storage projects can be a more sophisticated offering for investors than simply providing capacity and ancillary services such as frequency response, as revenues are finite.

Other procurement options for system services are being explored by various system operators, including week-ahead auctions which are already being seen in Europe and are to be launched in the UK. Investors see participation in balancing mechanisms as one of the main sources of income for energy storage. Price arbitrage also represents one promising operation strategy benefiting from price differentials.

Co-location

Co-location of storage is an attractive proposition for both renewable and conventional energy projects. A number of initiatives are already in the pipeline, both for retrofitting existing grid-connected projects, as well as new projects. Energy arbitrage could make subsidy-free projects more attractive and stakeholders could expect greater participation as energy projects get increasing market exposure.

If a battery storage system is to be co-located with an existing power plant, it is necessary to consider how the battery will interact with the project's subsidies, Power Purchase Agreements and financing arrangements. In September 2017, Anesco became the first commercial solar farm operator in the UK to retain its Renewables Obligation accreditations after co-locating 1.1MWh battery storage installations to each of its three 5MW solar sites. The producer is now getting paid for both the electricity it exports to the grid for the services provided by the solar panels and through the battery. Ofgem's landmark decision has been characterised a game-changer for the future of co-location with existing renewables projects in the UK.

For conventional fossil-fuel powered energy projects, battery storage solutions offer cost cuts to operators by replacing spinning reserve costs and increasing

For conventional fossil-fuel powered energy projects, battery storage solutions offer cost cuts to operators by replacing spinning reserve costs and increasing efficiency.

efficiency. In May 2018, Australian utility Alinta Energy commissioned a 30MW/11.4MWh Energy Storage System next to its 178MW OCGT Newman Power Station to manage peak demands and improve its efficiency.

Behind-the-meter/Storage-as-a-Service (SaaS)

Behind-the-meter storage systems alter the demand profile of both small and large consumers by giving them the freedom to control the way they purchase energy and use the energy stored. For instance, it allows large-scale energy consumers to offset the risks of fluctuating energy prices, while integrating additional generation and revenue streams.

When co-located with a renewable energy asset, large consumers, which are energy producers at the same time, can store intermittent energy produced to use at peak times when it is more expensive to import from the grid. This way, companies can make significant cost reductions. The stored energy can both function in an energy security capacity to ensure consistent energy flow, and provide further power for additional operations. As well as contributing to a company's sustainability objectives, the battery can also contribute to a company's bottom line by providing potential demand side response revenue streams.

SaaS offers this solution to customers not targeting ownership of battery storage assets but aiming to take advantage of the benefits on a service agreement basis. SaaS providers make a stacked business case by offering services to customers, combining back-up power, peak shaving, energy arbitrage, and market ancillary services.

What does the future hold for energy storage?



Natural Power

Hannah Staab,
Senior Due Diligence
Project Manager

Natural Power is an independent advisory firm offering services to a wide range of renewable energy clients. Their services extend to supporting the construction of battery storage projects as well as feasibility analysis and consenting for co-located onshore wind, solar and storage.

"I think there are definitely still some challenges in getting these projects financed from a technical point of view," says Staab. "Some of the most interesting risks are around battery performance and operational behaviour, because there isn't that much operational data out there yet on batteries, particularly not over a ten-year lifespan or even beyond that."

Understanding the temperament of your asset is crucial. Hannah states, "Operational performance monitoring is crucial to make sure you're getting the best out of your battery."

But performance data is very limited in the storage market. "Manufacturers are quite protective of their data. For wind and solar we have years of performance data to verify theoretical models. There is little long-term field data for battery projects yet. This knowledge gap will close over the next few years, but technology will move on at the same time."

Lenders currently look at this lack of data as a key technical risk, joining revenue uncertainty and a lack of visibility over the lifetime of batteries as primary concerns.

With regards to expected maturity and bankability of the storage market, Staab says, "I think the rise in co-location projects is going to get traditional wind and solar investors comfortable with storage."

Increased availability of debt financing

The learning curve on energy storage technology has allayed many concerns, including rapid battery degradation, revenue streams in system services and balancing, and behind-the-meter opportunities.

A report by Moody's suggested that in March 2018 project financing of battery storage projects had reached a risk parity with conventional power projects.

