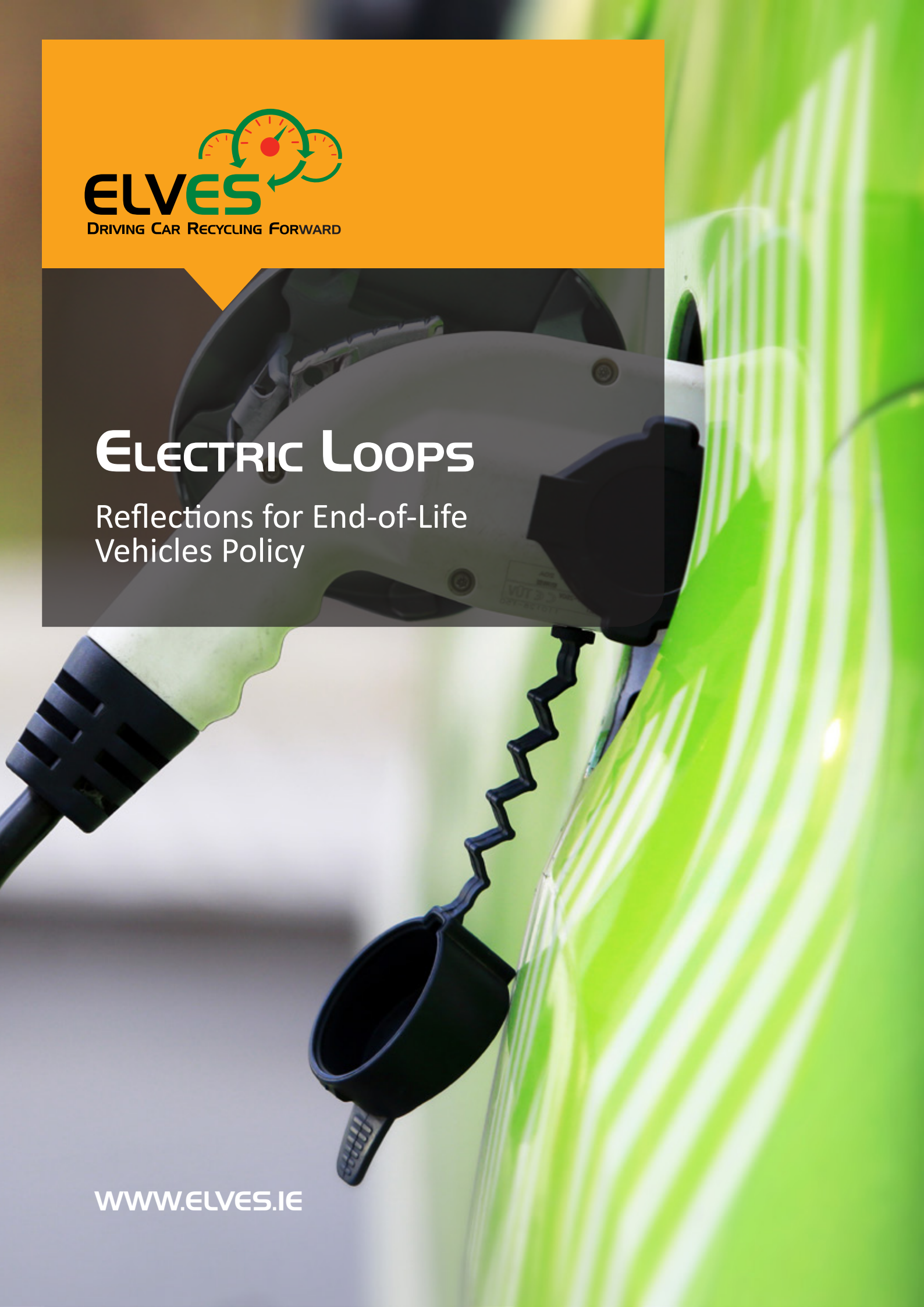
ELVES

DRIVING CAR RECYCLING FORWARD

Electric Loops

Reflections for End-of-Life Vehicles Policy



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Glossary

ARN:	Auto Recycling Nederland
ATF:	Authorised Treatment Facility
BEV:	Battery Electric Vehicle (full electric)
CVP:	Circular Vehicle Passport
DECC:	Department of the Environment, Climate and Communications
ELV:	End-of-Life Vehicle
EV:	Electric Vehicles (BEV, HEV and PHEV)
EPA:	Environmental Protection Agency
HEV:	Hybrid Electric Vehicle (hybrid no external charging)
ICE:	Internal Combustion Engine Vehicle
IDIS:	International Dismantling Information System (www.IDIS2.com)
PHEV:	Plug in Hybrid Electric Vehicle (hybrid with external charging)
PRO:	Producer Responsibility Organisation

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Executive Summary

The Electric Loops project explored the reuse and recycling potential of electric vehicles (EVs), focusing on the value of their EV specific components. Based on the results of this project, an Authorised Treatment Facility (ATF) Data Matrix and an accompanying Report for ATFs and Metal Recyclers were published in April 2024.

