White Paper 3

Understanding electric vehicle efficiency, charging costs and charging infrastructure

Vehicle Remarketing Association

Dr Euan McTurk
Plug Life Consulting
Vehicle Remarketing Association

January 2024

Contents

Introduction

Welcome to the third in our series of white papers on electric vehicles (EV) remarketing, this time looking at the cost of charging EVs and how different models compare when it comes to efficiency.

There is quite a lot of misinformation among car buyers on these subjects and motor retailers need to be able to clear away any misconceptions, explaining these crucial aspects of EV ownership in an easy-to-understand and transparent manner. This document should help them achieve that aim.

As ever, we'd welcome your feedback on this white paper from VRA members and others. We plan to continue this series to cover other aspects of EVs and would be pleased to hear about any ideas for subjects that we could cover in the future.

Philip Nothard

Philip Nothard
Chair
VRA

Introduction

Most motorists are aware of how much money they typically spend filling their vehicle with petrol or diesel, and how many miles they can get from a full tank or a given amount of fuel, whether measured by price or volume. Some will also know how many miles per gallon that their vehicle is delivering and, of course, all of them will know where they can go to fill up the tank again.

Switching to electric vehicles (EVs) presents motorists with a new set of numbers and filling options which at first might seem very different and unfamiliar. Vehicle remarketers have an important role to play in educating prospective customers in this area, providing information about their efficiency and charging costs, and helping them to understand the available charging options at home, at work and on the road. This will not only improve the customer's experience of EVs and increase the chances of a sale, but have a positive impact on the remarketer's reputation.

Understanding EV Efficiency

EV efficiency is almost always measured in miles per kWh – that is, the number of miles achieved per unit of electricity. As with the miles per gallon (MPG) of petrol and diesel vehicles, the achievable miles per kWh varies between different makes and models. For cars, the original Audi e-tron SUV was notorious for barely scraping above 2.0 miles per kWh in some real-life driving scenarios, while the Hyundai Ioniq (not to be confused with the newer, larger IONIQ 5) achieves in excess of 5.0 miles per kWh, resulting in its nickname, "the windknife," amongst owners. A decent average figure for miles per kWh amongst the most common makes and models of electric cars is 3.5 miles per kWh.

As with petrol and diesel fuel economy, the miles per kWh achieved from an EV is dependent on numerous factors, including ambient temperature, gradient, speed, wind resistance, and total weight of passengers and luggage. Unsurprisingly, efficiency decreases at motorway speeds and in winter conditions, but this is experienced with petrol and diesel cars too. If an EV driver wants to achieve maximum efficiency, then making full use of regenerative braking will help – by reading the road and letting the motor slow the vehicle when approaching corners and traffic lights, the electricity generated during deceleration will top up the battery and provide more range per charge. Many EVs allow the driver to adjust the level of regenerative braking, allowing them to get as much energy as possible back under braking, and some EV drivers prefer driving their vehicle in Eco Mode to further boost efficiency by reducing the harshness of the throttle.

Importantly, the idea that the range of an EV is impacted by using the lights, radio and windscreen wipers is a myth. These are low-power devices, cumulatively drawing around 100 times less power than the electric drive motor, and obtain their electricity from the vehicle's 12 volt auxiliary battery.