The first half of 2018 saw a steady stream of debt financing deals, for example in the UK with Santander leading the charge in lending GBP 28.5m to Battery Energy Storage Solutions. Gravis Capital Management also agreed a GBP 20m financing facility with Eelpower, which will fund Eelpower's ambitions to build, own and operate a fleet of grid-connected batteries.



Energy storage is expected to experience further cost reductions and performance improvements as it achieves commercial maturity. According to the International Renewable Energy Agency (IRENA), installed costs of battery storage systems are forecast to fall by 50-66% by 2030, opening up new economic opportunities for stakeholders as costs to support ancillary services and behind-the meter services for consumers drop significantly.

Alternative storage technologies

Compressed air energy storage (CAES) is expected to be a new technology on the rise. IRENA estimates installation costs will fall to USD 44/kWh by 2030. There is potential to repurpose old natural salt deposits or depleted oil fields as storage caverns for compressed air, which would be a welcome alternative seeing as purpose-built caverns hike CAES costs by 80%.

Hydrogen is increasingly referenced as an attractive alternative to battery storage. An area of development is water electrolysis whereby an electric current is passed through water to separate hydrogen and oxygen. According to the IEA, investments in building water electrolyzers picked up in 2017, with projects planned to come online in 2020 with a total capacity of 150MW.

Heat storage

Molten salt Thermal Energy Systems (TES) are rapidly developing as the preferred process for thermal storage, occupying a 75% share of total thermal storage operations.

Opportunities in microgrids, particularly 'community microgrids', are emerging, as seen in projects like the LO3 Energy and Brooklyn Microgrid project in New York.

Developments in thermal storage are developing alongside CAES in the form of advanced adiabatic compressed energy storage (AA-CAES). The most promising concepts of AA-CAES involve molten salt-based TES because its costs are expected to fall to USD 10/kWh by 2030. The Gotthard tunnel in Switzerland is being converted into an AA-CAES system, and is expected to reach efficiencies of up to 72%.

Blockchain in energy storage

Blockchain acts as the transaction layer by which users sell or consume energy transparently. Storage, on the other hand, offers valuable capacity flexibility. Opportunities in microgrids, particularly 'community microgrids', are emerging, as seen in projects like the LO3 Energy and Brooklyn Microgrid project in New York.

Blockchain applications are being explored by a number of consortiums of energy giants led by the Rocky Mountain Institute and Grid Singularity. A number of shareholders including Shell, Equinor, Engie and Centrica have launched a joint initiative to explore the topic. Peer-to-peer trading is also enabled in the storage and blockchain mix. Supported by the Australian Renewable Energy Agency, Power Ledger has initiated its first P2P trading of electricity, a 53.6kW solar PV system paired with a 150kW lithium ion battery storage system, for a residential apartment block in Fremantle, Western Australia.

"Some of the most interesting risks are around battery performance and operational behaviour, because there isn't that much operational data out there yet on batteries, particularly not over a ten-year lifespan or even beyond that."

Hannah Staab
Natural Power

Smart mobility

Smart mobility encompasses a wide-ranging set of technology-driven transformations that are reshaping the transport sector. Digitally enabled mobility platforms such as ride-hailing and ride-sharing apps (known collectively as ‘mobility as a service’ or MaaS) are challenging traditional transportation models.

Technology upgrades are making a radical impact on the railway industry too, helping to boost capacity, enhance travel safety and cut costs. However, the most significant change is set to be the mass deployment of autonomous vehicles (AVs), which will affect the whole sector, opening up new revenue streams and challenging established business models.

Based on our findings we have identified the following future key trends in the market:

Infrastructure set to require big data

Enabled by 5G networks, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication systems will lead to an exponential increase in the amount of data generated by infrastructure assets, allowing road operators to enhance travel safety and optimise traffic management, for example by upgrading electronic toll collection systems and reactive traffic management systems in major cities. For these systems to be implemented, countries will be required to spend considerable amounts improving their 4G and 5G networks. In order to support the analytics necessary to thrive in the digital age, infrastructure operators will have to form partnerships and joint ventures with tech companies.

Smart ticketing and digital railways are set to increase revenue streams

Through the digitisation of signalling, payments and ticketing, the railway industry is set to boost the performance of its assets and its revenues. Investment in signalling is vital to increase the network's capacity in order to meet demand growth. The introduction of smart ticketing will allow rail operators to cut equipment expenses, such as barriers and ticket printers, to minimise ticket fraud and to develop more user-centric services.

