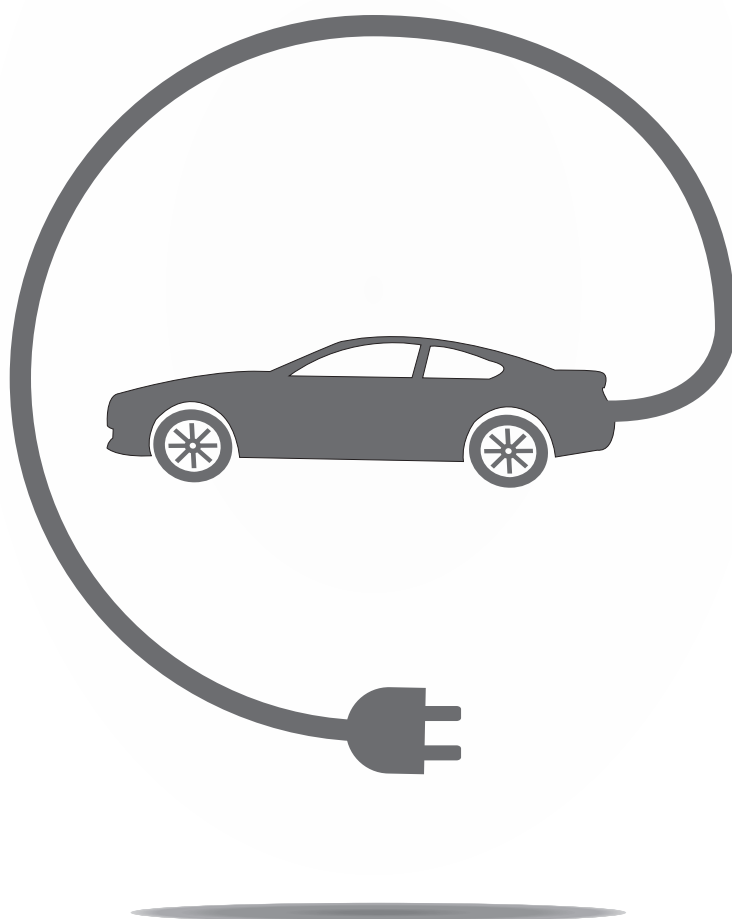


2019 EV Report

EVs | Smart charging | V2G



Partners



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Mapping the journey

The interest in electric vehicles dwarfs the number on the road. That will change over the next few years as carmakers make massive investments to retool their businesses.

They are pivoting, but the scale of their challenge should not be underestimated: carmakers ultimately have to ditch everything they have learned about engines and start again, while remaining profitable and selling cars in the meantime.

Toyota president, Akio Toyoda, describes it as a “once-in-a-century period of profound transformation”. His company is collaborating with Suzuki on EVs and compact cars for certain markets. Other carmakers, realising they need to spend hundreds of billions, are also pooling resources as the likes of Tesla (\$50bn market cap), which sells a relatively small number of cars, is valued more highly by the stock market than Ford (\$36bn).

Nevertheless businesses that want to decarbonise need vehicles today. Firms with large fleets, such as Mitie, are struggling to get commitments from carmakers. Others, such as UPS, initially had to convert their own trucks.

Meanwhile, increasing penetration of EVs requires national charging infrastructure. Those that invest now have to balance supply and demand risk. Electric vehicles and infrastructure are therefore the chicken and egg of our times, a phrase used liberally by many of the stakeholders interviewed for this report.

EV volumes should start to ramp up over the next few years, with analysis by Bloomberg and others suggesting cost parity in the next five years as a result of scale. In ten years’ time, National Grid’s Future Energy Scenarios suggest between 2m and 11m EVs may be on UK roads.

The electricity system operator is

not too worried about the impact of EVs on peak demand – and thinks it can be managed by smart charging. From 2030, it thinks EVs could play a “useful” role in the energy system by providing storage.

There are mixed views on when or if vehicle-to-grid technology will become mainstream. But about half of businesses and public sector organisations surveyed for this report demonstrate appetite to provide V2G.

Given *The Energyst*’s audience is energy focused, that figure may not be reflective of the population as a whole. But it suggests that car companies, energy suppliers and technology platforms will have an addressable market when volumes arrive. Oil majors such as Shell are also moving into the power space, while carmakers are partnering with energy technology companies and launching their own energy arms.

Those developments should drive both technological innovation and increase competition that will ultimately benefit businesses.

However, the distribution network is already constrained in some areas, and network operators have limited low voltage network visibility. They are working to address the challenges posed by high uptake of EVs, offering timed connections and smarter approaches to businesses. But energy suppliers (sponsors) interviewed for this report urged businesses considering EVs to understand capacity limitations and engage with DNOs to determine whether more is available – as upgrade costs can be significant.



While the timing of the EV boom is not yet clear, the message from most stakeholders is straightforward: Plan ahead and ensure any infrastructure installed today can cope with what is inevitably coming.

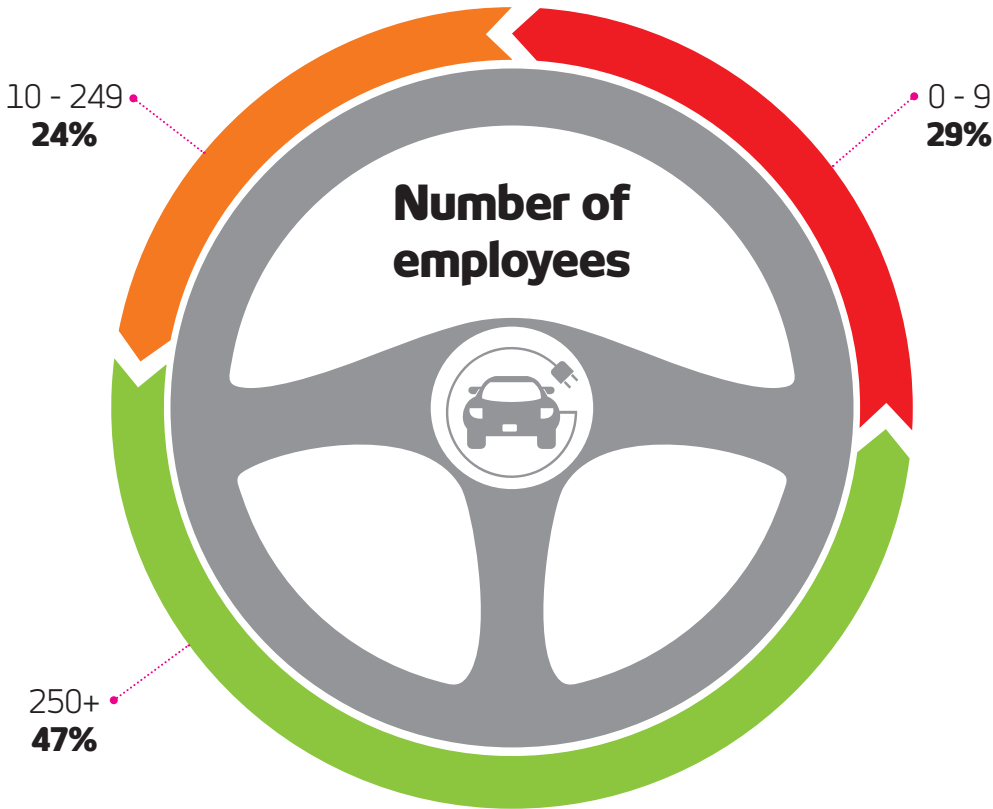
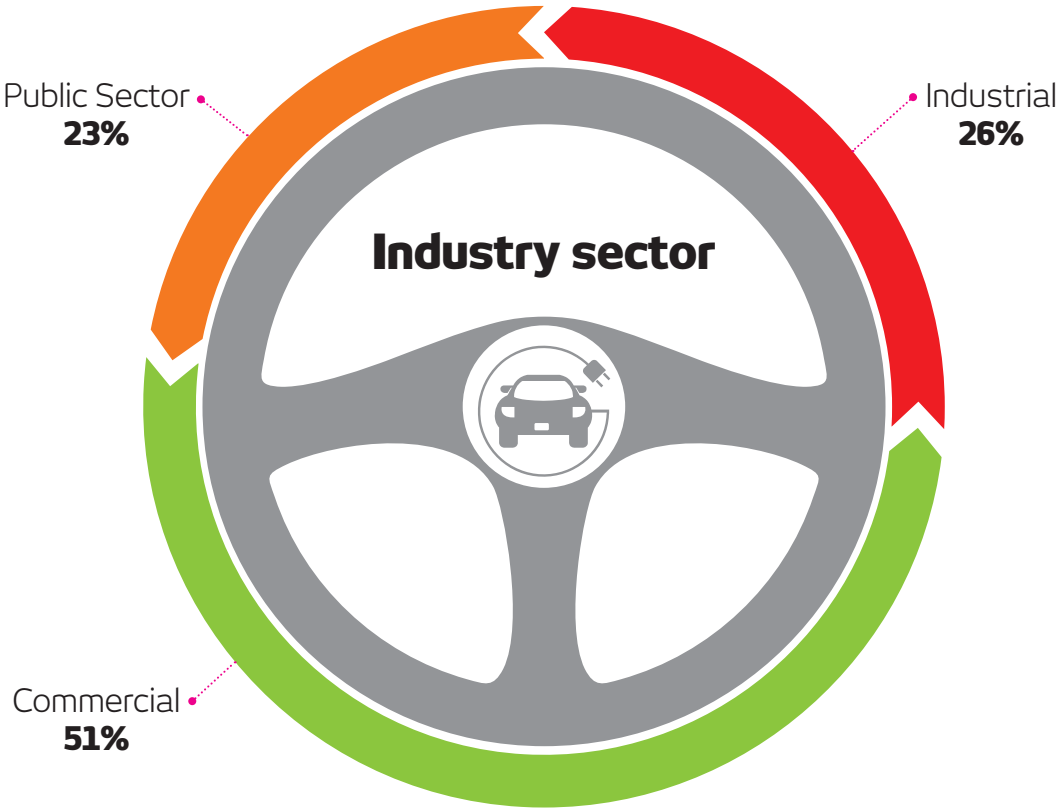
Thanks to sponsors Arup, EDF Energy, E.ON and Total Gas & Power and all of the businesses that shared their views for this report.

Brendan Coyne
Contributing editor – *The Energyst*

About the survey

The survey was conducted online from January to March, and also emailed to *The Energyst*’s subscribers, gaining around 190 responses. We removed insufficiently complete responses and based the survey on 140 responses, though not all respondents answered every question. Answers for most questions are based on 101-104 responses.

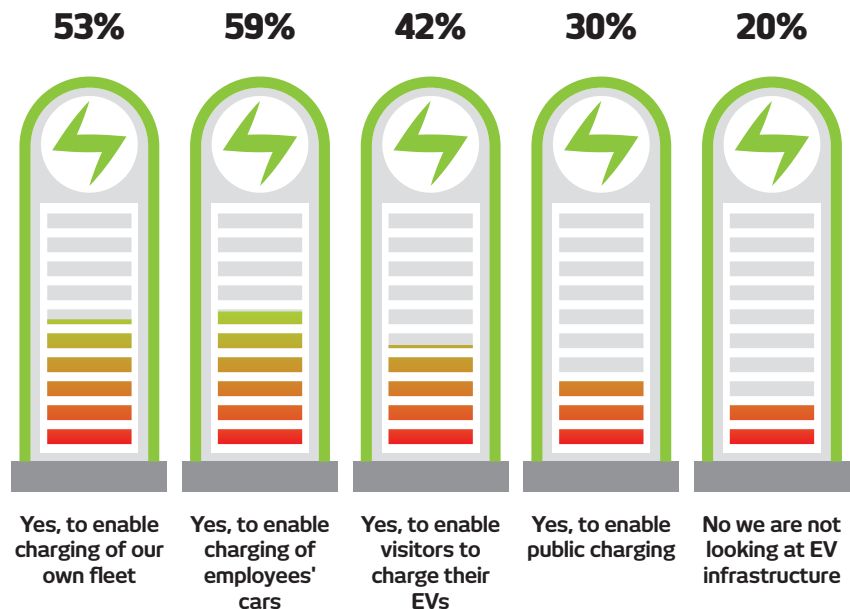
Survey respondents' demographic breakdown



Is your organisation considering installing EV infrastructure?

Respondents are considering charging for a range of reasons.

Answers were multiple choice and many respondents are considering installing chargers for a combination of fleet, employees and visitors.