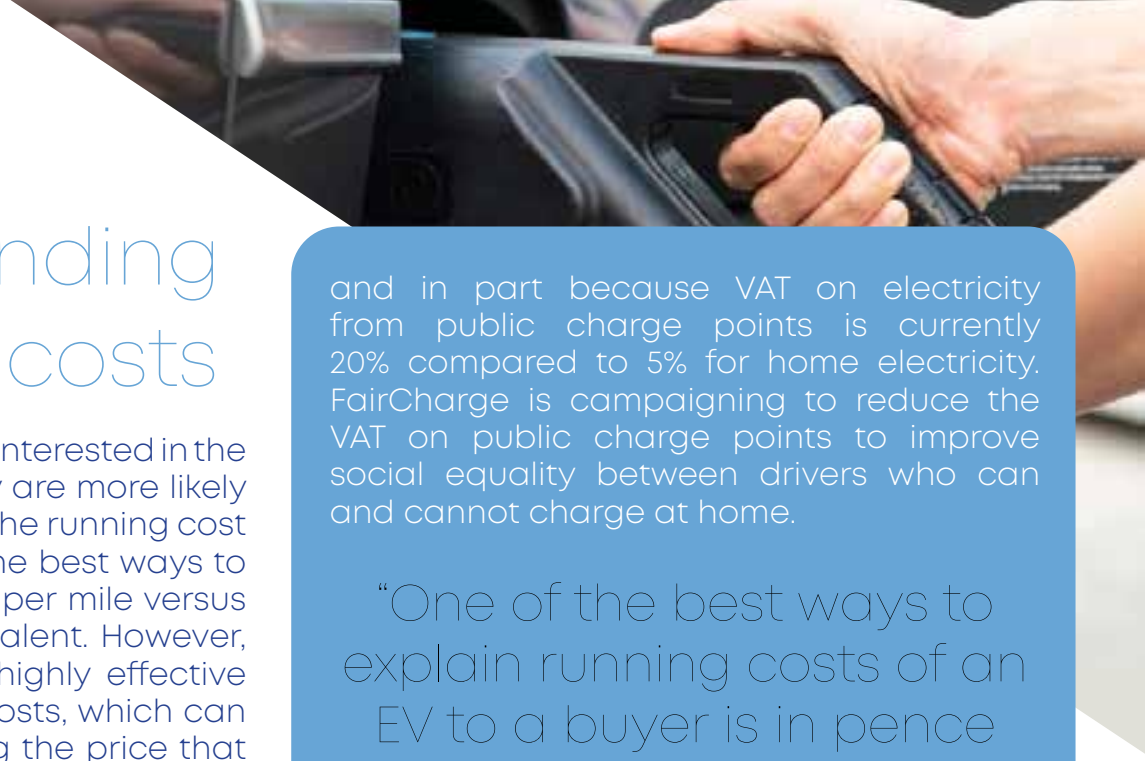
Also, the impact of cabin heating on range continues to decrease with newer EVs because, while the capacity of EV batteries has increased, the power draw of the cabin heater has either remained the same or even decreased, thanks to the introduction of heat pumps. Any prospective customer who is worried about being stuck in a traffic jam for several hours on a snowy winter's day needn't worry, as their EV's traction battery will power the cabin heater of even the oldest, lowest-capacity battery packs for hours on end, and avoid sending power unnecessarily to the electric motor while at a standstill. In fact, EV YouTuber Bjørn Nyland performed a test on a Tesla Model 3 in the middle of a freezing, snowy Norwegian winter and found that the traction battery powered its cabin heater for over 70 hours, with the cabin heater drawing around 1.0 kW. Compare this to a petrol or diesel car that inefficiently idles its engine to produce heat to keep the cabin warm, pulling the equivalent of between 4-10 kW of power just to keep the engine turning over.

In continental Europe, EV efficiency is expressed in kWh per 100 km, which is a more direct comparison to the litres per 100 km used to measure the efficiency of internal combustion engine vehicles. This is user-friendly since the customer understands the cost of a litre of fuel and a kWh of electricity. The equivalent comparison for UK customers is miles per gallon equivalent (MPGe) but this is not as straightforward and user-friendly as it may first seem.

"MPGe ratings for EVs provide a less impressive picture than they should really merit when selling to a UK customer."

MPGe is defined as the number of miles that an EV can drive on the equivalent amount of energy stored in a gallon of petrol, which in turn is defined as the amount of heat that would be generated by burning that gallon of petrol. However, MPGe was devised by the US Environmental Protection Agency and this means that it is based on the US gallon (3.785 litres), which is smaller than the imperial gallon that the UK uses (4.546 litres). Therefore, MPGe ratings for EVs provide a less impressive picture than they should really merit when selling to a UK customer - the number of miles that an EV could drive on the electrical equivalent amount of energy stored in an imperial gallon of petrol is actually 20% higher than that stated by MPGe.

