Electric Vehicle Battery Health:
What the remarketing sector needs to know

Vehicle Remarketing Association

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Contents

Introduction

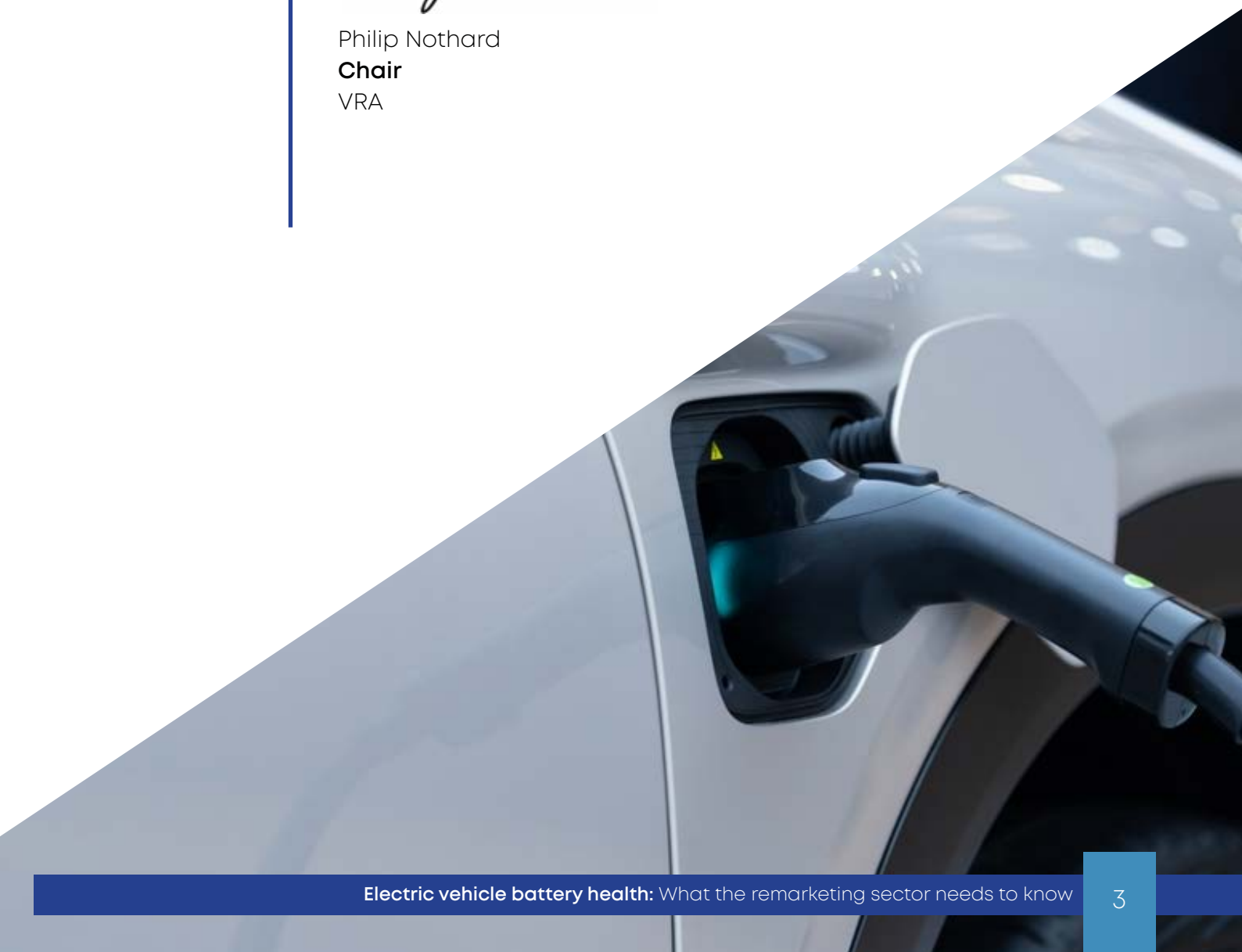
Welcome to the second in our series of new white papers on electric vehicles written especially for Vehicle Remarketing Association members by Dr Euan McTurk of Plug Life Consulting.