Private funding will be crucial to retrofit existing roads and build new ones

For the mass deployment of AVs to be economically viable, existing roads will need significant retrofitting to ensure compatibility with new vehicles, which will be electronic, connected and autonomous. This will involve investment in fibre networks, gantries, cameras and traffic lights, as well as standardised and AV-compatible paintwork and road signs. The upgrade of the network will need to include

both the main motorways and trunk routes as well as smaller roads and streets (both urban and rural) to ensure a seamless AV travel experience. The scope of the upgrade necessary will require considerable injections of both public and private capital.

The business models of car parks could be transformed

While the growth of MaaS is likely to reduce the number of vehicles on the road, this is not going to eliminate the need for car parks. In fact, the reduction in the number of car owners could be compensated by an increase in users who abandon buses and metros in favour of ride-hailing services. Small and medium urban car parks could be replaced by large suburban car parks catering to ride-hailing fleets, rather than to individual drivers, freeing up prime space in city centres for alternative development. Car parks could therefore rely on the stable and long-term revenues ensured by sizable corporate clients.

Public transport will need a tech upgrade to stay competitive

The increasing use of MaaS models could represent a challenge to public transport system as railways and metro. Ride-hailing services could start to compete directly with public transport operators, potentially eroding the latter's long-term profitability. In order to remain competitive, public transport would need to invest heavily in more user-centred and personalised travel experiences. This will be a significant challenge for the cash-constrained local and national governments, which currently support public transport systems.

Investment in cyber security

With the implementation of smart mobility technologies and applications, transport infrastructure will become vulnerable to security attacks. The more immediate cybersecurity concern for today's smart mobility sector is that the companies operating in this space are becoming repositories for huge amounts of customer data. Ensuring that the repositories of data are secure is an ongoing challenge, which requires unflinching vigilance and constant security updates. Investment in cyber security will be crucial to allow infrastructure operators to detect risks and ensure the resilience of critical infrastructure assets.



AppyParking

Ben Boutcher-West,
Head of Mobility

Smart parking aims to significantly reduce the time spent searching for parking, offering multiple benefits to application users, such as pay-as-you-go options and the elimination of overpayments and parking-tickets, while enabling drivers to make informed choices about their journey. AppyParking is a leader in mobility platforms.

“We’re the next generation connected car and traffic management platform that bridges the gap between big data, high definition mapping, IoT and payments,” says Ben Boutcher-West. Previously lead engineer at Jaguar Land Rover for autonomous driving and automotive lead for Bosch Mobility Services, he is now responsible for AppyParking's strategy, business development and R&D.

The Parking Platform™ provides a digital infrastructure layer over the existing road network and offers a Platform as a Service for local governments and car park operators to manage their kerbside and assets. Data-as-a-service (DaaS) is then licensed to the private sector in the form of a marketplace.

“Our agnostic approach offers a holistic and scalable connected car and smart city solution. We are on the eve of 5G technology – while the consumer market enjoys greater 4G coverage, people are connected more of the time, with that comes greater choice. Greater access and the opportunities with multimodal transport are so clear to me and so clear to the team at AppyParking. It's about access to healthcare, access to education and access to employment.”

“There are a lot of myths and legends associated with data. Handling the kerbside data is what cities are least equipped to do, and our technology looks to equip them with the means to manage the data involved, whilst also giving them a revenue opportunity to earn real money,” he continues.

“I think there is definitely a mobility cultural shift and people are taking a lot more responsibility for their mobility choices, embracing the range of options that are increasingly available to them,” Ben Boutcher-West says.

According to Ben the most attractive markets are those with the biggest pain-point of parking, such as megacities, but also those smaller communities where the car remains the most viable mobility solution for a long time to come – places public transport cannot reach, for example.

“There is a huge divide and we are very lucky to live in a megacity with fourteen or even more ways to travel home from the office. This is a massive contrast to other cities such as Birmingham, in which the car remains the king of transport in the outer suburbs,” he continues.

A vast amount of technological development is happening in areas such as Harrogate, Dundee, Bristol, Milton Keynes and Coventry, since these smaller towns are on the forefront of the latest technology. On the other hand, London has 33 individual boroughs and it is a struggle to integrate them and get the maximum value from new technology.

“It goes without saying that London is certainly going to lead the field on the opportunity that the mobility revolution offers for the UK, but we should not forget those smaller towns where a lot of R&D can happen without the complexity a megacity presents” Ben Boutcher-West predicts.