This subsequent *Electric Loops: Reflections for End-of-Life Vehicles Policy* report applies a policy and regulatory lens to the findings of the Electric Loops project. It focuses on data that provides insights into future target calculations and reflections considering the new Regulation on both EV Batteries and End-of-Life Vehicles (ELVs).

About the Electric Loops Project

The objective of the Electric Loops project was to investigate and understand the EV value chain from the perspective of ATFs - Authorised Treatment Facilities (scrapyards) and recyclers, the parties that have the ability to create the circular material flows of the future.

The project had three key objectives, to:

1. Create a dataset that will aid the activities of ATFs in the reuse and recycling of electric ELVs.
2. Disseminate the project data widely to ATFs and Metal Recyclers.
3. Create a dataset that will aid the activities of the EPA, DECC and ELVES in meeting the future requirements of the ELV and Batteries Regulations.

This Policy Makers report is a key part of objective 3. It is published alongside an updated Data Matrix.

Objectives 1 and 2 were achieved with the creation and dissemination of the Electric Loops ATF Data Matrix on EV component parts and accompanying ATF Report, both of which are publicly available at www.elves.ie/electricloops.

About ELVES

ELVES (ELV Environmental Services CLG) is the compliance scheme for ELVs in Ireland. Operating under ministerial approval since 2017, the organisation aims to improve the processing of ELVs in Ireland, meet the national EU reuse, recycling and recovery targets for this material stream and support the sector in its transition and contribution to a circular economy.

ELVES has a Network of over 65 ATFs around the country, accounting for around 80% of Certificates of Destruction (CoDs) issued on vehicles recycled. The Network has met both the national reuse and recycling target of 85% and the overall reuse and recovery target of 95% every year since its inception, and the Network's performance has been instrumental in the country meeting both of the EU targets since 2018.

In addition to target achievement, ELVES works on projects to assist in the improvement of ELV processing. In 2018 ELVES rolled out its Electric ELVES programme for industrial batteries; batteries in hybrid (HEV), plug-in hybrid (PHEV) and full EVs (BEVs), on behalf of its vehicle Producer members. The programme is available to all ATFs, providing for the free collection and recycling of EV batteries from ATFs, awareness training, and other information supports.


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Project Objectives

The Electric Loops project had three key objectives.

1. Create a dataset that will aid the activities of ATFs in the reuse and recycling of electric ELVs.

The key outcome of the Electric Loops project was the creation of the Electric Loops ATF Data Matrix. Published in April 2024, information in the ATF Data Matrix should aid ATFs and metal recyclers in the recycling of EVs now and into the future.

The ATF Data Matrix identifies:

- What specific parts are found in EVs compared to diesel/petrol vehicles.
- What parts are significantly different in an EV compared to a to diesel/petrol vehicle.
- What the role of these new car parts are in the vehicle.
- What the potential reuse value of these EV specific parts is.
- What we can tell about reuse demand for these parts.
- What value these parts would have if removed and sold as a separate recycling stream.