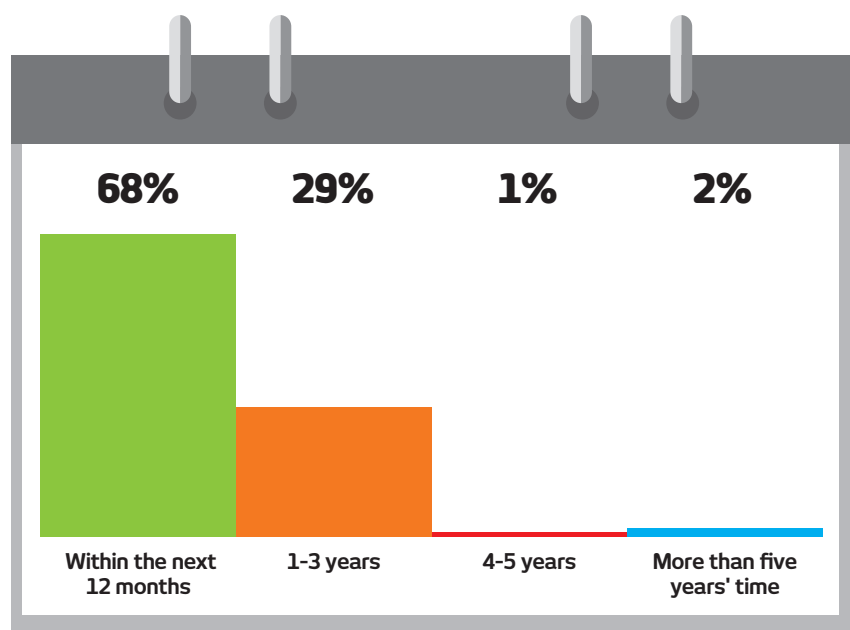


If you are considering deploying EV infrastructure, when do you plan to start installing it?

Virtually all those planning to install charging infrastructure plan to do so within three years, most within 12 months.

Of those planning to install within 12 months:

- 67% are large companies
- Seven in ten plan to install charging for employees and/or fleet use
- 44% plan to install fewer than 10 chargers
- 26% say they will need more capacity
- The majority (72%) of those that require more capacity are planning at least 20 chargers.



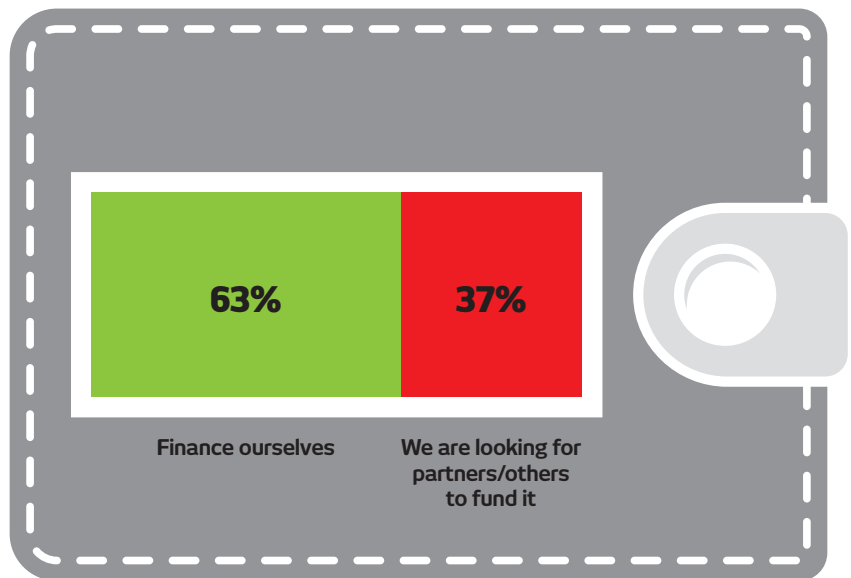
How do you think you will fund the infrastructure?

Of those planning to fund infrastructure themselves:

- 19% are in the public sector
- 60% plan 1-9 chargers
- 75% are installing to charge employees cars

Of those looking for partners to fund infrastructure:

- 43% are public sector
- 41% are commercial sector
- 70% plan to install at least 10 chargers
- local authorities made up the largest proportion of those seeking funding.

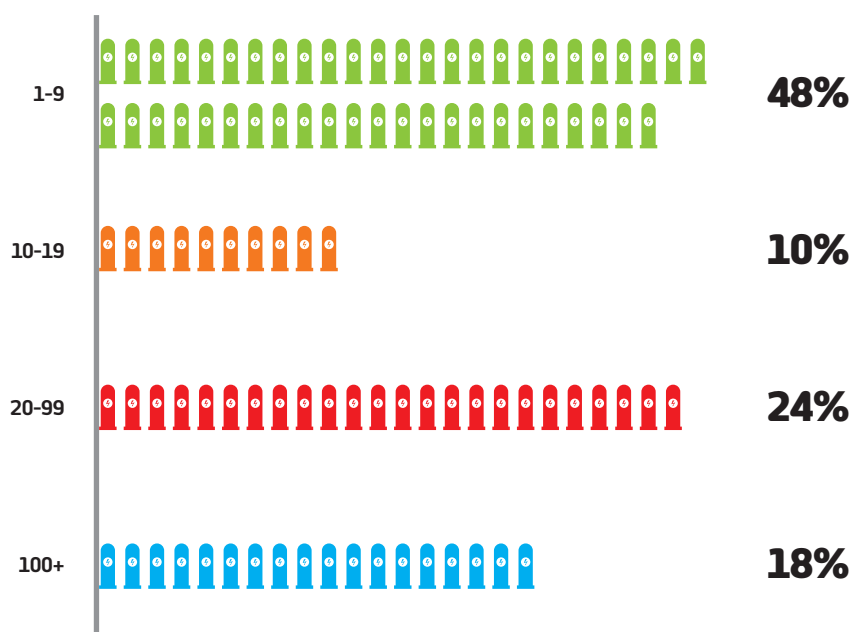


How many charging points in total are you considering?

Those putting in more than 100 chargers include water companies, NHS bodies, banks and a telco. But the majority are energy developers or service providers, so are not end-users per se.

Those putting in 20+ chargers are more representative, and include a number of local authorities and other public bodies, universities, steel and timber companies, property management companies, a leisure operator and a water company.

Those putting in 1-19 chargers reflect the full sample - public sector, education, commercial and industrial companies.

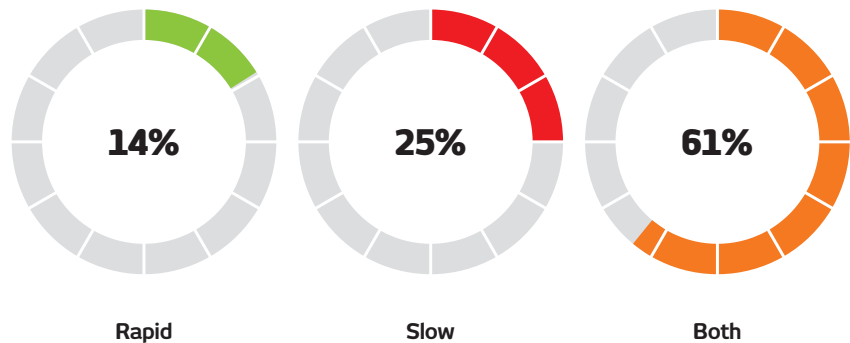


Are you considering rapid or slow chargers?

Most respondents are considering both rapid and slow chargers.

Those installing rapid chargers include local authorities, automotive, media, a builder's merchants, a housebuilder and a university, as well as some consultants.

92% of those installing slow chargers will fund them internally; 88% plan to install 1-9 chargers and 84% have considered capacity requirements and found it sufficient.

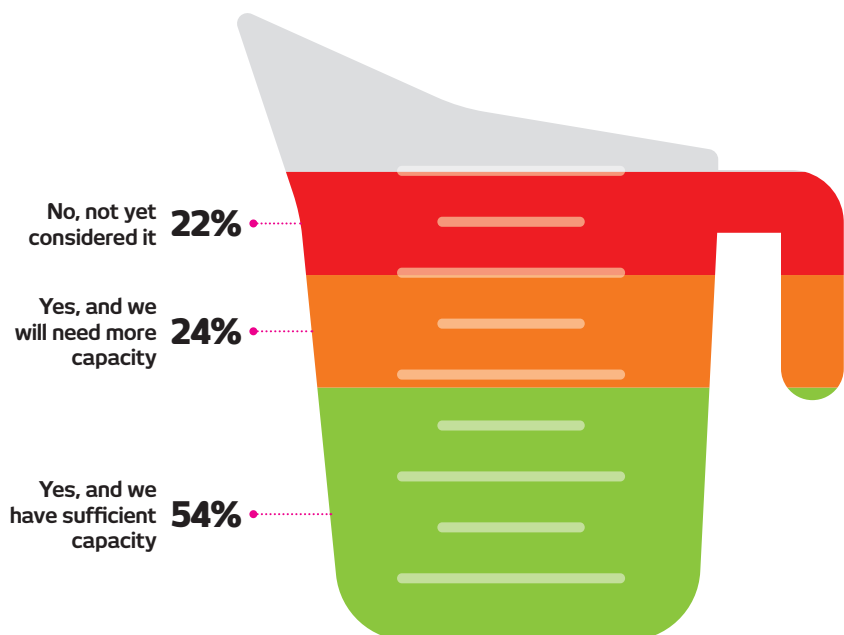


Have you considered the impact of EV infrastructure on your site's network capacity?

Almost seven in ten (68%) of those that have considered capacity and have enough were large organisations and are planning to install chargers within the next 12 months. Almost six in ten of those respondents (57%) also have some form of onsite generation.

Of those that need more capacity, almost eight in ten (78%) are installing both rapid and slower chargers.

Of those that have not yet considered capacity, only 43% intend to install chargers in the next 12 months.

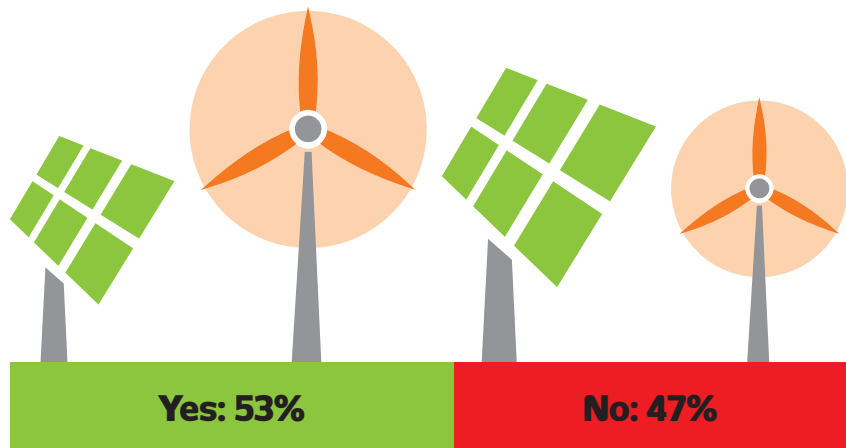


Do you have onsite generation?

Roughly half of organisations surveyed have some form of onsite generation. 49 respondents specified technology type.

Unsurprisingly, solar was by far the most popular (40 respondents).

Eight of those surveyed have some form of CHP, four have wind generation, two have hydro, two have back-up generators and one, a city council, has an energy from waste facility.



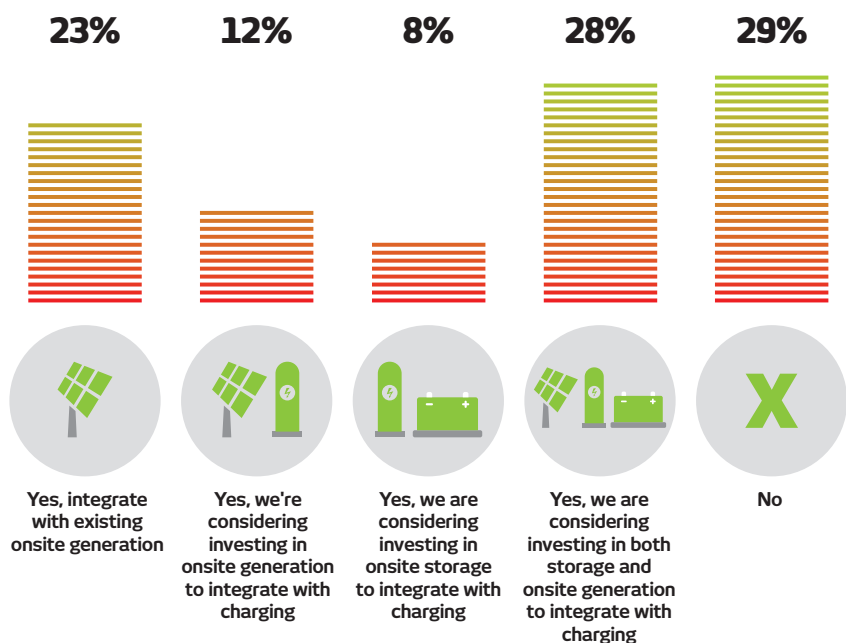
Would you use EV infrastructure in conjunction with onsite storage/generation?