However, the growing focus on smart mobility platforms and applications could widen the gap between rural and urban environments.

Still, there are a few obstacles ahead, and one of the main risks is represented by regulation. While the government approach continues to improve in this sector, a data ethics code that the private sector needs to comply with is needed to support business. The creation of a standardised regulatory framework for kerbside management will be necessary to avoid an exclusive focus on certain technologies, ensuring the full opportunity is not missed.

However, the future of smart parking looks bright, as the advent of AVs will bring a whole new range of opportunities.

“Since there will be no individuals responsible for parking, the vehicles and operators will be directly dialled into the digital platforms and permits will be requested on a case-by-case basis, in real time. With flexible services comes the need for even more accurate control of the kerbside. The AppyPlatform™ is designed specifically for this,” Ben Boutcher-West concludes.

In the spotlight: countries to watch

The most successful countries will be those that are swifter in upgrading their regulatory frameworks and in allowing testing. As smart mobility includes a range of different technologies at different stages of maturity, it is not always easy to compare progress across various countries. However, smaller and wealthier countries, such as Singapore and the UAE, are undoubtedly pioneering the implementation of smart city strategies, becoming test beds for new products and services.

We have singled out five key jurisdictions that we think pose the greatest opportunities for investors based on past deals, local incentives and predicted future investment activity:



UK Leading track record in publicly funded AV developments

The UK aims to be a world leader in AV technology, with four cities allowing public trials and driverless cars on the road by 2021. It holds an impressive track record in publicly funded AV development, and earlier in 2018 the government announced GBP 22m in funding for 22 R&D projects relating to driverless vehicle technology. The Automated and Electric Vehicle Bill became law in July 2018, effectively extending the traditional model for insurance coverage to AVs on UK roads. The private sector is also finding ways to explore the streamlining of transport services, such as Virgin Trains' agreement with Uber to provide last-mile mobility to and from stations.



Singapore Global leader in AV and smart mobility

Singapore is emerging as a global leader in self-driving technology and smart mobility. The country announced ambitions in 2014 to be the world's first smart nation. As part of this they have dedicated resource to improving transport systems and efficiently regulating them, putting Singapore ahead of the curve.

To improve its transport system, Singapore is concentrating on mobility-on-demand, contactless fares and AVs. From a regulatory point of view, they have established clear guidelines on liability, as well as specific zones and areas for the trial of self-driving

vehicles. The Singaporean government has awarded research grants not only for AVs and EVs, but also for the development of peripheral technology and products that will support smart mobility, such as start-ups that are creating broad optimisation programmes and smart mapping technologies. A dedicated pilot town unveiled in November 2017 has been built to test AVs, including self-driving buses.



Poland Emerging European hub for AV

Poland is a market leader for implementing intelligent infrastructure. In particular, the Mayor of Krakow has led the way in smart solutions. These include smart parking, a tram traffic control system and an urban traffic control system that helps reduce traffic and pollution. In Gdansk, the urban traffic and public transport fleet management system has reduced commute times by 7% by digitalising junctions, providing more information screens for travellers and increasing the number of traffic management centres.

Dubai has laid the foundations for smart mobility with the launch of its smart city project in 2013. Underpinned by large-scale improvements in fibre optic broadband, the city aims to make all transportation autonomous by 2030.



Poland is also emerging as a European hub for AV. In 2017 the city of Jaworzno, in Silesia, signed a letter of intent with the IT company Comtegra and the Motor Transport Institute regarding the development of legal, organisational and technical guidelines that will enable the testing of AVs on Polish roads.



UAE Hyperloops expected to be operational by early 2020

Dubai has laid the foundations for smart mobility with the launch of its smart city project in 2013. Underpinned by large-scale improvements in fibre optic broadband, the city aims to make all transportation autonomous by 2030. The first segment of a hyperloop between Dubai and Abu Dhabi could be operational as early as 2020.

In early 2018 Hyperloop TT signed an agreement with Abu Dhabi's real estate developer Aldar Properties PJSC to begin construction of a route linking the Al Maktoum International Airport with the Alghadeer residential area. The country has also become a test bed for delivery drones, and Dubai's Roads and Transportation Authority is pioneering self-driving taxis.

Hyperloop TT's co-founder and chairman Bibob Gresta highlights the challenge that regulation poses but advances are being made and all eyes are on the progress of the world's first commercial hyperloop in Abu Dhabi. Hyperloop TT expects to have up to 5km ready for operation by the launch of the Expo 2020 and has already completed the first full-scale passenger capsule.