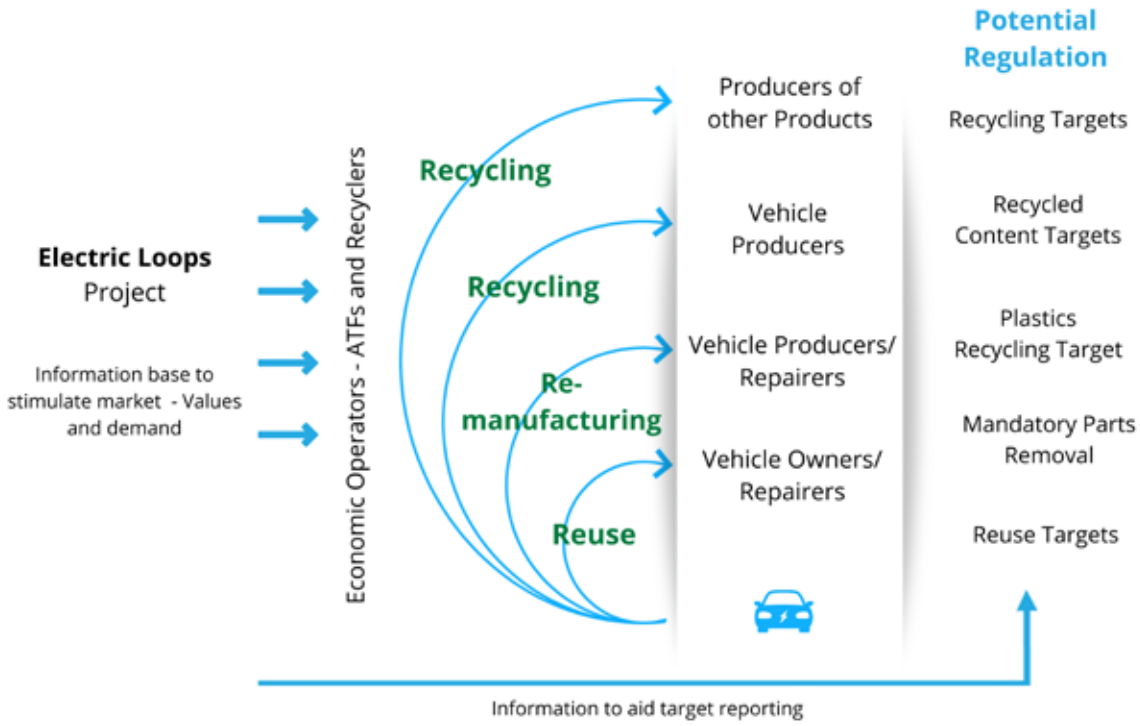
The ATF Data Matrix is presented in an easy-to-understand format, following consultation with a wide range of stakeholders including ATFs, metal recyclers and vehicle manufacturer representatives.

To support the use of the Data Matrix by ATFs and also to share the ATF relevant learnings from the project, an accompanying ATF Report was produced. The ATF Report covers aspects such as health and safety equipment required when dismantling an EV and differences in depollution steps.

Both the ATF Data Matrix and the *Report for Authorised Treatment Facilities (ATFs) and Metal Recyclers* are available at www.elves.ie/electricloops

2. Disseminate the project data widely to ATFs and Metal Recyclers.

Following production of the ATF Data Matrix and ATF Report, the results were widely distributed. This includes at events such as the ATF Professional Conference UK, an ELVES ATF Network meeting in Athlone, by post to all ATFs and via email. In December 2024, the project was shortlisted for an ATF Professional Award in the innovation category, further raising its profile.



A summary of the project results and detail on where to find full information is also now included in the EV dismantling training offered to ATFs by ELVES. This addition to the EV dismantling training was delivered for the first time in November 2024.

3. Create a dataset that will aid the activities of the EPA, DECC and ELVES in meeting the future requirements of the ELV and Batteries Regulations.

The intention of the project was to create a matrix of data tailored to the needs of ATFs and metal recyclers, to aid them in their recycling of EVs. Throughout the project however it was possible to gather other data of interest to policy makers and those undertaking ELV target calculations now and into the future.

This has resulted in this report and a Policy Makers Matrix – an extended matrix containing additional information gathered during the project.

How the Project was Carried Out

The project started with the creation of a list of the specific car parts that would be found in EVs. This included identifying completely new parts (e.g. inverters) and those that were significantly different in an EV compared to an internal combustion engine (ICE) vehicle.

In early June 2023, two battery electric vehicles (BEVs), a Renault Zoe and a Nissan Leaf, were depolluted and their EV specific parts were removed. The parts and the vehicles were then listed on *eBay* and *DoneDeal* to advertise them for sale for reuse. In addition, the parts were assessed by recyclers to ascertain a likely recycling value if that part were to arise in volume as a separate recycling stream. A survey was also sent out to remanufacturing companies to assess remanufacturing potential for the EV parts listed.

The data collected was turned into a matrix of results that were reviewed by focus groups of ATFs, recyclers and vehicle manufacturer representatives before publication. Eight months after the publication of results, a survey to evaluate the usefulness of the matrix results and accompanying report was circulated to the ELVES Network of ATFs.

Further information on how the project was undertaken can be found in Appendix A.