While 53% of respondents have onsite generation, only 23% of the sample plan to integrate it with EV infrastructure.

There could be many reasons for that disparity, not least that companies need to get to grips with a new technology without complicating the picture.

However, it is significant that only three in ten organisations surveyed would not consider using generation or storage as part of an EV solution.

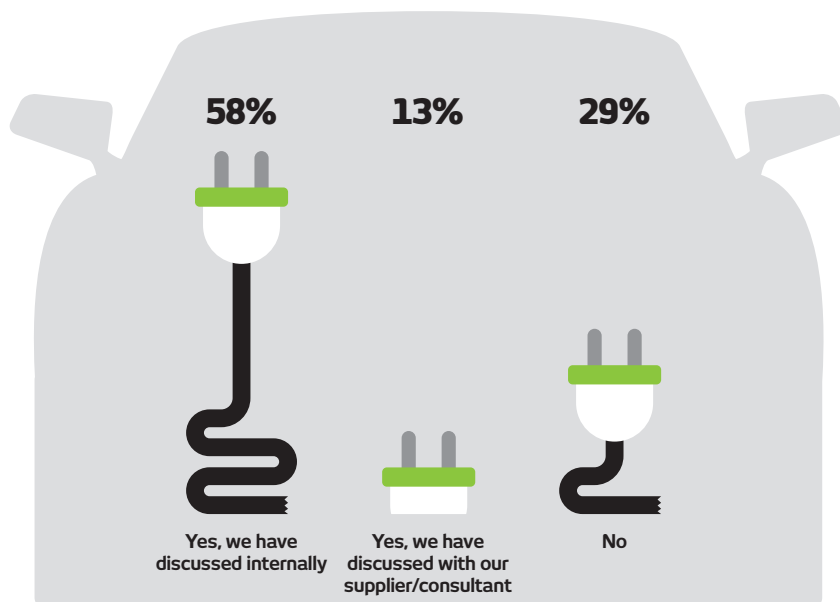
That suggests consumer appetite for an integrated approach.



Have you considered the impact of EVs on your energy strategy/consumption/contract?

Most people have discussed energy impacts, but at face value it appears engagement with suppliers or consultants is low. Those that have engaged with energy suppliers/consultants include councils, industrials and water companies. 85% of them are considering installing chargers within 12 months with 62% seeking a funded option.

Of those that have not discussed energy impacts, 50% are considering installing chargers within 12 months and 48% seek a funded option.

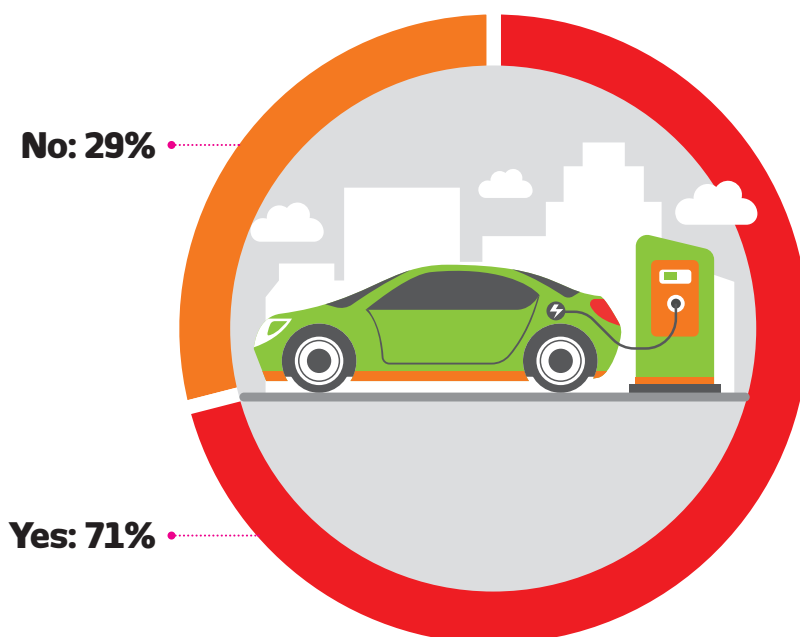


Will your EV infrastructure be controlled to limit costs/grid constraints (e.g. smart charging)?

Most respondents say their charging will be controlled.

Of those that say they will not install controlled, or 'smart', chargers:

- 86% will fund the infrastructure themselves
- 61% aim to deploy 1-9 chargers
- 71% aim to deploy within 12 months
- 61% have sufficient capacity
- 25% have not considered whether they have sufficient capacity
- 14% say they will need more capacity

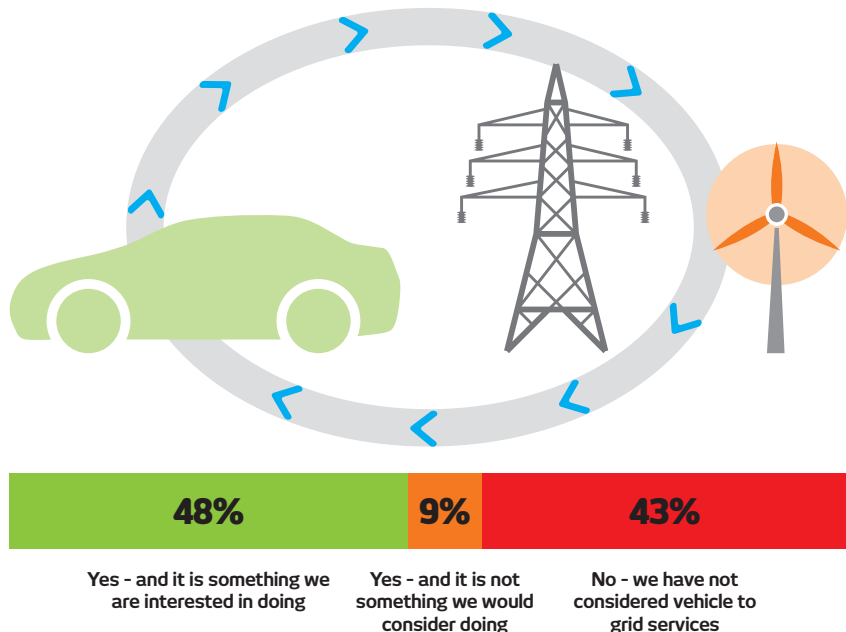


Have you considered using EV infrastructure to provide grid balancing services (vehicle-to-grid services)

Around half of those surveyed are interested in providing vehicle to grid services. That provides encouragement to those trying to commercialise V2G.

Around six in ten of those interested in providing V2G were large organisations (58%) and 19% were SMEs, suggesting there is a market for companies that can deliver compelling commercial propositions.

Large organisations interested in V2G included numerous local authorities, universities, health trusts, water companies, plus some industrials.



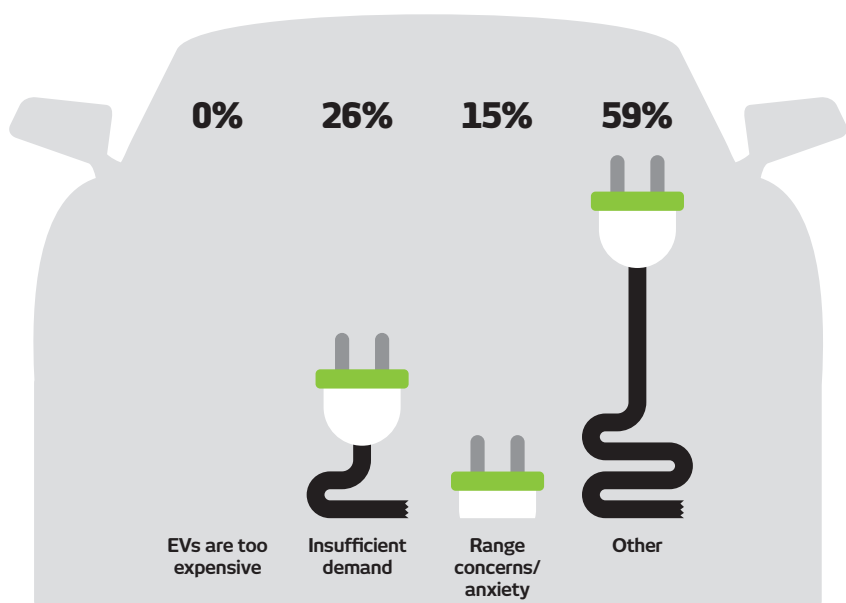
Why is your organisation not looking at EVs/EV infrastructure?

We assumed cost, range anxiety and insufficient demand would be the main reasons organisations are not considering EVs or charging infrastructure.

However, some respondents actually cited these reasons in the 'other' section.

Leased premises were the most cited 'other' reason, followed by location and parking issues, and a few respondents that have already installed chargers.

One respondent cited capacity cost issues, another suggested "fuel cells will render EVs obsolete when their costs are under control".



What incentives/policies might help your organisation to install EV infrastructure?

"The government already subsidises the actual charging units. However the largest cost of installation will most likely be the upgrading of electrical infrastructure to provide an appropriate amount of chargers for the organisation. Often this cost is completely out of the companies control. Some form of cost incentive built around electrical infrastructure could significantly improve cost prohibitive installs." – Clean energy developer

"More affordable rapid charging points, reduction in the capital cost of electric vehicles, wider choice of affordable leasing contracts funding for infrastructure/installations." – University energy manager

"We manage housing estates mainly, so it would be to help our residents charge their cars at home when they don't have their own drive. So a business model which enables this without us having to subsidise it would be very attractive." – Energy manager, charitable housing association

"Tax incentives for electricity discharged to public fleets." – University energy manager

"The trust leases its fleet vehicles and whilst the cost difference is now becoming more attractive, increased government support would encourage a quicker take up." – Head of corporate services, NHS foundation trust

"Higher fuel taxes; better tax breaks. Solar PV/EV incentives." – Community energy co-operative

"A worthwhile grant system." – Head of facilities & engineering, food and drink research group

"A grant for rural EV charging infrastructure." – Council energy projects officer

"Volume bulk supply of vehicles at a preferential rate." – FM company environmental energy manager

"Having an open protocol for charging points so fleet users don't have to have a number of cards/apps etc. to charge at different stations." – Water company energy advisor

"VAT refund on the installation and capital costs." – Director, decorator's merchant chain

"More rapid points available and legislation around minimum range of EVs." – Energy surveyor, property management company



Making the numbers stack up

EVs are going to hit the UK in big numbers. The question is when and how should businesses prepare?

National Grid envisages up to 11 million EVs on UK roads in around ten years' time. In 20 years carmakers will not be allowed to sell petrol and diesel vehicles. National and local clean air strategies may expedite change.

Recognising the challenge, carmakers are scrambling to pivot their businesses – and not just their powertrains: Some have entered the energy sector and more will likely follow.

But to redesign their operations takes time and a lot of money. For now, electric vehicles and charging infrastructure appears the chicken and egg of our times. Without the charging infrastructure, range anxiety persists, dampening uptake. Without the vehicles, infrastructure investors fear demand risk.

Ultimately, car manufacturers have to ramp up volumes to crack that conundrum. But businesses and local authorities can play an enabling role – and those surveyed by *The Energyst* display significant appetite. So should they consider?

DE-SILO

Start with a cross-company consultation that defines current requirements, a scalable roadmap and delivers benefits for all parties, suggests Matthew Trevaskis, founder of consultancy Ecodrive and



former head of electric vehicles at the Renewable Energy Association.

For businesses with fleets, those responsible for procurement, fleet management and FM must work more closely, he says. "The earlier that integration happens, the better the outcome tends to be."

Scalability is another key factor, says Trevaskis, advising businesses to determine their grid capacity, infrastructure requirements and charging profile today and consider how that may change in future.

GRID CAPACITY

EVs will add to grid demand and distribution network constraints. Grid connections are already ruling out about one in four sites, according to Engenie, which is undertaking a national charging rollout for pubco Marston's (see p20).

James Turner, head of propositions at Total Gas & Power, advises businesses that it will "really speed the process if you have a firm view of capacity, whether there is any scope to increase it, and what your actual charging needs are."