France Fibre-optic bedrock will boost smart mobility credentials

France has an excellent bedrock from which to build up its smart mobility credentials. Currently, France boasts Europe's greatest length of driverless metro lines and the country is gradually introducing digital signalling strategies and automation to its Paris metro lines. Digital signalling is already in use on France's high-speed TGV network. The country is now due to start testing driverless high-speed trains in 2019 on its TGV lines, with the aim of running fully driverless journeys by 2023. This system would be the world's first driverless high-speed railway. Railway company SNCF expects it to increase the number of journeys between Paris and Lyon by 25%.

France is now due to start testing driverless high-speed trains in 2019 on its TGV lines, with the aim of running fully driverless journeys by 2023.

Investment opportunities in smart mobility

Electronic tolling collection

A technological upgrade of the tolling system is necessary to enhance traffic flow and safety. Electronic toll collection (ETC) eliminates the need for cars to significantly decelerate or stop altogether, reducing congestion, fuel consumption and air pollution. ETC also provides the ability to optimise traffic flows and dis-incentivise road use in high-demand times through congestion pricing.

Norway and Japan are regarded as pioneers of ETC implementation, with widespread deployment across both countries. While ETC is not a new technology, when coupled with vehicle-to-infrastructure (V2I), vehicle-to-grid (V2G) and electronic parking fee collection, it will provide even deeper insights into travel patterns and user behaviour, allowing infrastructure owners to implement more dynamic pricing strategies, and so significantly increase revenues.

Digital railways

The railway system is set to experience a momentous transformation. Rapid global population growth and urbanisation, coupled with the need to reduce carbon emissions, is likely to lead to an increase in the worldwide demand for both railway passenger and freight rail services. Existing rail networks will need to be retrofitted and upgraded to keep up with this evolving demand. According to the International Forum of the Organisation for Economic Co-operation and Development (OECD) excessive growth between 2018 and 2050 in passenger mobility (200% – 300%) and freight activity (150% - 250%) will play a defining role in driving the smart railway growth and every aspect of its value chain.

Within the concept of smart railway, smart signalling is one of the most promising, as it will allow train operators to increase capacity, improve performance and safety, as well as reduce delays and costs. In the UK, digital signalling is being introduced over the next 15 years. Infrastructure manager Network Rail has welcomed the involvement of private financing for this.

Nick English, partner at Rock Infrastructure, has highlighted the importance of collaboration between all stakeholders to make this a success. "A successful introduction of digital signalling requires ever closer working between Network Rail and the operators, for a number of reasons: project management of train

fitment, trackside equipment, testing and driver training as a single coordinated project; and introduction to minimise disruption to passengers – including changes to timetables." According to English, this could suggest putting the operator at the centre of the procurement and potentially funding process in close partnership with Network Rail.

Smart ticketing

Smart ticketing is acknowledged as an extremely promising area for public transport, as it will allow metro, tram, bus and rail operators to reduce expenses on equipment such as paper ticket printers and barriers. The concept of smart ticketing includes dedicated smart cards (such as London's Oyster and the Helsinki Card), contactless credit and debit cards, as well as digital wallet services. Thanks to big data and machine learning, infrastructure operators will be able to gain deeper insights into consumer behaviours, delivering a customer-centric travel experience. In 2017, the UK government introduced a GBP 80m investment in smart ticketing, to ensure all passengers have the choice to travel without a paper ticket by the end of 2018.

Mobility-as-a-Service (MaaS)

The emergence of the concept of MaaS has prompted car manufacturers and tech companies to get involved in ride-hailing start-ups and MaaS development. Automotive companies such as BMW, Toyota and Volkswagen are all getting involved. While there are doubts over the short-term profitability of car sharing, involvement in this market will allow automotive players to learn about customer behaviour, in order to be ready for the transition to integrated mobility services. The combined value of M&A deals in the MaaS sector exceeded USD 45bn between 2016 and 2018.

It is predicted that car fleet operators will become the dominant force in city mobility. Several automobile manufacturers have already launched their own car sharing platforms; including DriveNow by BMW, Porsche Passport, Maven by General Motors and Via by Daimler. Car sharing companies are transforming the mobility landscape, with the launch of services such as Toronto's free-floating Communauto Flex in November 2018.