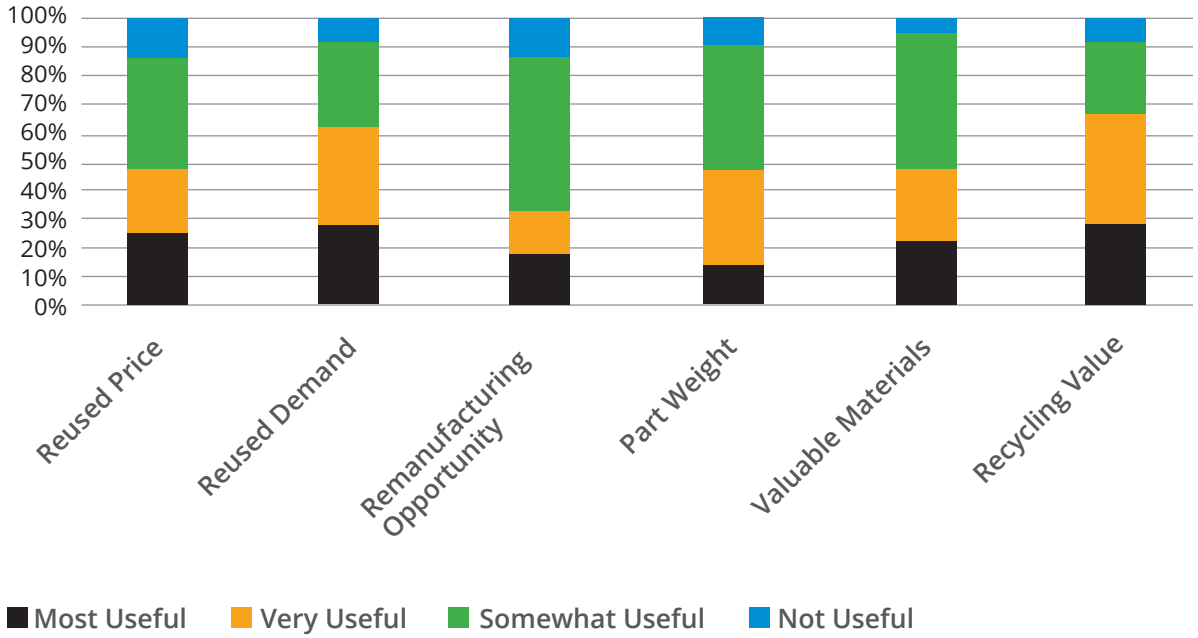
Feedback from ATFs on the Data Matrix

The ATF Data Matrix and accompanying report were published in April 2024. In January 2025, ATFs were surveyed to find out how useful they found the data. The sample included ATFs that sell parts and metal recyclers.

Over 95% of survey respondents that reviewed the Matrix said the results were *very useful*, a *little bit useful* or expect the results to be useful to them in the future. Importantly, and indicative of the current low volume of EVs, 38% answered that the Matrix was 'not useful at the moment but expect it to be useful in the future', with 48% of respondents reporting having no experience of selling EV parts.

The recycling value of component parts was recorded as being the *most useful* of the results categories. ATFs expressed interest in analysing further the costs and time involved in depolluting and dismantling EVs generally compared to ICE vehicles.

Usefulness of Data Matrix Categories



The Role of EVs in Wider Environmental Policy

EVs are a key decarbonisation tool in Irish and EU environmental policy. With the transport sector accounting for up to 25% of Ireland's carbon emissions, Ireland's Climate Action Plan includes a target of 1 million EVs on the road by 2030. In addition, as a sector with high resource use and potential for circularity, batteries and vehicles are a key focus in the EU's Circular Economy Action Plan 2020, a core component of the EU's Green Deal.

In 2023, a new EU Batteries Regulation was adopted aiming to improve the management, reuse and recycling of batteries. The Regulation created a new battery category, that of 'EV battery'. In July 2023, a proposal for a new EU ELV Regulation was published. Currently being negotiated, this Regulation will replace the ELV Directive, and will govern how ELVs, including electric ELVs, will be managed in the future. Both new pieces of legislation take a full life cycle approach, aiming to increase the circular economy of vehicles and their batteries.

In this report, the results of the project are considered in light of this wider policy and regulatory environment. Firstly, reflecting on the data requirements of the current ELV Regulation, and secondly with regard to the expected changes as a result of the new Batteries Regulation and the new ELV Regulation proposal.

Insights for Target Calculation Methodologies

Here the data collected in the project is analysed further, with consideration given to the ELV Regulations requirements, primarily target calculation methodology.