Overall, given the US versus imperial gallon issue with MPGe, and also the fact that an EV translates far more electricity to momentum than an internal combustion engine burning petrol or diesel, miles per kWh is by far the most user-friendly metric to use with British EV buyers, and the figure that will be of interest to the majority of them when choosing their next vehicle. Importantly, a key advantage of miles per kWh lies in its ability to quickly convey running costs to the potential buyer.



Understanding charging costs

While the buyer may be interested in the efficiency of an EV, they are more likely to want to know about the running cost of the vehicle. One of the best ways to explain this is in pence per mile versus a petrol or diesel equivalent. However, miles per kWh is also highly effective at conveying running costs, which can be calculated by taking the price that the customer pays for a unit (kWh) of electricity and dividing it by the miles per kWh efficiency of the vehicle. As an example, an EV with roughly 3.5 miles per kWh efficiency (such as a Nissan LEAF), charged on a 9.5 pence per kWh overnight tariff, costs 2.7 pence per mile to run, against approximately 14.3 pence per mile for a 50 mpg petrol car, based on an average UK petrol price of 156.93 pence per litre at the time of writing - a saving in fuel costs of over 80%.

Savvy buyers with the means to charge their vehicle at home can additionally slash their fuel costs by signing up to an off-peak electricity tariff, especially one that is designed for EVs. Octopus Go (9.5p/kWh for four hours overnight) and Intelligent Octopus (7.5p/kWh for roughly six hours overnight, with automatically scheduled smart charging) are two of the market leaders. Of course, these tariffs will have a peak rate too, which is around 30p/kWh, or 8.6 pence per mile for a 3.5 miles per kWh EV.

Public charging is typically more expensive than home charging, in part because the charging network has to cover the cost of installing and maintaining its charging infrastructure, and in part because VAT on electricity from public charge points is currently 20% compared to 5% for home electricity. FairCharge is campaigning to reduce the VAT on public charge points to improve social equality between drivers who can and cannot charge at home.

> "One of the best ways to explain running costs of an EV to a buyer is in pence per mile versus a petrol or diesel equivalent."

AC (Type 2) public charge points tend to have the cheapest public charging tariffs, because the charging infrastructure and its grid connection are relatively cheap to buy and install. Pod Point charge points in Tesco supermarkets currently charge 44p/kWh, or 12.6 pence per mile for a typical EV. DC (CHAdeMO or CCS) rapid chargers and high-power chargers – and their grid connections – are much more expensive to buy, install and maintain, but provide the convenience of a charge in minutes rather than hours. RAC Charge Watch monitors the average price of rapid and high-power charging tariffs, and as of September 2023, these were 71.41p/kWh and 74.81p/kWh respectively, translating to about 20.4p and 21.4p per mile for an EV.

While rapid charging may currently be more expensive than petrol or diesel in many cases, it is important to remember that the average UK round-trip commute is 26 miles, which is comfortably within the range of even the oldest EVs. As a result, rapid and high-power charging is typically the exception, not the norm, for most drivers, with the majority of charging done cheaply at or near home or work.

Vehicle retailers should explain that the premium cost of a high-power charge on a longer road trip once every few weeks or months is a drop in the ocean when compared to the overall fuel savings of running an EV. On top of this, wholesale electricity prices are trending downwards after the unprecedented spike in 2022 caused by Russia's invasion of Ukraine, and charging networks are starting to pass the savings onto drivers.