Distribution network operators (DNOs) say they recognise the need to provide better visibility of connections and capacity.

Northern Powergrid will this year rollout a mapping tool that shows

where businesses and councils can install chargers with or without reinforcement and associated costs.

DNOs such as Western Power Distribution have published costs and lead times for different types of chargers and reinforcement works. WPD said it plans to offer alternative connections where businesses can charge at certain times and avoid exceeding available local capacity (see p24).

UK Power Networks is also taking that approach and is working with fleet companies such as UPS to create smart charging solutions combined with behind-the-meter storage to avoid significant capacity upgrade costs (see p22).

While some businesses interviewed suggest it is too early to consider bundling integrated solutions around EVs and on-site generation, around seven in ten organisations surveyed for this report said they are at least open to that approach.

SMART CHARGING AND V2G

While a UK standard has yet to be defined, a smart charging approach will maximise use of existing capacity and infrastructure. That can be as simple as a timed connection to ensure EVs are charged out of peak periods, through to responding to dynamic price signals.

Ultimately, smart charging could develop into vehicle-to-building or vehicle-to-grid services, where EVs could be used to shift site load out of peak periods, or aggregated into virtual power plants.

Companies such as EDF Energy and Nissan are bullish on the prospects for V2G (see p28 and p30), while Pod Point CEO Erik Fairbairn also thinks it is "on the cusp" of commercial viability in certain applications.

Others believe it may be many years before vehicle-to-grid becomes mainstream, if ever. In the meantime, "lets not lose sight of the value of smart charging in the race to V2G", urges Ecodrive's Matthew Trevaskis.

VEHICLE SHORTAGES

Chargepoints, smart charging and vehicle-to-grid risk redundancy without greater numbers of EVs. According to the Society of Motor Manufacturers & Traders, 'pure' electric vehicle sales have not yet exceeded 1,600 in a single month, with 15,500 sold in 2018. Around 45,000 plug-in hybrids were registered in the UK in 2018.

That presents a challenge to institutional investors. Their capital will ultimately be necessary to fund charging infrastructure at the scale required, but they will only see return on investment when chargers are highly utilised (see p21). It also poses a problem for businesses that want to buy EVs now.

Fleet operators in particular are struggling to secure supply. Mitie has committed to switch 20 per cent of its cars and small vans to EVs by 2020, equating to around 717 vehicles (see p14). Fleet and procurement director, Simon King, says visibility is poor.

"We are used to buying 1,500 vehicles a year and having a fairly robust supply chain," he says. "My biggest ask of car and van manufacturers is: meet with us, commit to supply and provide visibility on what they can deliver through to the end of 2020."

Leasing companies could also be more proactive, said many of those interviewed.

COLLECT DATA NOW

Equally, businesses could better prepare. Those considering EVs, particularly fleet operators, should

Better public planning

National and local governments have a key roll to play in enabling a decarbonised transport system. But a joined up approach to clean air zones and charging infrastructure is essential for businesses to operate without being hit by EV costs on one hand and fines on the other.

"You have to consider the size of the clean air zone and how it is implemented," says Claire Thompson-Sage, sustainable development co-ordinator at UPS, with certain cities planning blanket implementation, and others zonal approaches.

Zonal clean air rollouts mean hybrids can use diesel range extenders to recharge batteries. But some cities plan to make the whole area a clean air zone. "That means there is no opportunity to recharge [via the diesel range extender]. So in Leeds, for example, we will have to opt for Euro 6 diesels as opposed to hybrids."

Colin Herron, MD at Zero Carbon Futures, says both local authorities and central government would benefit from taking a more considered approach, given the number of EVs on the road. He is sceptical that carmakers will direct volumes of pure electric cars and vans to the UK any time soon.

He says the number of plug-in vehicles on the road, mainly hybrids, equates to very few overall per local authority. "Don't panic, is what we tell local councils."

He urges better co-ordination to avoid wasting money.

"Some cities have got 20-30 rapid chargers, whereas some have three or four. So in some places you need more chargers and in other areas they are hardly ever used."

Herron's advice to councils seeking to improve air quality is succinct: "Ditch diesel taxis in city centres and sort the buses out first – you can buy them now."



Grants, funding, tax

Pod Point's website neatly summarises EV incentives available to businesses, including:

- The Workplace Charging Scheme: A grant of £500 per chargepoint for staff use, up to a maximum of £10,000, provided by the government Office for Low Emissions Vehicles (Olev).
- Benefit in Kind Tax (or company car tax): As of 1 April 2020, the company car tax rate for EVs drops to as low as 2%. Pod Point says this will likely trigger a surge in demand.
- The company's head of insights, James Mckemey, suggests that fuel duty, which contributes about 4% and £30bn of UK tax revenues, may ultimately become 'road pricing' under a pay-per-mile system. At 2014/15 rates, he thinks that would equate to a tax of around 8p/mile.

make data their start point, suggests Teodora Spasova, Associate, Business & Investor Advisory at Arup.

"We have met quite a few fleet owners and generally, they lack good visibility on vehicle usage. When they put telematics on their fleets they have been surprised by the results, but that is the first step," she says. "In order to provide the best solution, you need to know your travel patterns in detail."

Filippo Gaddo, director, Economics and Regulation at Arup, says the same applies to energy companies, many of whom are switching their own large fleets to EVs.

"They need to do better data

analysis – both usage data and location data, considering where best to put the chargers."



The big switch

Mitie has ambitious plans to convert its fleet to EVs. But getting hold of the vehicles is no mean feat

Mitie plans to switch 20 per cent of its cars and small vans to EVs by 2020. That's around 717 vehicles, says fleet and procurement director, Simon King.

"It's very important to focus on the fleet, because it makes up 93 per cent of Mitie's carbon footprint," says King. "That initial tranche of EVs will save over 4,000 tonnes of CO₂ per annum – about the same as planting 200,000 trees."

Switching 700 vehicles is ambitious. King sweated on his presentation to CEO Phil Bentley, but says he needn't have worried.

"Selling sustainability ideas into a business can be something of a challenge. I spent the weekend preparing a great presentation, but Phil said 'you don't need to persuade me, it's a great idea'."

ROADBLOCKS

King believes issues of cost and range "have largely been addressed", at least for small vans and cars, and that Mitie can make the switch cost neutral with upfront cost mitigated by fuel savings.

The roadblocks that remain, says King, are charging points and driver behavior.

"Zap-Map shows about 19,000 plug-in sockets in the UK, so we need to have the right charging points in place." These will be installed at employees' homes as well as Mitie



offices and the company is also approaching customers with a view to installing them at suitable sites.

"We will be deploying 800 chargers by the end of 2020," says King. "That's about the same amount as have been installed in the UK in the last three months."

DRIVER BEHAVIOUR

King says battery-powered cars require a shift in driver behaviour – topping up batteries regularly instead of filling up when the fuel light flickers.

The company is developing learning programmes for drivers to support safety and charging behaviour, but King thinks Mitie drivers have appetite for disruption. To gauge staff receptiveness, the firm emailed a survey to 1,200 drivers for whom an EV may be suitable. "Within three days we had over 500 responses, which shows a real willingness from employees," says King.

VEHICLES

Vehicle supply is a challenge. "My biggest ask of car and van

manufacturers is: meet with us, commit to supply and provide visibility on what they can deliver through to the end of 2020," says King. "We need partnerships and commitments."

With hindsight, he says Mitie would have engaged manufacturers even earlier to secure guarantees.

"We are used to buying 1,500 vehicles a year and having a fairly robust supply chain," says King. "Buying smaller numbers with different suppliers presents a different challenge. But vehicles ultimately spread to the wider market through fleets via the secondary market – so engaging will help us all do the right thing by the planet."

With current visibility, Mitie is attempting to match the rollout of chargers with incoming vehicles.

"There is an element of chicken and egg, but we are trying to address both parts. With our experience of managing professional services, we think we are ideally suited to manage that piece of work," says King.

Applying the insight from the project will also provide a commercial



advantage as Mitie starts to manage EV rollouts for customers.

BILLING AND BENEFITS

Working out how to recompense employees is not straightforward, says King.

"Electricity is not classed as fuel in the same way that diesel and petrol is, so there are some unique challenges in terms of recompense – and we know some other large fleets are struggling in exactly the same way."

Mitie will use technology to track how much electricity each EV uses to ensure employees with home chargers are fairly reimbursed. "But it is one of the biggest challenges," admits King.

"I believe we have a workable

solution, but I would like to see a situation where companies can pay directly for electricity being used at employees homes to charge EVs."

He says "utopia" would be a corporate renewable power contract that could extend to employee's home charging use, with all billing direct to Mitie. While "the regulation is not quite there" to support such an approach, Mitie is "interested in speaking with people that can support that aim", says King.

CHARGERS AND CAPACITY

Mitie aims to deploy 7.2kW chargers at homes and workplaces – which will be smart where possible, says King. At sites where a large number of chargers will be installed, they will be

"linked together to do load balancing", avoiding the cost of additional capacity, says King.

Mitie is also open to collaboration with other large fleets to access semi-public and rapid chargers, which will become increasingly useful as Mitie looks beyond small vans and cars.

However, that may take some time to eventuate.

"We have lots of transit sized vehicles, but [electric versions] are just not available," says King. The low volumes that are available don't cut it.

"Paying a high price for a 45-mile range in winter is not commercially viable," he says.

"If you know a manufacturer with a solution, give them my mobile number."

Testing the water

SES Water has decarbonised its power consumption, the next challenge is its transport emissions

SES Water is trialling 10 Nissan e-NV200 vans, installing chargers at its head office and at a treatment works. The aim is to prove that EVs can be cost competitive with diesels and plot a route to broader deployment.

The company will lease the vehicles, while Drax Group, parent company of SES's renewable energy supplier Haven Power, will provide a package that includes the cost of electricity for charging, telematics and usage data. Drax also helped with choosing the right charging infrastructure for the two sites and will provide maintenance and support services going forward.

Energy & Carbon Manager, Henrietta Stock, hopes the five-year trial will inform a broader rollout plan, by which time there should be a wider range of vehicles to meet more of SES Water's use cases. At that point, the company, which harnesses both onsite generation and load to sell flexibility services to the grid, may also look at integrating EVs with its energy assets.

"We're not looking at vehicle to grid (V2G) just yet, but it is something we have our eye on.

The data from the trial will lay the foundation to do V2G in the future."

For now, she says the company is concentrating on the basics, part of which is process.

"We switched to 100 per cent renewable electricity supply last June, which reduced our carbon emissions significantly. The major remaining aspect is emissions from vehicle fuel – so that comes under my energy and carbon remit. But we manage our vehicle fleet separately, so we need to ensure collaboration between departments," says Stock.

"I think that is a challenge businesses face – the vehicle fleet is not seen as an energy asset, despite the fact that we report on CO₂ emissions."

There are other housekeeping aspects to manage, such as working out the billing and benefits for employees that charge their cars at work. "I don't think companies are on top of that yet," says Stock. "Even without company charging points there can be challenges in charging for mileage in an EV."

Then there's the general aspect of helping staff become more comfortable with EVs.



"Quite a lot of people are unsure about electric vehicles – will there be charging spaces when we need them, range anxiety – minor concerns can easily become issues in a work environment so they need to be managed."

Stock says Drax has provided support in managing those challenges, but thinks other stakeholders could be more proactive.

"There could be more of a push from vehicle manufacturers and leasing companies," she says. "Demonstrating that EVs are cost competitive is really important and needs their input."

Put yourself in the driving seat

E.ON will switch its fleet to EVs by 2030. Its experience should drive smarter results for businesses

Whether rolling out a handful of EVs or hundreds, the golden rule is to put yourself in the driving seat – quite literally, says Hannah Collishaw, director of E.ON Drive.

"Our focus has been to follow the driver and fully understand their behaviour and needs. If you understand what they experience, you develop better solutions," says Collishaw. "We consider everything from the driver's perspective."

That maxim applies both to domestic drivers and business users. For the latter, particularly fleets, Collishaw believes a "virtual test drive" is the best place to start.

"Understand the nature of the journeys, where and when people will be charging," she advises. "That helps to select the right vehicles and charging infrastructure – and the best places to put it."

THINK AHEAD

A roadmap that considers EVs' future impact on energy consumption is also essential, given distribution network constraints.

"If you have a lot of vehicles, chargepoints can utilise a lot of power. A site's capacity – how much electricity it is allowed to draw from the distribution network – can be quite a big consideration," says Collishaw. "So it's important to think about how you implement EVs as part of a broader energy strategy."