The data below was collected from the two vehicles dismantled in the study, alongside comparative data from the International Dismantling Information System (IDIS). Given the size of the sample, the focus of the research and data limitations (e.g. scale tolerances), the data is provided as an initial insight and should not be used for target calculations.

Key Vehicle Weights

The following table provides a summary of the weights recorded in the study. As would be expected, due to the weight of the battery, the two vehicles were heavier than the average recorded in the last Irish Shredder Trial[1]. Post depollution, including removal of the battery, the vehicles were about 180kg heavier than the average from the Shredder Trial.

Key Vehicle Weights	Renault Zoe (kg)	Nissan Leaf (kg)
Kerb Weight of Vehicle (Factory weight of the vehicle including all fluids without passengers, cargo or optional equipment)	1,549.00	1,567.00
Start Weight in project, of which:	1,480.00	1,500.00
Liquids	4.31	7.37
EV Battery	290.00	292.10
Starter Battery	12.90	N/A
AC Gas	0.47	0.00
Wheels including Tyres	69.08	70.00
Weight post depollution, of which:	1,172.32	1,200.53
Electric Motor and Reducer	76.42	89.81
Inverter/Converters	37.92	48.06
High Voltage Cabling	4.75	3.19
AC Compressor	6.29	6.64
Positive Temperature Coefficient (PTC) Heater	0.33	3.02
Anti-Lock Braking System (ABS) Booster/ ABS Pump Modulator	5.31	2.07
Weight after removal of key EV Parts	**1,041.32**	**1,047.75**

[1] Irish shredder trial report can be found at www.elves.ie/about-elves

Depollution

Depollution of the two vehicles took place following review of the vehicle depollution documents available on IDIS.

The results show that at end-of-life the depollution materials in the vehicles were significantly lower than the weights reported in IDIS. This was more so the case for the Leaf, which was not in running order when obtained for the study and as such, possibly a better reflection of an end-of-life vehicle. Liquids and AC gases in the Leaf were approximately 6.8kg less than reported in IDIS, and 3.2kg less in the Zoe.

The results from the depollution were as follows. A more detailed comparison table can be found in the Policy Maker Matrix.

Renault Zoe

	Present?	Weight Reported on IDIS (Kg)	Weight Removed During Project (Kg)	Comments
Battery – Starter	✓	11.22kg	12.9kg	
Battery - Key	✓	3g	N/A	
Battery - BEV	✓	290kg	N/A	Not weighed during study – too heavy for scales onsite.
Coolant	✓	3.79kg	2.965kg	
Gear Box Oil	✓	0.46kg	0.45kg	Listed as Engine Oil on IDIS, reading as Gear Box Oil.
Brake Fluid	✓	0.6kg	0.67kg	
Shock Absorber Oil	✓	90g	N/A	Shock Absorber Oil - Not removed due to reuse potential. Listed on IDIS as Damper Oil/Suspension Fluid
Wash Fluid	✓	2.16	0.225kg	
Engine Oil	✗	N/A	N/A	
AC Gas – R1234yf	✓	0.990kg	0.467kg	

Nissan Leaf				
Depollution Item	**Present**	**Weight Reported on IDIS (Kg)**	**Weight Removed During Project (Kg)**	**Comments**
Battery - Starter	✓	12kg	N/A	Already removed from vehicle
Battery – Key	✓	2g	N/A	
Battery – BEV battery	✓	292.1kg	N/A	Not weighed during study – too heavy for scales onsite.
Coolant	✓	9.598kg	5.62kg	Weight removed is an estimate*. Coolant on IDIS listed twice – 7.768kg + 1.83kg = 9.598kg total
Gear Box Oil	✓	0.962kg	1.005kg	Listed as Clutch Fluid on IDIS, reading as Gear Box Oil - Included small amount of coolant*
Brake Fluid	✓	0.613kg	0.255kg	
Shock Absorber Oil	✓	0.469kg	N/A	Shock Absorber Oil - Not removed due to reuse potential. Listed as Damper Oil/Oil on IDIS.
Wash Fluid	✓	2.5kg	0.49	
Engine Oil	✗	N/A	N/A	
AC Gas - R134a	✓	0.450kg	0kg	Tested but none found

*Vehicle was depolluted and coolant removed. However, coolant lines ran the length of the vehicle, meaning additional coolant was unexpectedly found during dismantling which was not captured – 1kg of the estimated 5.65Kgs.

ARN, the ELV compliance scheme in the Netherlands, completed desk research comparing the liquids reported on IDIS for EVs, hybrids, and ICE vehicles. Considering 204 different models, including 50 EVs, the results were as follows.

