Global infrastructure report

Electric vehicles and charging infrastructure

Infrastructure for our ‘Connected Future’
Electric vehicles and charging infrastructure - Infrastructure for our ‘Connected Future’

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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.

Countries to watch

Germany China Norway UK Netherlands

This report is part of Connected Future. For more information, please visit cms.law/connectedfuture
Foreword

The uptake of electric vehicles (EVs) has soared in recent years (albeit from a very low base), with jurisdictions such as Norway and The Netherlands currently leading the pack. However, in order for a country to become a global EV leader, it is vital to consider all aspects of EV adoption, from regulatory frameworks which endorse the rollout of EVs, to the speed and availability of charging infrastructure (including interoperability), as well as incentives for companies and consumers.

The growth in EVs presents a number of opportunities for investors, the most significant of which are projected to be in public EV charging networks and corporate fleets. There are a number of pathways opening up for the deployment of EV infrastructure. At present, it is unclear as to which business model(s) will succeed, with diverse range currently being pursued by charging infrastructure providers and investors, each of which has different approaches in terms of revenue streams, demand risk, location and speed of charging.

The future of charging infrastructure is just around the corner, with original equipment manufacturers (OEMs) such as BMW and Vauxhall already launching EV models that can be powered wirelessly.

In addition, the use of hydrogen fuel cell vehicles may provide an alternative, once the technology is more commercially mature, with developments in hydrogen refuelling technology underway in California, China, Germany, Japan and South Korea.

I would like to thank our interviewees who gave up their time to contribute to our report: Daniel Saunders of Octopus Investments, James McKemey of Pod Point and Matt Allen of Pivot Power.

This report is one of four supplements, expanding on the findings of our 2018 Connected Future report and our 2017 CMS Infrastructure Index. The 2019 Infrastructure Index will be available at the end of 2019.

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Electric vehicles and charging infrastructure

There has been a major leap towards full-scale adoption of 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.
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.

To better showcase how the bundled solution functions, he offers further details on the Heathrow project, mentioning that for the vehicles it financed, the company has structured a pay-per-mile loan. “We’re going to install telematics and for every mile driven, we’ll charge a bit. Once enough miles have been driven, the loan has been fully repaid and that’s the end of the contract.”

The interest of the owner thus becomes aligned with the one of the investor, according to Saunders. “The more they drive the more they earn, the sooner we have our investment repaid. The same principle applies to buses and commercial vehicles.”

In comparison to EV fleet financing, the consumer retail market carries higher risk, as vehicles in this area are only used to approximately 10% of their potential. The idea of ‘alignment of interests’ does not apply in this situation, as it is not necessary to always use a personal car. Whereas for taxi services, being in operation means earning more money, therefore the repayment of the investment is also faster.

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.”

EVs will last longer than current vehicles; once the infrastructure is built, it can be used for decades and opened up to the external market. “Why couldn’t a bus operator also allow people who come in, to charge their vehicle in one side of their depot? It opens up a lot of possibilities.”

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

<table>
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<th>Year</th>
<th>EV stock (millions of units)</th>
</tr>
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<tr>
<td>2012</td>
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</tr>
<tr>
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<td>2016</td>
<td>3.0</td>
</tr>
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<td>2017</td>
<td>4.0</td>
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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 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.

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.
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.

### 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.

### 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.

### 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.
Since launching in 2009, Pod Point has developed into one of the UK’s leading providers of EV charging infrastructure. The company has installed around 2,000 public charging bays and also supplies smart home charging solutions.

A large part of the company’s revenues come from home charging. It installs between 700 and 900 home chargers around the UK each month. “60% of all energy will flow into the car at home, while at work another 30% charging is estimated,” says James McKemey, Head of Insights at Pod Point.

“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.” The remaining 10% includes a mix of what Pod Point calls destination charging – which encompasses hotels, overnight parking, supermarkets, train stations, airports and any other place where people leave their car – and a small proportion (circa 3%) of en-route rapid charging.

“The destination model is often something nice to have and a reason to visit certain businesses,” McKemey says. Clients can go shopping, for example, while their car is charging. “It becomes a top-up model. If you really need more power, then you’ll hit a more high-power unit on your way. But as ranges increase, need for that en-route charging decreases. That’s really important to understand from the investment standpoint. People are no longer completely reliant on the petrol station model.”

According to McKemey, the people working in the industry deal with two main questions. The first is how far EVs can travel on one charge. “Ranges are of vital importance. Once we obtain a fully reliable machine exceeding 200 miles, it will become useable for basically everyone, perhaps with the exception of super-high mileage drivers where we might need to consider a 300-400 mile range,” he says.

“For more than 90% of drivers, the 200 mile range is more than needed, and that’s what’s really high in the market now.”

The second question is how long it takes to charge EVs. According to McKemey, the question is based on a complete 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. “Wouldn’t it be wonderful if it fuels itself to 95% when you’re not trying to drive it somewhere? Once you’ve gotten this idea, EV starts to make a lot more sense, from the convenience point of view,” he says. “That is what we try to do at Pod Point. We put the charging points in all the places where a car is going to spend its time doing nothing.”

As a result of the growing interest in the sector, global EV sales are soaring, and consequently the industry represents a big opportunity for private investors. But producers remain behind on the delivery of vehicles to customers due to high market demand.

Tesla’s Model 3 was regarded as the most successful product launched in a very long time. In Q3 2018 the model became the best-selling car in the US in terms of revenue, outperforming Toyota with over US$3 billion in total revenue generated, and placed fifth in terms of volume. “The change is coming, but the challenge is taking care of the supply of vehicles,” says McKemey.

On rapid charging, he says, “We are sceptical of the infrastructure funding approach for 50kW rapid chargers, which is to sink a £30-50,000 unit into the ground anywhere you can and then try to get that paid off through utilisation, with no secondary income.”

“The price you can set for usage per kWh is benchmarked against what you pay at home. This means small margins with relatively low utilisation and high capital costs.”

Another issue identified with rapid charging is the limitation of the 50kW charger, which is not quick enough when charging larger batteries, such as those found in Tesla vehicles, in the midst of long journeys.

According to McKemey, a 150kW charger – as a genuine en-route solution – is likely the most suitable, while 350kW would be excessive for cars.
“The change is coming, but the challenge is taking care of the supply of vehicles.”
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.
Electric vehicles and charging infrastructure

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

Hear from Matt Allen about how Pivot Power raises funding
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.
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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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About Inspiratia

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