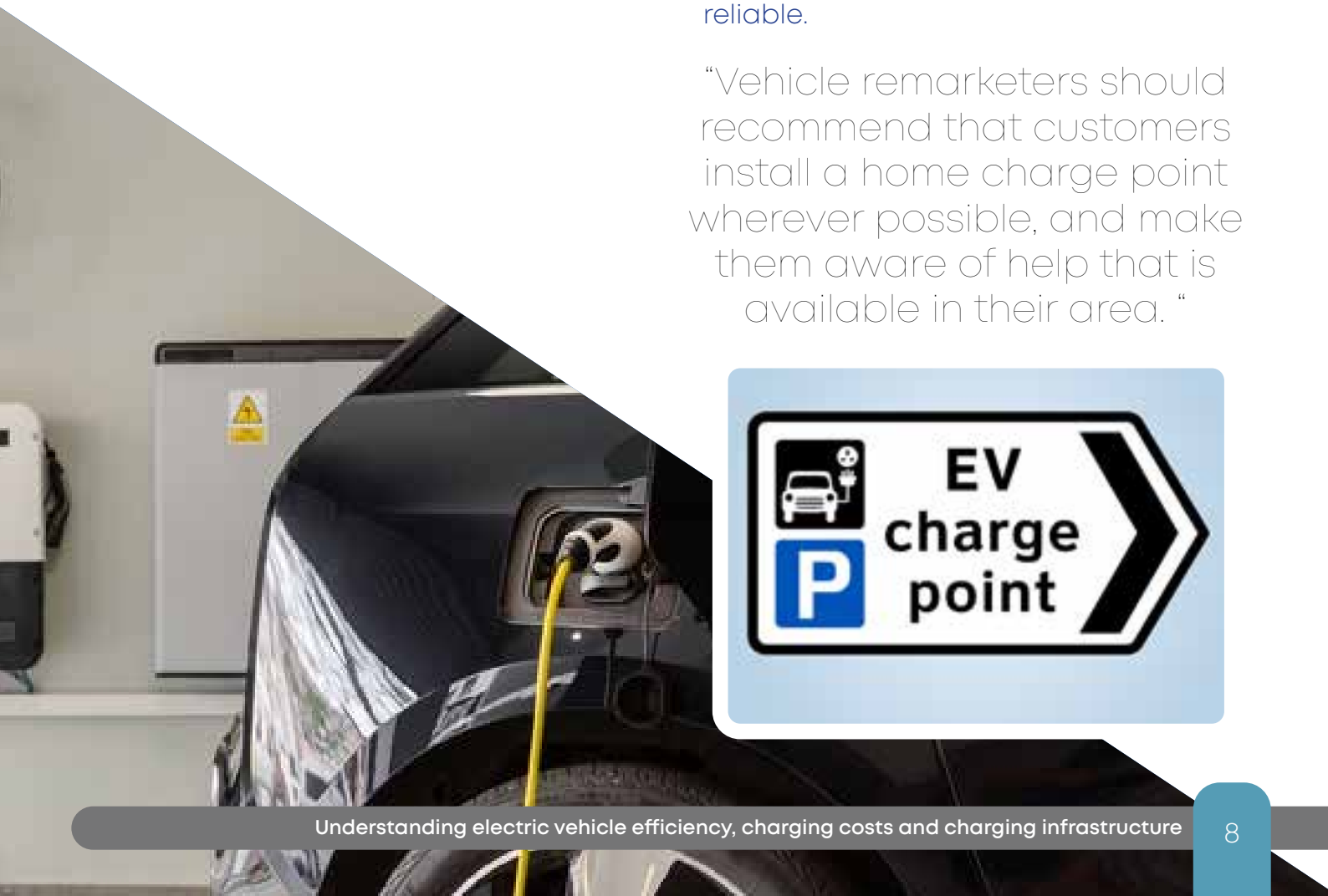
Additionally, for drivers who are heavy users of public chargers, roaming services like Bonnet, Zap-Pay and Octopus Electroverse, as well as Paua for business customers, may offer cost-competitive tariffs across multiple charging networks. Some individual networks offer discounted charging rates to drivers who sign up as members with a small monthly fee, while others, such as Char.gy, are working to reduce the gap between home and public charging prices by offering discounted off-peak tariffs for overnight charging when demand is low, wind power is typically high, and the cost of wholesale electricity is cheap.