Anecdotally, Collishaw says capacity is constrained at around one in three sites. Where reinforcement is required, "costs can be significant, upwards of £100,000, but that is rare", she says. "They are typically much lower, perhaps £15,000."

SMART CHARGING

Smart charging can negate the need for network upgrades. This can take two forms; dynamic load management, where the available

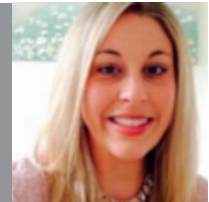
Accelerating the rate of change

The shift to EVs is inevitable – as evidenced by car manufacturers pivoting their businesses. But Collishaw thinks government could speed the transition and help ensure more vehicles are shipped to the UK than elsewhere.

Bringing forward government's 2040 target to ban sales of petrol and diesel vehicles nearer to 2030 would be a good start, suggests Collishaw.

Benefit-in-kind changes coming into force next year will make EVs more financially attractive and should boost uptake, though Collishaw urges government not to ditch current fiscal incentives.

"Anything that helps organisations to digest upfront costs has a direct effect on the car manufacturers," she says. "At the moment, supply and demand is definitely a challenge – and we see that in our own EV rollout. You don't really want to wait 11 months for vehicles to arrive if you want to change your fleet today."



capacity is intelligently shared between a number of vehicles, and load shifting.

"Load shifting ensures best fit with the site's energy usage; matching the ebb and flow of energy use throughout the day to optimise how and when the chargers are used," says Collishaw. She believes smart charging will be "massively important" as the UK continues to decarbonise, and more drivers switch to EVs.

For example, on sunny, windy days there may be too much power on the system at midday. Charging during that period could benefit both for the power system and EV owners, especially when time-of-use tariffs become mainstream, says Collishaw. As such, it is "critical to incorporate a smart approach to charging".

ONSITE GENERATION

There's debate around public acceptance of controlled charging, but Collishaw says businesses are "highly engaged and very open to the conversation."

Larger organisations may also have onsite generation, which can be integrated with charging.

Or they may consider investing in generation as part of an overall solution, "particularly businesses with their own fleet, or those with a sustainability agenda", adds Collishaw. "And when people are engaged it becomes a point of interest to build around."

FUTURE PROOF

E.ON typically installs 22kW 'fast' chargers at business sites, which are capable of fully charging vehicles in a couple of hours.

At present, the most common EV, Nissan's Leaf, charges at 6.6kW (unless connected through a 50kW rapid charger). It will therefore charge at the same rate on a 22kW charger as a 7kW charger (six hours). However, Collishaw says that by installing 22kW chargepoints, businesses are future-proofing: They can charge more vehicles today using less infrastructure, while preparing for broader uptake and range of vehicles that can take higher rates of charge.

"A 7kW charger may be cheaper, but may not be the best overall solution," she says. "Our aim is always to strike that balance between current and future needs."

Understand constraints and requirements

Total's James Turner says businesses that plan ahead for EV uptake will save cost and effort in the long run

When it comes to installing charging points, site capacity is king, says James Turner, head of propositions at Total Gas & Power.

"There's a lot of interest in rapid chargers, 50kW or even 100kW, but if they are going to take out site capacity, they are probably not the right solution – and if you have a fleet that sits there overnight, you won't require them," says Turner.

"It will really speed up the process if you have a firm view of capacity, whether there is any scope to increase it, and what your actual charging needs are."

While increasing site capacity can significantly increase upfront costs, businesses need to forward plan," says Turner. He says suppliers can be proactive in helping them mitigate risk within contract structures.

FORWARD PLANNING

To date, Total's chargepoint activity has focused largely on workplace and mid-sized retail schemes. He says a recurring client concern is obsolescence.

"They might be spending £100,000, but they don't yet know how the cars and chargers will evolve. So the models that may start to gain traction are schemes where the provider will replace the chargepoints after 5-10 years as part of the agreement."



For similar reasons, he thinks it wise to spend slightly more on initial installation.

"Businesses might only be installing five chargers today, but you want to avoid digging up the ground every time you expand," says Turner. "Putting in electrical infrastructure that can cope with expansions first time around means that in future you only need to add charge points, rather than paying again for ground works."

Turner says most clients are receptive to that approach, "with the caveat that the overall costs often come as a bit of a shock due to the cost of installation".

PAYMENT MODELS

There are ways of avoiding upfront costs and Turner advises careful consideration of various payment and operating models.

"Under one model, the customer buys and owns the hardware, effectively becoming the chargepoint operator. That provides the ability to charge what you like and have overall control," he explains.

"There are other models where a third party becomes the network operator, which might suit local authorities or businesses that don't want the hassle of management," he says. "But, in the main, if someone manages the risk, they take the revenue."

"If you want to retain control without upfront costs you can use a finance agreement, so there are different models. But bear in mind that there can be other fees, subscriptions, software agreements, advanced warranties – some may not be immediately obvious."

ENERGY BILL ADD-ON

In rolling out EV infrastructure, Total has initially focused on its energy supply customers. Turner says a

funding option has proved popular, with the cost added to their energy bill.

"That is proving attractive because they avoid the upfront cost and retain control," he says. "Any capital investment has to go through procurement, but making it an operating expenditure via the energy contract avoids that, and you are dealing with the same people within a business for both aspects."

However, he says large fleet installations may need to sit separately and will probably require a full tender process.

SMART APPROACHES

When there are millions of EVs drawing power from the grid, there may be high demand for integrated solar-storage-chargepoint solutions. But Turner says the market is not quite there yet.

"We have looked at offers combining batteries and solar and a carport - it is a nice combined proposition - but it is a bit early," he suggests. "It adds complexity to an already complex conversation."

However, smart charging is in demand, he says, laying a foundation to integrate EVs and buildings in the future.

"People expect things to be smart – and we only offer smart charging. It provides better management and control, better data and a clearer understanding of benefits. If you installed a dumb charger, you would just see an increase on your bill with no understanding of what is going on – which is not what businesses want."

For that reason, Turner says it is vital for businesses to ensure the system they specify is configurable with any energy management system. That way, as the elements required for a flexible energy system fall into place, they can take a fully smart approach in future.

Supermarkets, forecourts and electric buses

The tipping point is coming, say charging point companies, fossil majors and would-be disruptors building charging networks.

"Within five years, EV charging will be like wifi; a hygiene factor that you have to offer or customers will be unhappy," says Erik Fairbairn, CEO & founder, Pod Point.

Supermarkets and other retail and destination sites are mobilising. Tesco has struck a deal with Pod Point and Volkswagen to install 2,400 EV charging bays across 600 stores over the next three years, the biggest UK rollout of its type to date. Some will be free-to-use 7kW units, others 50kW rapid chargers, which shoppers will pay to use.

As Tesco's competitors start to respond, Fairbairn says, "it will move the market".

"I would be unsurprised if in six month's time we see a deal of another order of magnitude. Corporates with customer car parks understand EVs are something they have to deal with now – not in a few years," says Fairbairn. "It is a megatrend."

Legal & General shares that view. It has acquired a 13 per cent stake in Pod Point – giving the firm both significant expansion capital and boosting its development pipeline: Legal & General plans to install charging points across its estate and new homes portfolio.

DRIVING PROFIT

Tom Callow, director of communications and strategy at



BP Chargemaster, agrees and says destination charging drives both footfall and spend.

"Our data shows drivers are going into those sites and spending money," he says, providing a breakdown via email:

- The majority of drivers who charged at these locations did so more than once a month, creating regular footfall
- The majority of drivers who charged at the locations - up to 84% for one type of location - spent money there
- For one type of location, more than 1 in 4 drivers were not members of the relevant loyalty scheme, suggesting they may not otherwise have visited the site
- Presence of charging points made a visit to these sites more likely for 95% of drivers.



FORECOURT MODELS

BP, which bought Chargemaster in 2018, has some 1,200 UK forecourts (300 owned and operated and over 900 owned and operated by dealers) and is commencing a rollout of 150kW superfast chargers.

"Forecourts are designed for a quick turnaround so the 150kW units fit that profile nicely," says Callow. "Rapid and ultra rapid chargers will take up an increasing proportion of our network."

Yet even with that amount of power – where cars can take such speeds – a full charge still takes around 20 minutes. That could present challenges to forecourt operators and motorists alike. But Callow thinks it may be an opportunity.

"Most people don't fill up a fuel tank from full to empty, they tend to top up with 20-30 litres. With electric cars, we will see a similar top-up culture," he says.

"An efficient EV does around 4 miles per kilowatt hour. If you can offer 100 miles of range in ten minutes, it is not that much longer than current fuel courts," suggests Callow.

"Okay, topping up the tank takes two minutes, but by the time you have queued and paid, it is not a million miles away."

Moreover, drivers do not need to attend electric cars while they are charging – so they can buy a coffee or other goods and services on offer. Callow says this is where BP's experience with retailers such as M&S will help "make all of that fit together".

BP Chargemaster will begin its 150kW forecourts rollout "as soon as possible this year", says Callow. But he stresses that 'rollout' is the operative word.

"This is not a trial, but a network rollout. Others are talking about dipping toes in the water; BP is definitely going for a swim."

POWER STRUGGLES

Securing megawatts of capacity for forecourts will be neither easy nor cheap. "The power piece will be a challenge," admits Callow. He says obtaining distribution network connections and capacity can occasionally become "like a game of battleships" with DNOs.

Everyone deploying significant numbers of chargers therefore needs to find "creative ways" of managing capacity challenges, he adds, with BP Chargemaster no exception.

What about connecting directly to the transmission network?

"That is outside my business unit," says Callow. But he does not rule it out: "It's safe to say all businesses in this area are looking at all options on the table rather than a single avenue."

TRANSMISSION PIVOT

Pivot Power is connecting 49.9MW batteries directly to the transmission system with a view to delivering grid services – and later, EV charging.

The firm hopes to work with chargepoint operators – and thinks they may ultimately come to Pivot. Chief operating officer, Matthew



Matthew Boulton

Electric buses-as-a-service

With cities establishing low emission zones, bus companies are under pressure to switch their fleets to alternative fuels. Their challenge is cost and complexity, says Daniel Saunders, investment director at Octopus Investments. The company thinks it can solve that by offering electric buses as a service.

"For bus operators firstly the buses are very expensive and secondly they have to invest in their depots, which probably means they must also invest in the local grid," he says. While depot investments can sit on balance sheets, grid upgrades do not, making an investment harder to justify to shareholders. Saunders thinks that makes a pay-per-mile approach attractive. "They stay in control and choose the buses they want to run. We package that together with the infrastructure and they pay off the investment as they use the vehicles."

Saunders agrees with Pivot's Matthew Boulton that some operators may choose to move closer to grid infrastructure than pay for upgrades.

"That is not always straightforward, but if that is what they want to do, we will support it. We are coming at this with no restrictions."



Solar+storage+EV forecourts

Gridserve has unveiled plans to build 100 Electric Forecourts. CEO Toddington Harper says Gridserve has 80 sites in various stages of planning. The aim is to build 20 forecourts within the next two years and over 100 within five – each with retail, services and restaurants – and EV showrooms or 'experience hubs'.

Where possible, the firm will deploy megawatts of solar and storage at each site – as it is doing in York and Hull via a £62m deal with Warrington Council. Construction at the first of those projects, a 34.7MWp solar farm and 27MW battery storage system at York, is now underway.

Harper says the sites will have optimised queuing systems to avoid charge rage. "You don't want to get that wrong."

There will be up to 12 super chargers "capable of 500kW per charger" as well as up to 12 spaces for fleet and commercial vehicles per site. With a "well-organised queuing system", the company's modelling suggests drivers will typically be waiting "for a few minutes, which is acceptable", Harper says.



Boulton, says its transmission-connected approach "is unblocking a problem they will face".

"It is not just about securing the 1-2MW they will need for 10-15 fast chargers, but future proofing. In five to 10 years the utilisation rates will reach a level of demand that no DNO can provide for today, because they cannot promise reserve capacity."

Boulton says the "dream" scenario would be to turn some of the 45 sites Pivot is planning into "EV flagship sites" with showrooms and rentals, alongside other retail.

He also believes Pivot's city edge sites could prove interesting to fleet operators and transport providers. Boulton thinks bus companies "could be massive" for Pivot.

Capacity constraints may lead

some transport companies to set up around the grid, rather than trying to bring the grid to their existing depots. Boulton says the company is in "very early" discussions with one bus company about that.

"Its depot is split across two leased sites without long-term commitments," says Boulton. "But I think we will find other scenarios where the depot is close to the city centre and not within reach of our city edge substation. Town real estate has considerable development value, does it make commercial sense to move further out?"