Sample Size	74	50		
	Petrol Diesel	**EV**		**% Difference EV to Petrol/Diesel**
	Average	Average	No. reported	
Brake Fluid	738.32	794.90	49	107.66%
Coolant	7763.32	9432.46	39	121.50%
Shock absorber Oil	461.07	330.84	46	71.76%
Differential Oil	1103.87	600.00	2	54.35%
Motor Oil	5120.01	2225.00	6	43.46%
Oil Filter	352.03	260.00	1	73.86%
Gearbox Oil	4416.73	2267.77	30	51.34%
Windshield wiper fluid	3640.30	3371.67	49	92.62%
HV Converter fluid	N/A	4733.00	4	N/A
Battery Cooling Fluid	N/A	7698.67	15	N/A

Source: ARN (Auto Recycling Netherland), data provided to Electric Loops project September 2023.

For brake fluid and particularly coolant, the ARN study would suggest these are found in higher volumes in EVs than in ICE vehicles. Other oils such as gearbox, differential, and shock absorber oils would be found in lesser quantities. It is however acknowledged that there may be inconsistencies in how the data is recorded on IDIS. For example, in the IDIS depollution documents for both project vehicles, neither listed gearbox oil, one reporting clutch oil and the other motor oil. These were taken to mean gearbox oil during depollution.

Non-Metal Content of EV Specific Parts Sold for Reuse

As part of ELV target calculations, the non-metal weight of parts sold for reuse is counted towards the 85% reuse and recycling target. As such, related data from the project is considered here.

The focus of this study was to assess reuse and recycling value from the perspective of ATFs and metal recyclers. As such it was not possible to undertake a material breakdown of all the parts placed for sale as they were needed primarily for reuse.

However, it was possible to further break down and analyse two parts from the study and one part was opened to assess its internal make up. An X-ray fluorescent (XRF) gun was used where available to analyse the material make-up of the parts. This aided recycling assessments and also our understanding of the non-metal weight if sold for reuse. Examples of the material breakdown analysis undertaken during the project are provided in the Policy Maker's Matrix.

The results are as follows.

Part	Weight (kg)	Metal/Nonmetal	Estimated non-metal weight
Electric Motor and Reducer 	76.4	The motor and reducer were broken down into five parts; the armature, the magnet drum, the case, internal gear parts and connection plate, all appeared to be and scanned as metal.	Less than 5% - plastic connections, glue round copper in the armature.
DC DC Converter 	15.21	A more extensive breakdown was undertaken, separating the unit into 15 components, of which 5 were considered to be all or part plastic/glass. These were the plastic components, the Printed Circuit Board (PCB), cabling, and some fuses, large and small.	Estimated 15% of the weight of the unit was considered to be non-metal.
Onboard Charger 	16.39	Part opened to assess contents. The case was scanned using an XRF gun which showed it was 95% aluminium with a steel front panel. Inside was a circuit board, covering nearly one third of the space, cables, wiring, and plastic connectors.	Unable to assess.

To accurately assess the non-metal content of EV specific parts, a dedicated study would be needed. Such a study would need to consider a wider range of parts, involve a complete part breakdown, and ideally assess the same part from more than one brand. As discussed in the ELV (End-of-Life) Regulation section of this report, EV specific parts are often combined in different ways in different EVs making clear categorisation and generalisations difficult to achieve. This would add an extra layer of complexity to any study on average non-metal content.

New Regulation on End-of-Life Vehicles and Batteries.

In this section, the project results and learnings are used to provide insights into the potential impacts on and from two pieces of legislation – the ELV Regulation currently in negotiation and the Batteries Regulation.

ELV (End-of-Life Vehicle) Regulation

The Proposal for a Regulation on circularity requirements for vehicle design and on management of end-of-life vehicles was published on the 13th of July 2023. The proposal is designed to replace the current ELV Directive as well as Directive 2005/64/EC on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability ("3R type-approval Directive", adopted in 2005).

The proposal is still under negotiation, but once agreed may well affect the options available to ATFs in the reuse and recycling of EV vehicles. The latest Presidency Compromise text, under the Hungarian Presidency was released in December 2024. In late January 2025 the European Parliament released a Draft Report putting forward a number of changes to the proposal.

The original text, the December 2024 Compromise text and the European Parliament's report are considered here.