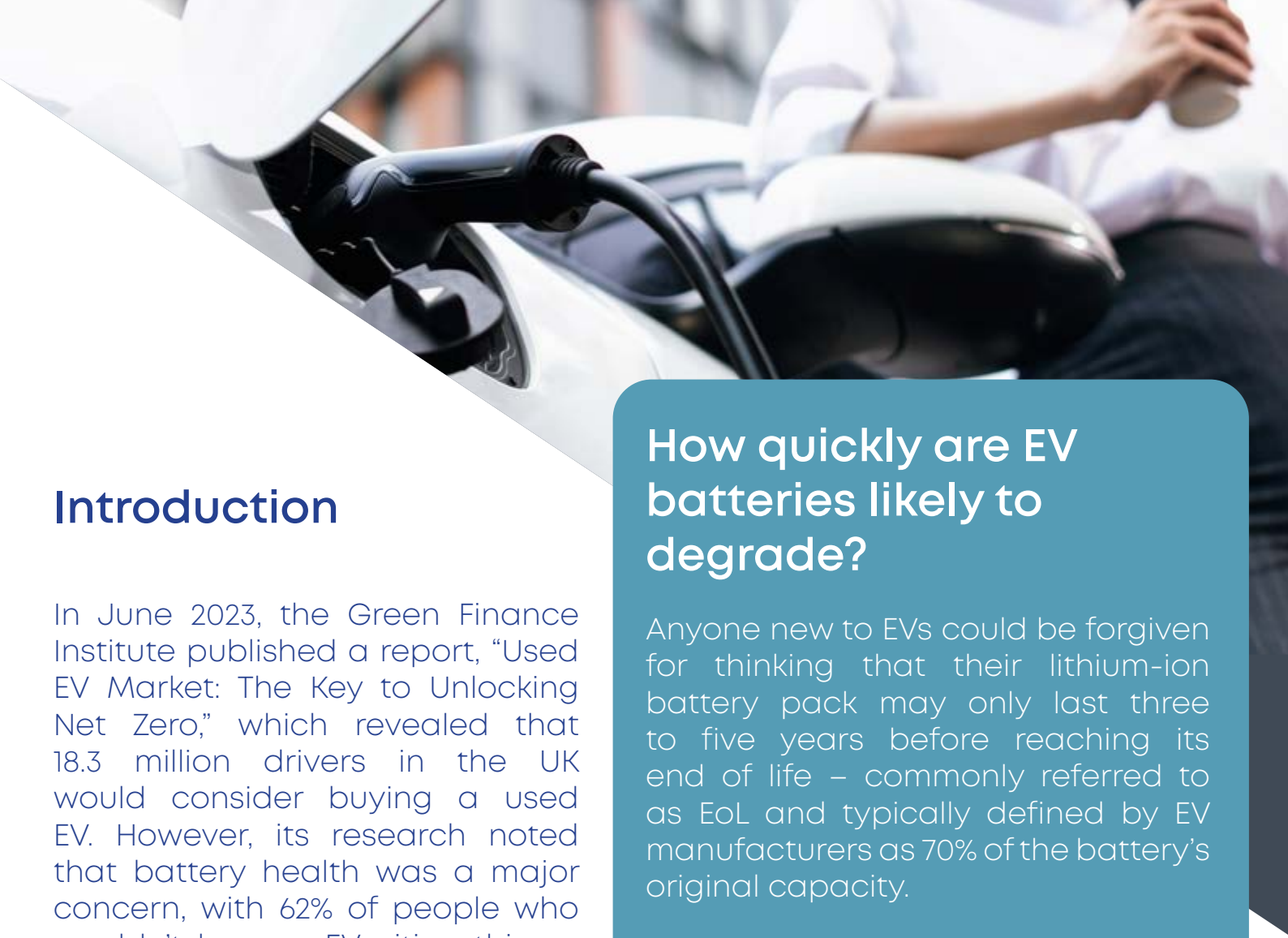
In some ways, this is the most important. Public perceptions about battery health are a major obstacle to used car buyer acceptance of EVs. However, as this document explains, most of these concerns are misplaced, and technology is emerging that will help to resolve these issues.