In some cases, Boulton thinks that may be the only way Pivot can provide power for depots. "We're not proposing to take a 33kV cable through a city centre," he says.

Pubs the new petrol stations?



Marston's is installing 400 rapid charges at pubs across the country under a deal with charging firm Engenie. The chain thinks the move will increase footfall at its pubs – and potentially extend opening hours.

Marston's energy manager, Andy Kershaw, wouldn't be drawn on how he managed to get the deal signed off by the board, nor financial terms of the 15-year leasing and revenue share arrangement. But he said the company hopes to capitalise on an EV "ownership boom" in the next few years.

The 50kW rapid chargers, owned and operated by Engenie, mean people can charge their cars in 30-60 minutes. "That fits well with the dwell times of a meal in a pub," said Kershaw. "It's almost a perfect match."

The pubco also has lodges at some sites and may install slower chargers for overnight guests in a bid to keep rapid chargers free for passing trade.

Engenie business development director, Patrick Sherriff, however, said that when slow and fast chargers are sited next to each other, "people always go for the fast charger." Marston's would therefore need to work on marketing and incentives to make that approach work.

But Kershaw said Marston's sees "a lot to gain from being an early adopter".

He added that the company was keen to work with Engenie because of its open model – it can charge all

types of vehicle, doesn't require any specialist kit or subscriptions, and means vehicles can be charged with 100% renewable electricity with a tap of a card.

FULL SERVICE

Customers will be charged 30p/kWh plus VAT and Marston's will take a cut. But Kershaw said the business isn't banking on "hundreds of thousands of pounds" coming in from charging revenue any time soon.

"For us, it is not about profit, it is about service. In some locations it will give us the ability to extend the trading day slightly. A traditional pub might not open until late morning. But it may now become a breakfast site, or a place to meet for coffee and cake while you charge your car," said Kershaw. "The days of being a traditional boozer are long gone."

The deal with Engenie intends to deliver 400 chargers across 200 sites, but Kershaw said Marston's, with around 1,500 pubs, may ultimately build its own network.

PUBS THE NEW FILLING STATIONS?

Engenie's Sherriff thinks pubs and other destination locations could ultimately become the new filling stations.

"There are around 8,500 [petrol stations] in the UK. They will only be able to do a tiny percentage of EV charging because of grid constraints," said Sherriff. "Marston's will be able to

attract people from that market."

GRID CONSTRAINTS

However, grid constraints are not limited to petrol stations. "Grid [capacity] is an issue," said Kershaw. Adding 50kW-plus of chargers "is like building a pub next to a pub [in terms of consumption] and that capacity is just not available in a number of parts of the country."

Given the cost of capacity, "developers want to keep headroom to a minimum," said Kershaw. That leaves very little for the pubco to work with when it acquires the building and wants to install chargers.

"The cost of getting grid capacity to site is probably the most significant part of the [EV charging infrastructure] equation," he said.

Sherriff suggested smart charging and batteries, should prices fall, may in future help address constraint issues. But despite current challenges, both he and Kershaw think faster chargers at destination sites likely have more mileage than other models.

"Many of Marston's sites are in built up areas," said Sherriff. "Half of people who own a car do not have off street parking. Where are they going to charge? Not from a 1kW lamppost."

Kershaw agrees. "As we are seeing in Scandinavia, people will change their habits and plan their journeys." Instead of driving to the petrol station, "they will go to a pub, a restaurant, a shopping centre to charge their cars".

Flexibility is key for infrastructure investors

Arup's Filippo Gaddo and Teodora Spasova say timing and demand risk are key investor challenges

Arup works with companies considering investment in EV charging. Its consultancy around EVs covers network and investor considerations as well as technical, commercial and regulatory aspects.

Filippo Gaddo, director, Economics and Regulation, suggests much of the market is at point of departure, with numerous companies working through different business models for domestic, workplace and destination charging, as well as public and highway models.

"Nobody has really cracked any of them yet," he says, "but they see the need to enter the market", with most players focusing on one or two niche models, rather than investing across the board.

Yet they all have one thing in common: timing risk.

"It is very difficult to forecast the tipping point [for EV penetration], so to maintain some flexibility in investment parameters is critical," he advises. "Solid objectives are good, but the reality is you need to be flexible. Those that have too stringent criteria won't end up investing."

PARTNERSHIPS

Gaddo points out that many of the companies now planning EV charging infrastructure are not following traditional investor model, but are developing partnerships with the supply chain.



"A partnership makes a successful business case at the moment, whether the partner is an OEM, one of the oil majors seeking to diversify, or an anchor corporate or local authority that provides some level of demand certainty. Currently, they are the types of structures that are going ahead; diversification of risk is a definite market trend."

RISK MANAGEMENT

Timing risk translates to demand risk, which is the biggest stumbling block for clients, says Gaddo. Hence many early investors and developers rushing to tie-down deals in areas that people are most likely to park and charge – such as fleet depots, supermarkets, retail parks and public car parks.

Even so, attracting the scale of investment required to decarbonise transport over the next 20 years may require some form of instrument to mitigate demand risk, suggests Teodora Spasova, associate, Business & Investor Advisory at Arup.

While she believes a fully regulated asset base model "is unnecessary for this kind of industry", there may be a requirement for "some kind of mechanism to ensure risk is not prohibitive".

Spasova thinks something akin to a cap and floor regime might work for parts of the investment – and Gaddo agrees.

"In the main, the market can handle

it, but there is a component of demand risk that might need some incentive," he suggests. "This may require involvement from the energy regulator Ofgem at some point, even if it is just to outline what they will do or not do."

SMART CHARGING

By their nature, smart charging is not suitable for faster chargers. But it "becomes more feasible and potentially necessary for slower speeds," says Spasova. She adds that while there are technical variables around smart charging, the commercial arrangements are perhaps as complex.

"How do you perform the load shift: Is it a pricing incentive; what level of control is required over the vehicle; is it the owner or the charging operator that enables the smart charging?"

Determining which bit is smart and ensuring implementation at scale will be key to unlocking smart benefits, says Spasova. That necessitates that time of use tariffs and smart meters are also in market at scale.

For that reason, Spasova believes smart charging is unlikely to become mainstream until at least 2022/23, when smart meters and half hourly settlement for all should be in place, and Ofgem's charging reforms complete. "If you are paying the same rate, why would you shift load unless you have an incentive? So other enabling mechanisms are almost pre-requisites."

While distribution network operators are keen to push smart charging and the need for flexibility, Spasova says that is a secondary issue for investor clients. They are focusing on flexibility of another kind.

"What they are most interested in is not how smart they need to make it, but when will the demand turning point come, and therefore how much flexibility do they need to build into their rollout plans?" she says.

"That is the key question."



Smart approach, practical insight

UPS outlines what it has learned from deploying electric vans in central London – and why smart charging could be key to electrifying transport

UPS first trialed electric vehicles in New York in 1930. The technology has moved on somewhat, yet in 2019, decarbonising a delivery fleet at scale remains a complex challenge with many moving parts.

In Europe, UPS revisited electric vans in 2008, with six of 12 ordered from manufacturer MODEC destined for London. But MODEC soon stopped producing them due to lack of demand. That led UPS to convert some of its diesel vehicles, sending them to Germany to be refitted.

Currently, UPS has more than 300 EVs deployed in Europe and the U.S., with 65 stationed at its Camden base. With a range of 50-60 miles a day, UPS is using the knowledge it is gaining at Camden to inform the next phases of its strategy.

INFRASTRUCTURE CHALLENGE

One of the first lessons learned was that the associated electrical infrastructure is a key challenge, says Claire Thompson-Sage, sustainable development co-ordinator at UPS.

Ensuring the site had sufficient power capacity necessitated a substantial grid upgrade – and one that came with caveats.

"Where the substation was outside of our leased area, the landlord did not want responsibility for maintaining supply if we ever moved out," explains Thompson-Sage. "So

"We had to agree that we would pay to strip it all back should that eventuate. In terms of financing, it was a tricky situation."

SMART CHARGING

Hence when seeking to further electrify the central London fleet (UPS ultimately hopes to go all electric with 170 central London vans), it sought a different approach.

Working with UK Power Networks and Cross River Partnership, via a project part-funded by OLEV, the consortium has developed a smart grid system. It uses battery storage, network monitoring and smart controls to accommodate vehicle charging at the site – which would otherwise have required an expensive grid upgrade (see box).

While the system currently uses new batteries, UPS ultimately hopes to use batteries from its current electric fleet as they approach end of life.

UPS is also exploring the option of exporting power generated from solar PV into battery storage systems at its London Gateway Facility – and while the Camden base does not have PV, UPS is "exploring that option", says Thompson-Sage.

SMART BENEFITS

At Camden, where smart charging has been in place since April 2017, it has been "hugely beneficial", says Thompson-Sage. The system interrogates battery state and charges each accordingly, giving only as much as each battery

requires. Because it is designed for full electrification of the fleet, and the site is not yet at capacity, it can charge later at night, says Thompson-Sage, when electricity is cheaper.

"So we are paying less for electricity via the smart system and it has also helped with maintenance," she explains. "If a vehicle is not charging at the rate it should be, that is a warning sign that something might not be right, such as faulty cables."

PRACTICAL CHALLENGES: MAINTENANCE

Any change of system throws up challenges. But Thompson-Sage says practical aspects should not be overlooked.

"Probably the biggest unexpected item was damage to cables," she says. "Vehicle maintenance is cheaper – but with so many vehicles charging in one depot, it was easy for loose cables to get damaged."

Thompson-Sage says UPS is now looking into wireless charging infrastructure.

"Wireless wasn't available in 2008 [when UPS first trialed electric vans at Camden]. Although it is more expensive upfront and there are some losses, there is less kit to maintain – so wireless charging could be a more cost-effective option overall."

Maintenance may also become a challenge as more companies switch to EVs.

"One thing that gets overlooked is the availability of mechanics



Sustainability goals

UPS has committed to make one in four new vehicles purchased by 2020 being an alternative fuel or advanced technology vehicle.

The company has also pledged to obtain 25 per cent of the electricity it consumes from renewable energy sources by 2025 and replace 40 per cent of all ground fuel with sources other than conventional petrol and diesel.



Smart charging: Overcoming grid constraints

UPS wanted to increase the number of EVs at its Camden base, but was limited by grid infrastructure. So it collaborated with distribution network operator UK Power Networks and consultancy Cross River Partnership on the Smart Electric Urban Logistics Project (SEUL), which commenced in April 2017 with government funding from OLEV.

The project designed and implemented a smart charging and energy storage system that takes into account variations in daily demand on the network.

Taking that approach meant UKPN could immediately add another 20 vehicles to the depot, which previously had charging capacity for a maximum of 52 vehicles. The system means it can now manage up 170 electric vehicles via its existing grid connection agreement, future proofing the site.

Taking a smart approach brings down capex. Without it, UPS would have had to increase its grid connection from 1,250kVA to 2,200kVA.

It can also reduce opex, because smart charging can take advantage of cheaper periods.

The system has the potential to provide other benefits, such as grid balancing services from the battery stack, should UPS wish to do so.

For details, see: tinyurl.com/y39eaaw3

and engineers: If there is an influx of electric vehicles to maintain, do we have the trained mechanics to service them? If there is a shortage, labour costs will increase," says Thompson-Sage. "That is a very important issue, but one that gets missed."

PRACTICAL CHALLENGE: PLANNING AHEAD

If the company is to deliver on its ambitious decarbonisation goals, it will need to expand electric or alternative-fuelled vehicles outside of London.

Planning a major logistics operation on limited range must account for many variables, says Thompson-Sage.

"Currently, a lot of the electric vans are limited to around 50 miles a day. We need to identify routes that could be undertaken by an EV, then factor

in the current power availability at each of those buildings and how many vehicles could be charged without the need for a grid upgrade," she explains.

Looking first at cities that are implementing clean air zones helps focus that activity, says Thompson-Sage, but throws further elements into the equation.

"You have to consider the size of the clean air zone and how it is implemented," she says, with certain cities planning blanket implementation, and others zonal approaches.

Zonal clean air zones means hybrids can use diesel range extenders to recharge batteries. But some cities plan to make the whole area a clean air zone. "That means there is no opportunity to recharge [via the diesel range extender]. So in Leeds, for example, we will have to

opt for Euro 6 diesels as opposed to hybrids."

Could ultra rapid chargers not solve that problem?

"Not practically. Drivers are doing up to 120 stops a day. A 20-30 minute charging stop is not really an option," says Thompson-Sage. "Plus generally, the quicker the charge, the more expensive it is. So we have to charge in our own centres."