Based on the proposal the new ELV Regulation has the potential to:

A. Introduce a list of parts that should be removed at ATFs prior to vehicle shredding (Article 30, Part C Annex VII).

B. Introduce a Circular Vehicle Passport that should provide additional information to ATFs and recyclers on part location and removal, and vehicle recyclability (Article 13).

C. Introduce labelling and warranty requirements for second hand parts. The Regulation states that parts and components assessed as fit for reuse, remanufacturing or refurbishment shall not be considered waste.1 (Article 32).

D. Require Member States to take necessary incentives to promote the reuse, remanufacturing and refurbishment of parts and components, including the option to require maintenance/repair operators to offer used, remanufactured or refurbished parts alongside new parts (Article 33).

E. Introduce a plastics specific recycling target (Article 34).

[1] In the latest European Parliament Draft Report (January 2025), the words 'parts and components' are replaced with the term 'cores'.

These aspects are considered here in relation to the project results.

A and B: List of Parts for Removal and the Circular Vehicle Passport

Of particular relevance to this project is Article 30 of the proposal which outlines a list of parts for removal from all ELVs prior to shredding. The table below presents the initial, Presidency Compromise text and the European Parliament Draft Report versions of this list so far.

	Original Proposal - July 2023 Annex VII, PART C: MANDATORY REMOVAL OF PARTS AND COMPONENTS FROM END-OF-LIFE VEHICLES	Hungarian Compromise Proposal – Dec 2024 Annex VII, PART C: MANDATORY REMOVAL OF PARTS AND COMPONENTS FROM END-OF-LIFE VEHICLES	European Parliament Draft Report 29 January 2025 As is in original proposal unless otherwise stated.	Part in EV
1	Electric vehicle batteries	Electric vehicle batteries, as defined in Article 3 point (141) of Regulation (EU) 2023/1542), including their battery management systems, onboard chargers, casing or housing if present; LMT batteries, as defined in Article 3 point (11) of Regulation (EU) 2023/1542), including their battery management systems, onboard chargers for EVs, casing or housing if present;	Electric vehicle batteries as defined in Article 3, point (14), of Regulation (EU) 2023/1542;	EV Battery
2	E-drive motors, including their casings and any associated control units, wiring, and other parts, components and materials	E-drive motors, including their casings, generators, alternators and cooling fan motors if present		Electric Motor & associated parts
3	SLI batteries (Starting, lighting and ignition) as defined in Article 3, point (12), of Regulation (EU) 2023/****[on batteries and waste batteries]	SLI batteries as defined in Article 3, point (12), of Regulation (EU) 2023/1542 and other batteries as defined in Article 3, point (9) of Regulation (EU) 2023/1542	SLI batteries as defined in Article 3, point (12), of Regulation (EU) 2023/1542 and portable batteries as defined in Article 3, point (9), of Regulation (EU) 2023/1542;	Lead Acid Starter Battery (potentially Li-ion in some marques)
4	Engines	Combustion engines blocks		N/A for BEV but would apply to PHEV and HEV
5	Catalytic converters	Catalytic converters		N/A for BEV but would apply to PHEV and HEV
6	Gear boxes	Gear boxes including control units		Reducer
7	Windshields, rear and side windows made of glass	At least 70% of the total glass from windshields, rear and side windows made of glass, including rooftop glass installations	- Removed from list	Yes, same as ICE
8	Wheels	Rims		Yes, same as ICE
9	Tyres	Rubber Tyres		Yes, same as ICE
10	Dashboards	- Removed from list	- Removed from list	Yes, same as ICE
11	Directly accessible parts of the infotainment system, including sound, navigation, and multimedia controllers, including displays of a surface greater than 100 square centimetres	Directly accessible parts of the infotainment system, including sound, navigation, including radar or lidar control units and sensors if present, and multimedia controllers, including displays of a surface greater than 100 square centimetres	- Removed from list	Yes, 2 units - same as ICE - Display Unit (Sat Nav/Media) Display Unit (Speedometer/ instrument panel)