As with any other initiative from the VRA, we welcome your feedback, so please let us know your thoughts as well as any ideas for future white papers.

Philip Nothard

Philip Nothard
Chair
VRA





Introduction

In June 2023, the Green Finance Institute published a report, "Used EV Market: The Key to Unlocking Net Zero," which revealed that 18.3 million drivers in the UK would consider buying a used EV. However, its research noted that battery health was a major concern, with 62% of people who wouldn't buy an EV citing this as their main reason. As such, a means of informing the customer of the health of a battery through some form of certification is clearly very important to encourage drivers to electrify.

At present, EV battery health checks are not standardised, and are easier to perform on some makes and models than others. With proposals on the horizon to introduce a standardised battery health monitoring procedure, what do vehicle remarketers need to know?

How quickly are EV batteries likely to degrade?

Anyone new to EVs could be forgiven for thinking that their lithium-ion battery pack may only last three to five years before reaching its end of life – commonly referred to as EoL and typically defined by EV manufacturers as 70% of the battery's original capacity.

However, as evidenced by the number of Renault Zoes and BMW i3s from the early 2010s that are still showing most of their original range on a full charge, this is not the case. Crucial differentiators between electric cars and consumer electronics that an EV keeps its battery cool using a thermal management system. A smartphone or laptop will push cell voltages as high as possible for the sake of a few extra minutes of run time, EVs deliberately block off the top and bottom of their battery's capacity to reduce degradation and extend lifespan.