Another potentially overlooked issue is licences and drivers. As vehicles with longer ranges and bigger batteries are developed, they increase in weight. If vans exceed 3.5 tonnes, younger drivers require category C driving licences. Thompson-Sage says that is something to bear in mind.

FINANCE

The cost of electric vans is "cost-comparable" to internal combustion vehicles over a nine-year service life, says Thompson-Sage. But she says the first year is "very capex intensive; the upfront cost is significant".

As a global corporation committed to decarbonising its fleet, UPS has the resources to manage those costs, says Thompson-Sage, but smaller companies may struggle to swallow them – especially if grid upgrades are also required.

SCALE AND SHARE

Bringing down those costs is therefore key to decarbonising transport – and the broader economy. In that sense, working through the challenges and sharing learning is something UPS hopes will bring its own rewards.

"UPS has always had a very strong sustainable ethos and wants to be a leader in industry," says Thompson-Sage. "Hence working with partners not just to provide solutions for UPS, but for the whole marketplace."

Rather than altruism, she says that approach is good business sense.

"Scale brings the cost down for everybody, which is why we aim to develop solutions with partners and bring technology to market," says Thompson-Sage.

"Our goals are not just reducing carbon emissions and increasing sustainability but improving air quality and helping to reduce congestions – because it is central to what we do."

DNOs prepare for increased demand

Distribution network operators are preparing for significant impact on their networks – and how to manage it

Western Power Distribution's new EV strategy details what its network can handle, costs of connections and upgrades – and some interesting plans to pay customers that charge their cars flexibly.

Western Power Distribution has published an electric vehicle strategy that outlines how it plans to handle increased uptake by households, businesses and local authorities.

The distribution network operator (DNO) also said it is in discussions with an airport about deploying a vehicle-to-grid system that would deliver frequency response to National Grid.

NUMBER CRUNCHING

The strategy details WPD's estimations of EV uptake. It thinks 217,000 chargers will be connected to its network by 2023 – up from around 7,000 a year ago.

The DNO indicates it has spare capacity to handle those kind of numbers in urban areas, with existing infrastructure – ground mounted transformers – able to provide a charge for customers every five days, provided charging is "optimised", or managed. However, in rural areas, which use overhead networks, "options are somewhat less".

The company plans to produce a heat map of transformer capacity,

showing where capacity is available and where constraints are likely. It said aggregators could use that map to determine where they can offer flexibility solutions, or signal directly to EV owners that they will need to pay more if they want to charge at certain times via time of use tariffs.

Either way, WPD said it would not allow domestic users to blow fuses and inconvenience other customers – and will use tools to manage demand within known limits ahead of overloads.

COSTS

The plan outlines the cost, lead times and related works required

Charge Point type and power output	Likely installation location	Specific connection requirements	Network considerations	Likely charge time for a 35kWh charge
Slow up to 3kW	Domestic	None – connects via household plug/socket	None	12 hours
Fast 3.7kW	Domestic or street side	Dedicated household circuit or on street equivalent	In some cases limited local reinforcement is required	9 hours
Fast 7kW	Domestic or street side	Dedicated household circuit or on street equivalent	Likely upgrade to service cable and local mains	5 hours
Fast 22kW	Street side or public charging location	Three phase dedicated supply point	Requirement for three phase connection and likely local mains upgrade	1.5 hours
Rapid 43kW	Public charging location	Three phase dedicated supply point	Requirement for three phase connection and likely local mains and transformer upgrade	45 minutes
Super 130kW or multiple rapid chargers	Public charging location	Supply point from dedicated transformer	In most cases a new transformer will be established	15 minutes

Charge Point type and power output	Likely installation location	Approximate connection lead-time	Network considerations	Approximate connection cost
Slow up to 3kW	Domestic	Immediate	None	None
Fast 3.7kW	Domestic or street side	Immediate in most cases	Usually none	Usually none
Fast 7kW	Domestic or street side	4 to 8 weeks	Likely upgrade to service cable and local mains	£1,000 to £3,000
Fast 22kW	Street side or public charging location	8 to 12 weeks	Streetworks and permissions	£3,500 to £12,000
Rapid 43kW	Public charging location	8 to 12 weeks	Streetworks and permissions	£3,500 to £12,000
Super 130kW or multiple rapid chargers	Public charging location	16 weeks	Streetworks, permissions and cost of land for transformer	£70,000 to £120,000

Source: WPD

to connect different types of chargers, ranging from nothing and immediately for slow (3kW) domestic chargers, to £120,000 and 16 weeks for a 130kW super charger or multiple rapid chargers.

It states that businesses with depot-based fleets seeking to install significant numbers of chargers – and that are likely to mostly charge at night when demand is low – will be offered alternative connections in order to mitigate costs and minimise required reinforcement.

For other workplaces and EV charging destinations, such as supermarkets and retail parks, WPD said it will make use of existing supply where it is capable of supporting the additional load, or charge for reinforcement works where required.

For on-street parking WPD said it may be able to deliver options through new street lighting.

FLEXIBILITY: FOR HOUSEHOLDS

As well as flagging discussions with an airport over vehicle-to-grid

potential, WPD trailed plans to create an 'active' domestic flexibility product for EV owners, "where we are able to pay directly for energy deferred under demand response demonstrated through metering".

However, it said this would likely go through suppliers or other entities who will aggregate customers and then need to show to WPD that an action has been taken to qualify for payment.

It will also create a 'passive' product, where WPD pays an annual fee to EV owners that sign up for a time of use tariff, and then uses price signals to encourage customers to shift charging away from constraint periods.

FLEXIBILITY: FOR BUSINESSES

WPD said there is potential for depots and long stay car parks to participate in flexibility programmes – less so for rapid charging destinations.

While the DNO already procures flexibility from businesses in certain postcodes, it will also launch projects

to show how flexibility could be used within EV charging to free up capacity.

It will start with simple 'alternative connections' approaches – where the business agrees to charge overnight and use capacity that is not required during that period. It will then move to 'active network management' or ANM solutions, where customers react to constraint signals. WPD said it has already implemented an ANM system at a car showroom in Lincolnshire.

WHOLE SYSTEM FLEXIBILITY

WPD's plan also hints at offering further commercial incentives to people that use local generation, storage and EV charging in ways that help the grid.

It states: "As vehicle to grid solutions and smart charging develop we have the opportunity to make use of these flexible solutions on our network. In fact, a customer who makes use of local generation, storage and EV charging could actually reduce their impact on the network and help us avoid conventional reinforcement."

Start a smarter conversation

UK Power Networks has one key message for organisations planning charging infrastructure rollouts, says Adriana Laguna, senior innovation strategy manager at the distribution network operator.

"Talk to us. Consider your long term needs, then we can work



together towards the best long term solution."

As EV chargers increasingly connect to the low voltage network, lack of visibility is a key challenge for DNOs.

"We traditionally have not monitored secondary substations - and that is a shift the industry is going through. What was a top down network is changing, all the action is taking place on the LV network," says Laguna. "And we need visibility both ways, so understanding where EVs are connecting is a good start; the better data we have today, the better we can plan."

HOW SMART IS SMART?

Deploying a smart approach to charging is necessary in areas that are likely to become constrained. "That can be anything from a simple

timed connected to active network management," says Laguna.

But one of the challenges facing industry is defining 'smart'. "What does smart charging mean, what does it require from an IT architecture perspective and how do you make it standardised," Laguna explains.

"We [the DNOs] all agree that smart charging should happen, so how do we as networks enable anyone that wants to do smart charging to do so and what do we need to have in place?"

UKPN's Smart Car innovation trial examined different smart charging models, from DNO controlled to free market approaches.

"The conclusion was the market approach was generally favoured by customers," says Laguna. "So the next phase at the project aims to

test what a market signal looks like, working with suppliers, operators and owners to see how efficient that is.”

CAPACITY UNCHAINED

For business deploying EVs, particularly those with larger fleets, a smart approach is necessary to mitigate cost. Laguna cites UPS as an exemplary case study (see p 22).

“UPS is embracing change. They approached us, we worked with them to define their minimum power requirement and how to optimise behind the meter, how to maximise the connection [capacity] that they have on site.”

The benefit goes both ways, says Laguna. “Partnering on that project and taking a different approach to connections has been very eye opening.”

Meanwhile, deploying storage and active network management at the UPS site shows what is possible.

“These are the kind of solutions customers definitely need to look at to optimise their connection,” says Laguna. “Storage is a fantastic example of technology evolving to get the most out of the network – and to put back in. Again, there is a lot of education required, and that is where we can definitely help.”

The broader challenge for businesses is that “they are not energy specialists,” says Laguna. The transition to electrification demands wider investment and “will not be easy for a lot of companies ... so partnering to develop the optimum solution is key.”

SMARTER THINKING REQUIRED

Iain Miller, head of innovation, Northern Powergrid agrees on the need to define smart charging.

“Getting government policy right,



Iain Miller



that in itself is a smart option,” he says.

Miller says intelligence is also required around price signals for smart charging, given the changing generation mix.

While there is a view that charging might best occur overnight when demand is lower from businesses and households, there is also less generation output overnight. “So it makes sense to charge vehicles during the day as well,” he says.

SIGNAL FAILURES

Should solar generation continue to grow, charging during the day might become more attractive in future, says Miller. But if EV owners react *en masse*, it could create challenges for DNOs, whose networks are built around a diversified maximum demand.

“If a signal comes through that says, ‘it’s sunny, power’s cheap, start charging’ and everyone reacts, that would be more than the system is designed for and may cause significant issues,” says Miller.

“Equally, we should not be telling people they cannot do that when wind and solar are available.”

LOCAL BALANCING

He says one solution is to consider where solar is located in the first place. From a domestic perspective, using rooftop solar is ideal, he says, because it then never needs to be exported onto the network.

Bundling EVs, solar and storage would enable a “useful, joined up” approach, from that perspective, says

Miller. It would also help enable new network models.

“We like the idea of fractal balancing or nested microgrids, essentially the same thing,” says Miller. That is, balance the house and transfer as little through the meter as possible, then incentivise balancing of the local distribution substation to minimise usage of the high voltage system, which in turn is balanced to minimise use of the extra high voltage network.

That approach theoretically could lead to “a point where you almost never call on National Grid, which totally changes the way the energy system runs,” says Miller, focusing user upwards rather than top down.

However, Miller also sees merit in laying fatter LV cables, given it adds little cost if networks are digging up the road anyway.

BETTER VISIBILITY

Meanwhile, he says it is incumbent on DNOs to direct local authorities, communities and business to the best places to install charging points.

Northern Powergrid will launch a mapping tool later this year that allows developers to input what they wish to install, and the system will show “feeder segment by feeder segment” where they can install, with or without reinforcement. Miller says in some case that can differ from one side of the road to another.

It will also give a budget quote in real time – or minutes at least – depending on location.

“That should make life easier,” says Miller.

Vehicle-to-grid: Are we nearly there yet?

Millions of EVs on the roads equates to gigawatts of potential flexibility, if it can be unlocked

In its most recent Future Energy Scenarios, National Grid predicts up to 11m EVs on UK roads by 2030, and as many as 36m by 2040.

All scenarios feature smart charging to manage peak demand. Vehicle-to-grid (V2G) services - using car batteries to balance the grid or arbitrage wholesale market prices via bi-directional chargers - will provide "useful levels of support" after 2030, said National Grid, up to 8GW by 2040 and 13GW in 2050.

All of National Grid's scenarios suggest just 2% of EVs will provide V2G services in 2030. Nevertheless, in high penetration scenarios, that represents 220,000 vehicles engaged in V2G in about 10 years' time - more than the entire volume of plug-in cars in the UK up to December 2018. Assuming a 10kW bi-directional charger, that could represent more than 2GW of system flexibility.

Carmakers such as Nissan are bullish on V2G (see p30). Energy companies are also investing: EDF Energy will rollout 4,000 V2G chargers over the next three years (see p28).

However, V2G is challenged by high costs arising from lack of scale. Competing technology standards do not help.

CHADEMO VERSUS CCS

Car manufacturers use different charging protocols. In general, European manufacturers use the Combined Charging System (CCS), which does not currently enable V2G, though the body promoting CCS, CharIN, recently said the standard will support V2G by 2025. Japanese manufacturers tend to use the CHAdeMO protocol - which does enable V2G services. China has its own standard, as does Tesla. How these standards either converge or can be made to work together may have a bearing on the uptake of V2G.

BATTERY DRAIN?

Whether batteries designed for one function can be successfully deployed for another without suffering a higher degradation is subject to debate.