Autonomous vehicles (AVs)

AVs will be more expensive for individual consumers than conventional cars, at least in the early years of use. This will increase the likelihood that fleets of AVs will be

sold to corporates, who will lease them to consumers or provide them on a MaaS basis, both as autonomous cars (such as robo-taxis) and buses. Early investment structures for AV fleets could display similarities to privately financed rolling stock. If leasing contracts are structured correctly then long-term and stable revenue streams could be achieved, enticing infrastructure investors and associated debt providers. For the mass deployment of AVs to be economically viable, existing roads will need retrofitting for AV-compatibility, including clear and standardised paintwork and road signs.

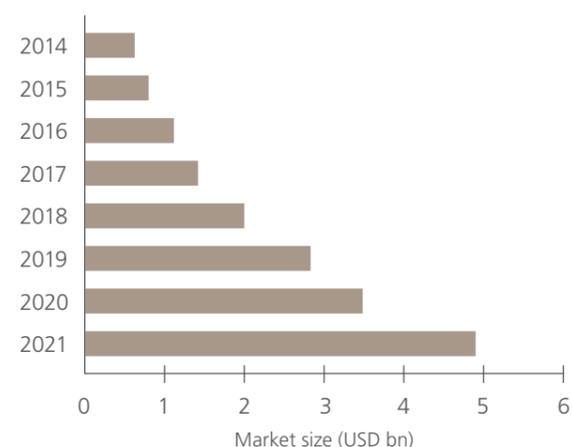
Drones for deliveries

With global e-commerce continuing to grow and competition increasing, delivery companies are looking for ways to make their business models more cost-efficient. One method to enhance efficiency is the introduction of delivery drones, which can cut delivery costs significantly, as well as providing faster shipping. In the early stages, it is likely that drone technology will make its way into rural areas, where van delivery is less economical due to the large distances between drop-off points and regulation of the less crowded airspace will be easier than in urban areas.

Many global logistics and retail companies are exploring ways to utilise drones. Amazon has set up a drone development centre in Cambridge, UK, with commercial operations expected to begin in 2020. A Chinese e-commerce giant, JD.com, is the first to start commercial operations, with 40 drones and two dispatch centres covering 100 villages in Shaanxi province. If drones are widely adopted in the delivery sector, they may also need some sort of launching infrastructure, such as moving vehicles or fixed dispatch centres.

As drone technology matures and its demand spreads across wider applications, the value of its market will expand by 688% between 2014 and 2021, according to a Pepperdine Graziadio Business School report. As shown below, the commercial drone market size is expected to be increased with a 34.3% annual rate from a USD 0.609bn in 2014 to approximately USD 4.8bn in 2021.

Worldwide commercial drones market size (2014-2021)



Source: Pepperdine Graziadio Business School 2018



Technology Scotland

Alastair McInroy,
Senior Programme Manager

Through their newly established MaaS Scotland network, Technology Scotland and ScotlandIS aim to advocate for the concept of mobility as a service (MaaS) and demonstrate the benefits it can bring to operators, transport authorities and users.

"The idea of MaaS is mainly data-driven. The platform itself will be a digital portal, which gathers together all the information on the transport modes available in a particular region — including both public and private services", says McInroy.

The platform includes all modes of transport, from buses and trains, to bike and ride-sharing. However, the most innovative element is represented by the integration of a payment service, which can either be on a pay-as-you-go basis or a subscription-style model that would include a monthly fee for people to make use of all the transports available in an area.

"Automotive manufacturers are beginning to react", he says. "Ford, BMW and Porsche are already looking into alternative mobility solutions. They are aware that in the near future they might not be selling cars, but services", he adds.

When it comes to the business model, McInroy believes that MaaS can fulfil its true potential only through private-public partnerships.

"If the deployment of MaaS services is led completely by the private sector then local and central government authorities risk losing a degree of control over public transportation." In this case, the concept of transport as a public service would be in peril, as transportation would become a pure commodity.

From an investor's perspective, the participation of the government is increasing investor confidence and helping to significantly manage the risks when investing in such a nascent concept.

What does the future hold for smart mobility?

Start-ups and tech companies are constantly changing the game with new innovations in sharing and technology-driven mobility solutions. While it is hard to predict what mobility services will look like in 2030, it is easy to see that some technologies have already won the confidence of the industry and the public and have the potential to reshape our transportation infrastructure.