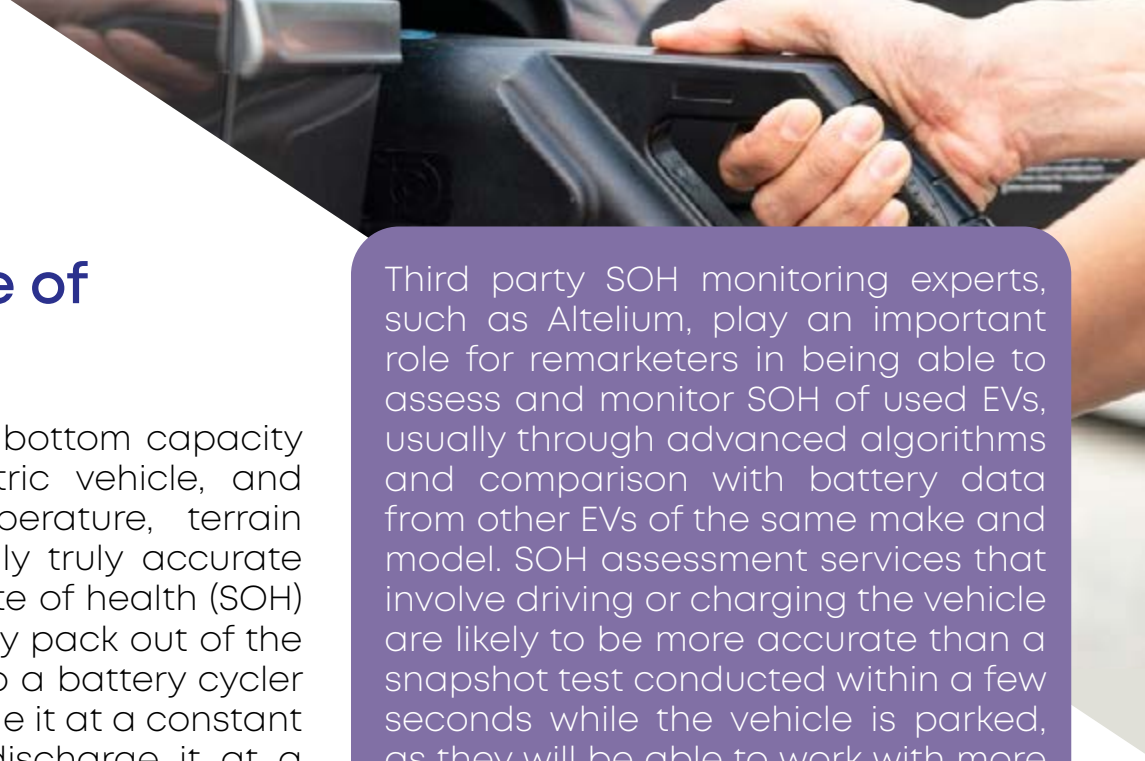
Tesla 4680 Battery Pack

A notable exception to is the Nissan LEAF, which has no thermal management system. The original cell chemistry used (2010-2013 models) was not heat tolerant, and so degraded quickly. However, UK-built models (2014 onwards) feature a much more robust chemistry that offers a much greater lifespan, albeit one that is generally still less than EVs with liquid-cooled batteries. In comparison, batteries from mid-2010 Teslas show degradation of less than 10% after 160,000 miles.

Most modern, liquid-cooled EV batteries being made today should last at least 300,000 miles, with Elon Musk claiming in 2019 that Tesla's long range Model 3 and Y batteries should cover 500,000. This lifespan is set to continue to increase, with academics who are close to Tesla unveiling one million and four million mile batteries in recent.

Some EVs can use their traction battery to power electric devices using an inbuilt plug socket (called vehicle-to-load or V2L), or send power back to a home or grid (called V2H and V2G). While some people have expressed concern over the impact of these uses on battery lifespan, a study by academics has indicated that they can actually improve an EV's battery life by 10%. This is likely in part due to the battery spending less time fully charged and also V2X duty cycles being far less strenuous on the battery than drive cycles, due to their lower and more consistent power draw.

"Most modern, liquid-cooled EV batteries last at least 300,000 miles"



How can we measure battery state of health?

Due to the top and bottom capacity buffers in an electric vehicle, and variables like temperature, terrain and throttle, the only truly accurate way to measure state of health (SOH) is to drop the battery pack out of the vehicle, connect it to a battery cycler in the lab, fully charge it at a constant current, then fully discharge it at a constant current and measure the energy discharged out of the pack. Of course, this is not practical, so health-checking algorithms are used that typically look at cell voltages, temperatures and currents, and "coulomb count" the charge in and out of the battery, to provide as accurate an estimate as possible.

Very few EVs show their SOH on the dashboard, with the notable exception being 24 and 30 kWh Nissan LEAFs. Many other EV SOH readings are obtainable via the CANbus and will typically be accurate to within a few percent - but some earlier efforts should be taken with a pinch of salt.

For example, the aforementioned LEAF's SOH meter is notoriously sensitive to charge power and ambient temperature, such that colder temperatures and faster charging artificially inflate the SOH reading and vice versa. Some other EVs are reluctant to reveal their SOH, with the estimated range on the dashboard being the only visible clue available to remarketers and buyers.

Third party SOH monitoring experts, such as Altelium, play an important role for remarketers in being able to assess and monitor SOH of used EVs, usually through advanced algorithms and comparison with battery data from other EVs of the same make and model. SOH assessment services that involve driving or charging the vehicle are likely to be more accurate than a snapshot test conducted within a few seconds while the vehicle is parked, as they will be able to work with more data to improve accuracy, such as detecting how cell voltages and temperatures react to charge and discharge conditions.

That said, snapshot tests should improve in accuracy, with the dataset used to compare and assess SOH. Furthermore, some SOH monitoring experts also offer extended battery warranties, which should boost customer confidence when buying an older or higher mileage EV.

What is being done to make monitoring and reporting battery health easier?

The UK Government is working with the United Nations Economic Commission for Europe (UNECE) and other partners to specify Global Technical Regulations on EV battery health monitoring, with the aim to adopt the finalised regulations into UK law.

A two-fold approach will see the installation of battery health monitoring devices on new EVs as standard, with accompanying minimum battery health warranties based on the age and mileage of the vehicle. The former will adhere to predefined accuracy requirements and measure battery health to the nearest 1%. This will be easily accessible by EV drivers and customers as well as manufacturers, dealers and remarketers, using a dashboard or infotainment display, or the vehicle's smartphone app. The latter will mandate that an EV battery maintains a minimum of 80% of its original capacity after five years or 60,000 miles, and 70% of its original capacity after eight years or 100,000 miles.