Vehicle remarketers should recommend that customers install a home charge point wherever possible, and make them aware of help that is available in their area. These may include Transport Scotland's grants for home charge points for households in rural areas and UK Government grants to help people who own or rent in flats to install a charge point at their parking space.

Furthermore, vehicle remarketers should advise customers to investigate EV-friendly off-peak domestic electricity tariffs - of which remarketers should be aware of leading examples from Octopus as a bare minimum - and to look into home renewables such as solar panels to help reduce charging costs even further.

Customers should also be advised to check Zap-Map for public charging infrastructure on their usual routes, and to sign up to networks that require apps for their use, such as Ionity and Pod Point, if these are likely to be used on a regular basis. It is also strongly advisable to look at Zap-Map's user survey of public charging networks to see which ones are the most reliable.

"Vehicle remarketers should recommend that customers install a home charge point wherever possible, and make them aware of help that is available in their area. "




Best EV charging networks 2023
Rapid / En-route
zapmap
Rank
EV network
Overall rating*
Star rating**
Equivalent Rank 2022 ***
1 FASTNED 4.3 1
2 mfg EVPOWER 3.9 1
3 Osprey 3.8 4
4 IONITY 3.7 5
5 INSTAVOLT 3.6 3
6 GRIDSERVE ELECTRIC HIGHWAY 3.2 6
7 ChargePlace Scotland 3.1 7
8 SWARCO E.CONNECT 3.0 8
9 Shell Recharge 2.9 9
10 bp pulse 2.3 11
11 GeniePoint 2.0 10
*Overall Rating calculated to one decimal place for overall ranking
**Star Rating rounded to nearest 0.5 for display
***Equivalent Rank 2022 shows position with comparable rapid networks included
For inclusion in the Rapid/En-route rankings, networks must have a minimum of: 75 rapid or ultra-rapid devices (50kW+) and greater than 20% of their network are rapid or ultra-rapid devices, 100 responses in the survey
The Tesla network is excluded from the rankings, as the majority of charge points are still only available to Tesla drivers
Zapmap Survey October 2023, 3620 BEV drivers ranked each network they used within the last 6 months.


Best EV charging networks 2023
Destination / On-street
zapmap
Rank
EV network
Overall rating*
Star rating**
1
mer
Pure energy from Statkraft
3.4
2
Connected Kerb
3.3
ubitricity
3.3
3
pod POINT
3.0
4
source LONDON
2.6
5
GWEFRU DRAGON CHARGING
2.4
*Overall Rating calculated to one decimal place for overall ranking
**Star Rating rounded to nearest 0.5 for display
For inclusion in the Destination/On-street rankings, networks must have a minimum of: 100 devices, 80% of slow or fast devices and 50 responses in the survey.
Zapmap Survey October 2023 of 4282 BEV drivers.

Charging infrastructure for vehicle remarketers

As covered in the first white paper of this series, it is strongly recommended to install multiple Type 2 charge points at your premises as a bare minimum. This will allow you to charge EVs in your inventory overnight, or over a period of a few hours during the day, enabling you to hand over the keys to fully charged EVs for test drives or customers collecting their new purchase.

Charging infrastructure at your premises could be made available to customers and members of the public, and placed on charge point finding apps such as Zap-Map to allow other EV drivers to find them. This has many advantages for your business. Firstly, it shows that you cater for EVs – and presumably understand and likely sell them – which in turn will make you more appealing to prospective buyers. Secondly, depending on the location of your premises, you could be filling a major gap in the public charging network and help drivers to get out of trouble if they're running low on charge. Thirdly, having a range of EVs on display near to your charge points could be the nudge that a visiting driver needs to convince them to switch to a newer EV, bought from you. Arnold Clark has likely factored in all of this into its decision to roll out a high-power charging network across its dealerships, using high quality hardware, which will be available for public use.