Hyperloop

Hyperloop uses electric propulsion to accelerate pods through a low-pressure tube at high speeds and promises unprecedented fast and convenient city-to-city transportation, even over long distances. Major developers include Virgin Hyperloop and Hyperloop Transportation Technologies, both headquartered in California. This method of transport could become a major competitor for rail or even air travel. With the claim of being the most efficient and safe means of transport, Hyperloop promises speeds of up to 760 mph (1220 km/h) – a promise that could make London to Glasgow a 25-minute trip, or New York to Washington DC a 30-minute one, possibly changing forever the way we perceive distance and travelling.

The US and UAE are the most active countries exploring hyperloop opportunities for their respective regions; the line that would connect Dubai to Abu Dhabi is most likely to be the first one commercialised thanks to strong government support. Interestingly, Asia Pacific also has multiple countries exploring hyperloop schemes. Indonesia for instance has signed a Memorandum of Understanding with Hyperloop Transportation Technologies to conduct a USD 2.5m feasibility study.

Blockchain

Blockchain offers greater security and transparency, as well as faster transactions, but it is constrained by the lack of infrastructure and regulatory framework. One promising company is Car eWallet, a blockchain-based transaction platform, established by a joint venture between ZF, UBS, and IBM. The platform will enable full end-to-end integration of mobility services, vehicles and infrastructure, allowing self-driving cars to be truly autonomous. Blockchain can also be applied to streamline electronic tolling, eliminating credit card fees and enhancing data security. In 2018, Danish shipping giant A.P. Moller-Maersk announced the creation of TradeLens, a blockchain-enabled solution to ensure a more secure and efficient global trade, in partnership with IBM.

Small satellites

Satellites are already going through a transition from predominantly academic and military tools to wider commercial utilisation, including imagery, telecommunication, geospatial mapping, building information modelling and navigation systems, and are expected to grow in number over the next 10 years. As the market is constantly expanding, one challenge facing the industry is the lack of launch vehicles and, consequently, significant delays to satellite launches. However, companies such as SpaceX, Virgin Orbit and Rocket Lab have already committed to building new facilities.

Space ports

In an era where space is moving from the public to the private sector, perhaps best exemplified by SpaceX and other companies' successful launch programmes, spaceports could follow suit. In the UK, as part of the current government's industrial strategy, GBP 50m in funding was set aside in late 2017 for new launch sites, with the intention of priming the growth of a new hi-tech industry for the country. The government calculates that around GBP 3.8bn revenue could be generated in the area over the next decade. The first recipients of the capital made available emerged in 2018, with a new spaceport project in Sutherland, Scotland being awarded GBP 2.5m in funding in July by the government-owned UK Space Agency.

In the UK, as part of the current government's industrial strategy, GBP 50m in funding was set aside in late 2017 for new launch sites, with the intention of priming the growth of a new hi-tech industry for the country.

Methodology

Our research aims to identify the most promising markets and jurisdictions for investment for broadband, electric vehicles, energy storage and smart mobility. Since the four sectors analysed are markedly different in terms of their maturity, research methods have been tailored accordingly. The analysis of more mature sectors, for example, digital has been more quantitative, other sectors (i.e. smart mobility) required a more qualitative approach.

The quantitative data collated has been categorised according to sector, country, financing model, transaction stage, transaction value, participant role and status, with the goal of developing advanced data-driven analytics and insights. Our main source was dataLive, inspiratia's proprietary project database that monitors global project-financed social infrastructure, transport and renewables deals. Other sources include governments, international organisations, rating agencies, consulting firms, academic literature, newspapers, specialist press, press releases and in-depth interviews with market participants.

Our qualitative analysis was based on in-depth interviews with leading market practitioners to assess the interest of potential investors. This analysis provided insights on potential revenue streams, risks and inhibitors to successful investment, deeper understanding of the successful case studies, political support, regulatory framework, investment climate, technology maturity and gain an understanding of any other issues potentially affecting the investment landscape.

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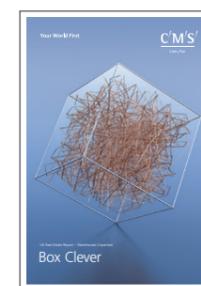
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CMS Cameron McKenna Nabarro Olswang LLP
Cannon Place
78 Cannon Street
London EC4N 6AF

T +44 (0)20 7367 3000
F +44 (0)20 7367 2000

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