UNECE has defined state of certified energy (SOCE) and state of certified range (SOCR) as the metrics to be used when monitoring battery health, with the former based on usable battery energy (UBE), factoring in the voltage and capacity buffers at the high and low states of charge that most EVs use to extend the lifespan of their battery packs. The regulations have been designed in such a way that they account for any battery use in V2X applications and will also adapt to any new battery chemistries as these start to be deployed in EVs.

UNECE's Global Technical Regulations are also being agreed with the USA, EU, China, Japan, South Korea and Canada. Meanwhile, the proposed Euro 7 standard is looking to introduce SOH monitors to electric vehicles in 2025. All of this means that the likelihood of battery SOH monitors being implemented in new EVs for UK and international markets is strong, since any EV that is produced for any of these major automotive markets – and major automotive manufacturing nations and blocs – must comply with these new regulations when introduced.

In tandem with this, battery passports are being proposed. Rather than showing the SOH of the battery, the passport provides a wealth of historic information on the origin of the battery and how it has been treated in use. This will indicate if a battery has had a particularly demanding or easy life, and complement the SOH monitoring and certification processes.

How does battery health affect residual values?

Since most modern EVs can cover in excess of 200 miles per charge, loss of range with decreasing SOH is becoming less of an issue for all but the most extreme use cases. For example, a Kia e-Niro with a range of around 250 miles when new will still be able to travel 175 miles even if the battery falls to the 70% figure - easily a week's worth of driving for the average UK motorist.

However, as with anything less than perfect on any used vehicle, battery health is still a powerful bargaining chip for consumers when negotiating a deal. For example, it is common for savvy buyers of 24 and 30 kWh LEAFs to count the SOH bars on the dashboard and demand a reduction in price if the vehicle has anything less than a full complement of 12 bars. This may reduce the price at which the vehicle is sold but it most certainly does not render the vehicle worthless. This is evidenced by the oldest LEAFs from 2011-2013 which - with the original cell chemistry, 9 out of 12 SOH bars showing and with 60,000-80,000 miles on the clock – are still typically fetching around £4,500-£5,000 on Auto Trader, around double the price of an equivalent petrol or diesel Ford Focus. There will always be buyers who just need a vehicle for occasional, low-mileage journeys, for which an older EV with a degraded battery suits their needs and budget.

"The battery health of a used vehicle is a powerful bargaining chip for consumers when negotiating a deal."

Why is a used EV battery health checking standard important for vehicle remarketers and buyers?

At first, a battery health certificate may seem like a risk to a remarketer if it advertises to prospective customers that an EV in your inventory has a somewhat degraded battery. However, a battery health certificate provides certainty to vehicle remarketers because it allows them to set a fair price at which to buy the used EV, as well as a fair price at which to sell. This removes the uncertainty of buying an EV for your inventory that looks fine at first glance but later turns out to have a battery that is more heavily degraded than average. It also helps to improve profitability and customer satisfaction, and could reduce the time that the vehicle spends on the forecourt by removing any ambiguity around its battery health and certifying that it is suitable for the buyer's needs.

As mentioned previously, there are battery insurance companies that offer extended EV battery warranties, which could be paid for by the remarketer or customer to further reduce the financial risk of battery degradation.

It is also possible that battery health certificates will lead to EV manufacturers using higher quality cell chemistries and battery designs to provide maximum pack lifespan. However, it is important to remember that EV batteries are already built for longevity, with the vast majority on the road today showing very little battery degradation, and close to their original range on a full charge. Battery degradation is unlikely to be a significant issue for all but a handful of EV models for many years, and educating customers about this point will help to increase used EV uptake. However, when degradation does start to become more noticeable, a battery health certificate will help remarketers and customers to establish a fair price and a high degree of confidence in the are buying and selling.

"A battery health certificate provides certainty to vehicle remarketers allowing them to set a fair price to buy and sell the used EV."

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

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