Vehicle remarketers who would like to be brought up to scratch on the different types of electric vehicle charging plugs, and their purpose and charging speeds, may find the Plug Life Television episode "A guide to electric vehicle plug types and charging speeds" useful, available on YouTube (https://www.youtube.com/watch?v=yCjtiCFTFbk).

Type 2 charge points typically cost between £1,000 to £3,000 to buy and install, depending on the location and whether the unit is wall or pedestal mounted. More powerful 50 kW rapid chargers are typically an order of magnitude more expensive to buy and install, owing to their complex electronics, with high power chargers (typically 150+ kW) often costing in the region of £60,000 to £80,000. While some vehicle remarketers may be unable to afford to install their own rapid or high-power chargers, they may find that there are public charging networks interested in installing this infrastructure on their premises for free and covering all of the electricity and maintenance costs for the chargers, while paying the remarketer ground rent for access to their property, provided that the chargers are made available for public use.

When it comes to charger reliability, vehicle remarketers should perform due diligence on offers from suppliers and public charging networks. For example, look at Zap-Map user survey results and feedback from EV drivers regarding other sites that are operated by the network in question to get a representative picture of their effectiveness. The reliability of chargers on your premises will heavily influence the reputation of your business and the efficiency of your operation, so it is vital that your business gets this right first time. Be sure to include performance criteria and escape clauses in any contracts that are signed.

"The reliability of chargers on your premises will heavily influence the reputation of your business and the efficiency of your operation."

Similarly, vehicle remarketers should look at the proposed hardware that is to be installed by an installer or public charging network, and ensure that it has a good reputation amongst EV drivers and other owners or operators of that hardware. Charging networks, fleet managers and EV driver associations will be more than happy to provide feedback on various makes and models of hardware with regards to user-friendliness and reliability. All should be OCPP 1.6 compliant as a bare minimum, allowing them to connect to the majority of back offices available today to allow you or the charging network to bill for electricity used by customers and members of the public. Even if you do not plan to connect your own charge points to a back office immediately, it makes sense to have the capability to do this in the future. For publicly accessible rapid and high-power chargers, contactless credit card payment terminals are a must for user-friendliness, ensuring that no app or RFID card is required by members of the public.

Crucially, vehicle remarketers should request that the installer follows PAS 1899 guidance on accessible public charging infrastructure as much as possible when installing charging infrastructure at your premises. This includes simple but effective measures such as ensuring there are no raised kerbs between the charger and charging bay; that spaces are wide enough to allow wheelchair access; and any bump stops do not prohibit wheelchair access to the charger. ChargeSafe is an excellent independent consultant that can advise vehicle remarketers on best practice for charging bay design, having already worked with major UK public charging networks in this regard. By following these guidelines, you will be helping to ensure that no one is left behind during the transition to EVs.

"By following these guidelines, vehicle remarketers will be helping to ensure that no one is left behind during the transition to EVs."

Vehicle Remarketing Association

The Vehicle Remarketing Association exists to promote networking and provide essential briefings for companies who work in the handling, selling, inspection, transportation and management of used vehicles.

We aim to help our members – who together process more than 1.5 million cars, vans and trucks every year – to forge new and productive links as well as share good practices to help them prosper in a rapidly changing and challenging environment.

The VRA creates a crucial environment where industry issues are addressed by the sector's leading experts in a collegiate and constructive manner. As a result of this successful approach, the Association has expanded by 25% since 2020.

The key objectives of the VRA are:

- To create better awareness of the activities of professional remarketing
- To raise standards and generate an accepted best practice across the industry for key disciplines like vehicle inspection
- To provide a much needed voice to represent the sector in the trade and consumer media on issues which affect remarketing suppliers and customers
- To provide an effective focal point through which major matters concerning those involved in remarketing can be addressed
- To raise the profile and professionalism of the industry to ensure recruiting good quality people becomes much easier
- To generate views and opinions of the industry for use in lobbying for the greater good of the remarketing sector
- To create a forum where members can network, exchange views, debate key topics and share best practice

For more information contact:

info@thevra.co.uk

www.thevra.co.uk