Numerous studies suggest degradation is an issue. While recent research by the University of Warwick suggests V2G could potentially extend battery life, a study by the University of Hawaii found the opposite. The two researchers later collaborated to conclude that battery life could be extended - provided the algorithms had that objective.



Ultimately, they said further research is required.

Dago Cedillos, strategy and innovation lead at Open Energi, thinks the issue is overblown.

"A lot of people are concerned about battery warranties, but to put it into context, taking your whole house off the grid during peak may only need 5% of your battery. Depending on the use case, it is not much of an additional throughput," he says.

"There is definitely a way to agree on how we can operate [V2G services] without having a detrimental impact on the battery."

CONSUMER ACCEPTANCE

Around half (48%) of the public and private sector organisations surveyed for this report expressed interest in providing V2G, suggesting significant appetite.

The charging, technology and energy companies interviewed offered mixed views on whether V2G will become a mainstream proposition. Most believe it has greatest potential within fleet and b2b markets.

The consensus is that for V2G to succeed, whoever owns the customer relationship - carmakers, energy companies or aggregators - will need strong commercial propositions backed by case studies. EDF Energy thinks these will start to emerge in numbers in the UK by the end of 2019.

First building, then grid

Honda is working with UK technology company, Moixa, on smart charging and V2G services. Moixa aims to enable both vehicle-to-building services and aggregation of EV batteries into a virtual power plant.

Its first UK site is Islington Town Hall. Chief technology officer, Chris Wright, says "even five cars will be able to offset the building's baseload", and by learning from consumption and driving patterns, Moixa aims to create "optimised plans" that reduce Islington's energy bill.

Wright believes V2G "will happen when it becomes normalised and much cheaper." He thinks battery degradation is not a V2G barrier and cites the University of Warwick study that found around 10% battery life improvement is possible.

"[The study] found what is most damaging is to charge batteries to full every time," says Wright. "That is part of what we will demonstrate - that the machine learning platform considers status health when it is optimising the system."



EDF Energy: Vehicle to grid is already here

EDF Energy is rolling out V2G across its own estate to apply insight to UK fleet customers

When it comes to vehicle-to-grid services, Niall Riddell, Electric Vehicles Lead at EDF Energy, channels sci-fi author William Gibson: "The future is already here, it is just not evenly distributed yet," he says.

The company has ambitious plans for vehicle-to-grid, investing in V2G and smart charging specialist Nuvve and inking a deal to install up to 1,500 V2G chargers in the UK. This is in line with EDF Energy's intention to become the leading provider of mobility and energy services to EVs in Europe by 2022, rolling out 4,000 V2G chargers across UK, France, Italy and Belgium. Nuvve's smart charging and V2G platform will support that mission (see box).

EDF Energy will install the chargers at its own sites and at customer premises - and thinks that initial tranche will ultimately deliver 15MW of storage capacity that can be traded, with returns shared.

But with only 200,000 plug-in cars on the road, it is early days, says Riddell - and V2G is a complicated topic to throw into the mix.

"There is a high level of customer interest, but not many people with huge experience in this space. So education and information is challenge number one," says Riddell.

For now, V2G ready vehicles are also limited. However, Nissan's LEAF and eNV200 vans and the Mitsubishi Outlander PHEV are compatible today - and more vehicle manufacturers are readying V2G capable cars, he adds.

Meanwhile, bi-directional chargers - a pre-requisite to V2G - are also relatively limited, though carmakers and other OEMs are ramping up scalable technology. That will boost confidence, says Riddell, but businesses need time to adjust.

"Companies might be considering EVs - but then they have to

Making V2G plug-in and play

EDF aims to have a 30 per cent share of the UK EV charging market by 2022, with smart charging and vehicle to grid services part of that roadmap. It is backing Nuvve to help deliver the smart aspect.

Nuvve chief commercial officer, Erik van Kaathoven, says the firm has achieved a headline figure for V2G revenues of €1,860 per vehicle per annum. That number is based on average annual revenues for a 10-vehicle fleet for one of Nuvve's first customers in Europe, a Danish utility has been using V2G services since 2016.

He points out those revenues are shared, but are also derived purely from providing primary frequency response. Adding other services means returns could potentially be greater, suggests van Kaathoven.

Value is very much a case-by-case basis, he says, but it is not "vastly different" from battery storage business models.

"The difference here is that the batteries move about," he says. "My job is to make an unreliable asset reliable, through forecasting, aggregation and AI technology."

Fundamental to V2G becoming mainstream is "ensuring simplicity for the end user, so they just have to plug in whenever they return to their parking place to minimise cost and maximise use of renewables," says van Kaathoven.

"That is essentially what we do."



think about vehicles, charging infrastructure and capacity," he says. "If you throw in vehicle-to-grid, you are quite quickly having a number of complicated conversations."

These factors mean it can be perceived as "quite a challenging commercial case, but, for the right projects, there is significant value to be had," says Riddell.

"We have a healthy list of customers that are interested, so the pipeline is definitely there and we are on a journey to deliver commercial V2G projects."

V2G IN 2019

Riddell believes the sector - including energy suppliers, OEMs and charging companies - will be able to complete "a large number of installs by the end of 2019, with commercial propositions and operational assets behind them". He says EDF Energy hopes to be able to showcase "a healthy number of V2G case studies" within broadly the same timeframe.

"We have been supplying electricity for a long time, likewise energy services. EVs, smart charging and vehicle-to-grid services, are a natural step. We are very confident that we have the partners and the expertise to help customers on their journey."

While the road to vehicle-to-grid services may not be as straightforward as getting from A to B, Riddell returns to William Gibson.

"All the component pieces for V2G exist. It is not yet a mainstream, mass residential proposition in the UK; it is the start of a journey. But in that sense, the future for vehicle-to-grid is already here."

Nottingham trials EVs as storage

Nottingham City Council is gearing up to electrify its fleet and use the vehicles as form of battery storage

Nottingham City Council has launched tenders for battery storage and bi-directional chargers. The authority is one of the lead cities in a EU-funded vehicle-to-grid (V2G) trial.

It has ordered 40 new electric vehicles and plans to use them as part of an integrated system that combines vehicles, battery storage, solar PV and a smart management system. The aim is to work out how EVs, storage and on-site generation can help optimise charging, maximise use of renewable generation and help balance the grid.

Nottingham also intends to use the system to bid into ancillary services, as well as wholesale market arbitrage.

The council will site the project at its Eastcroft Depot, home to a waste transfer station. The 'CleanMobilEnergy' project, funded by Interreg, hopes to develop technology that can be replicated at scale.

GRID CHALLENGES

Nottingham is now laying the groundwork for the project

and working through technical challenges.

Katie Greenhalgh, energy projects manager at NCC's Energy Projects Team, says grid constraints are a hurdle, with "major upgrade works" required.

The site has six MPANs, she explains, which will be consolidated into a single incoming HV supply.

"While the distribution network operator (WPD) knows we are creating a smart system, they have to take a risk averse approach," says Greenhalgh. "That means we need a grid connection large enough for all of the building's consumption, all the import of the battery, all of the vehicles."

That means additional cost (some £750,000) and disruption, given the working site's electrical infrastructure will require reconfiguring. However, given the council's plans to electrify its vehicle fleet – some 240 vehicles – and that the six supplies are at capacity, it should ultimately be worth it, says Greenhalgh.

"It's complex, beyond what we saw when we signed up [to the



trial], but we like a challenge," she says.

CHARGERS

As well as bi-directional chargers, Nottingham will also install around 40 smart chargers to help manage power flows and peaks. It may also need to install "one or two" rapid chargers for vehicles such as road sweepers that require quick turnarounds for multiple shifts. As well as sweepers and cage tippers, the council even plans to trial an electric bin lorry.

"That's exciting, but it creates charging challenges," says Greenhalgh. "Ideally we could manage without [rapid chargers]... but the standalone battery means we can avoid a huge draw on the grid, which is the whole point of the project, and provide grid services where we can."

V2G

While the trial will look at how to integrate solar PV and storage into a smart EV management system, a key aspect is that the vehicles will also be used to feed energy back into the battery, the site, or the grid, says Greenhalgh.

Vans usually return to the depot at around 3-4pm, which would give plenty of time to feed back some of their remaining power. "In theory, it should work well," says Greenhalgh.

Over the next two years, the council hopes to test that theory.

A tale of four cities

The 'CleanMobilEnergy' project is trialing systems that integrate renewables, storage and electric transport in four European cities:

1. Arnhem: medium size city, large renewable energy production, large storage in industrial area;
2. Nottingham: medium size city, large renewable energy production, medium size storage, electric vehicles and bi-directional chargers in a controlled area (depot);
3. London: large city, large renewable energy production at multiple locations, large storage, electric vehicles and bi-directional chargers in controlled areas with separate grid (depot);
4. Schwäbisch Gmünd: small city, small renewable energy production, storage facilities and electric bikes in residential area.

The pilots were chosen to represent a wide range of city sizes and environments in order to develop a widely applicable system for future implementation across Europe.

Nissan: High hopes for vehicle-to-grid

Nissan sees 2019 as "a breakthrough year" for vehicle to grid services

Nissan has almost 400,000 EVs on the road worldwide, hypothetically equating to "about 4 gigawatts already connected to the grid," if all were connected via 10kW bi-directional chargers, says Eduardo Mascarell, head of energy aggregation and vehicle to grid at Nissan Europe.

At the end of 2018, Nissan had sold 28,000 EVs in the UK. In 2019 the company hopes broader EV sector growth will continue at the current rate of "50-60 per cent a year, and even higher in some countries," says Mascarell.

He hopes 2019 will also mark the turning point for V2G - and the company will launch its own designed and specified bi-directional chargers in the second quarter.

"I think 2019 has to be the breakthrough [for V2G], because we are moving from charging infrastructure that was costly to manage to something that is smaller, bi-directional and competitive in terms of cost," he said. Moreover, other infrastructure providers are coming to market. "Five or six will compete, which will reduce costs and improve service," adds Mascarell.

FREE FUEL

Mascarell told National Grid's 2017 Power Responsive conference that Nissan's trials in Denmark indicated EVs could earn around €1,300 a year if used to help balance the grid. "In countries like the UK, that are more dynamic and flexible, that could be even higher," he says.

That value does not all accrue to end users. "But it would not be very challenging to offer the customer something like free transportation - all the electricity you use for driving the car could be covered by these kind of operations," he says.

Mascarell said it is incumbent on carmakers and service providers to market propositions in those terms.

"Not to talk about kilowatts or kilowatt hours, or frequency services, because that is complex. But how to make things really easy for people to understand that the car is no longer a car, but a platform that gives you transport and energy services."

Service propositions are also not just about money, adds Mascarell.

"People are not always looking to save pennies or pounds, but to have a sensation of control: I am managing my own environment, my data, appliances and energy. These things are coming together and the EV will be a part of that."

CONSTRAINT OR SOLUTION?

Smart charging and V2G is necessary to decarbonise power and transport without having to build more infrastructure than necessary, says Mascarell.

"If we only use EVs as big, dumb washing machines with wheels, that will of course create grid constraints. But we can turn them into something that actually helps the grid. In the future you will see that we are not just talking about 'an end user', but entire districts and neighbourhoods collectively helping to balance the grid, becoming new market agents that create a sustainable solution for the whole system."

B2B OR B2C?

Both business and household markets are "really attractive" in terms of V2G potential, says Mascarell, though he thinks the former may initially scale faster.

"B2b is easier because you can access multiple EVs in one shot. Fleet managers have parking lots, space to install chargers and enough power [capacity] to include charging and discharging solutions," he said. "It is also possible for them to build an ecosystem, based on PV, batteries and EVs that can help reduce peak consumption and do other things."



SECOND LIFE BATTERIES

Second life batteries could form part of that solution, suggests Mascarell, with Nissan selling domestic and commercial battery packs made from used car batteries. Once EV batteries degrade to "about 70% state of health", Nissan recovers them, but degradation is not uniform. "Once you open up the pack you find many modules have up to 85 per cent state of health. We reuse those with enough lifetime and it is very competitive," says Mascarell.

RANGE ANXIETY

While EV sales are rising, range anxiety remains a concern - and could prove a roadblock for companies with vehicle to grid ambitions. Mascarell thinks those fears will subside as the charging infrastructure rollout gathers pace and carmakers can demonstrate that using cars to balance the grid will not drain batteries.

"Our trials prove the technology is not a challenge. The challenge is the customer proposition - and we need some time for people to learn that the technology is useful and driving patterns are okay for EVs and vehicle to grid," he says.

"People still have the same concerns, but those with range anxiety are those who have never driven an EV. We are confident we can make V2G very attractive for our customers."

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