12	Headlights, including their actuators	Head and taillights, including their actuators		Yes, same as ICE
13	Wire harnesses	Main wire harnesses, including internal and external charging cables if present	- Removed from list	May include high voltage cabling in addition to Wire Harness in EVs
14	Bumpers	Crash management system, including bumper covers, beams and crash boxes		Yes, same as ICE
15	Fluid containers	Plastic fuel tanks	Fuel containers	BEV and PHEV would not have fuel tank but would have other fluid containers for liquids like coolant.
16	Heat exchangers	Heat exchangers	- Removed from list	AC Condenser/Radiator, PTC Heaters
17	Any other mono-material metal components, heavier than 10 kg	- Removed from list		None identified in study
18	Any other mono-material plastic components, heavier than 10 kg	- Removed from list		None identified in study
19	Electrical and electronic components: · inverters of the electric vehicles; · printed circuit boards with a surface area, larger than 10 cm^2; · photo-voltaic (PV) panels with a surface area larger than 0.2 m^2; · control modules and valve boxes for the automatic transmission.	Electrical and electronic components: a) inverters and DC-DC converters with electric voltage of at least 24V or a weight above 1 kilogram of electric vehicles; b) printed circuit containing boards with particularly high precious metal content; c) photo-voltaic (PV) panels with a surface area, larger than 0.2 square metres; d) control modules and valve boxes for the automatic transmission; e) oxygen, radar and lidar sensors if present.		Likely to apply to: Inverters /Converters/Onboard Chargers in the vehicle
20	-	E-call system		Yes, same as ICE
21	-	Components of carbon fibre reinforced plastics		

Parts in orange are those that are potentially exempted from the mandatory removal requirement under certain circumstances.
Article 30 Point 2:
Original Proposal (July 2023): Requirement to remove pre shredder shall not apply to this part if an ATF demonstrates that post-shredder technologies separate materials from parts and components listed as efficiently as manual dismantling processes or semi-automated disassembly processes.
Hungarian Compromise Text (December 2024): Parts or components without a reuse, remanufacturing or refurbishing potential are not mandatory to remove prior to shredding if an ATF demonstrates, that post-shredder technologies separates materials from parts and components as designated in the second column of Part C, of Annex VII, as efficiently as manual dismantling processes or semi-automated disassembly processes and that the criteria and limit values of Part G, points (1) and (2), of Annex VII are met.
European Parliament Draft Report (January 2025): It shall not be mandatory to remove prior to shredding parts or components without a reuse, remanufacturing or refurbishing potential if an authorised treatment facility demonstrates, that post-shredder technologies separates materials from parts and components listed in Part C, entries 13 to 19, of Annex VII, as efficiently as manual dismantling processes or semiautomated disassembly processes or if there is no demand for the used parts and components of these entries.

The original proposal states that alongside parts found in both EVs and ICE vehicles, EV Batteries and E-drive motors will be required to be removed at the ATF level for reuse or separate recycling. Inverters and some parts with printed circuit boards will also be subject to this requirement, unless it can be proven their materials can be separated in line with the required standards post shredder. The most recent European Parliament Draft Report proposes that these parts will not need to be removed if there is no demand for the used parts and components.

IDIS has the potential to aid ATFs in the identification of these parts and their location as does the introduction of Circular Vehicle Passports (CVPs). Both have the potential to support the *Design Circular* objective of the ELV Regulation proposal which aims to improve exchange of information with the dismantling sector. It is currently not known exactly how the two systems, IDIS and the CVP, will interact.

Based on experience from this project, specific EV parts including those currently in Annex VII, PART C, may not be immediately identifiable. As such any measures to remedy this through easily accessible information provision will be vital to support any removal requirements agreed through proposal negotiations.

The study highlighted that variation in both design, naming and location of EV specific parts across marques slowed part identification as well as dismantling time.

The project found that EV specific parts come in different combinations. For example, in one vehicle the DC DC Converter and the Traction Motor Inverter were separate, in the other they were combined. For other parts, they had the same name and were visually similar to their ICE vehicle counterparts, but in practice were high voltage alternatives only found in EVs. This is of less importance to the application of the current list of parts for removal, but its importance could change if removal requirements were placed on parts based on their specific EV characteristics.

Differences in part names across marques included the DC DC Converter also known as the Auxiliary Power Module by some vehicle manufacturers. Another part name, the Power Electronics Controller, was recognised by some manufacturers and not by others.

In terms of variation in part location, a key example from the project was the Onboard Charger that was in the front of one vehicle, the rear of the other.

As EV volumes increase the accessibility of information on the presence of parts, their identification and their location will become increasingly important. This is important not only to support voluntary reuse and recycling initiatives but will be vital if a mandatory list of EV parts for removal remains in the proposal.

The recycling value estimates gathered during the project indicate that it may be of financial benefit for ATFs to remove certain components regardless of their inclusion in the final list of mandatory parts removal. This may apply to items like EV circuit boards and other component sources of precious metal recovery. This stream would likely see ATFs funnel materials to electronics recyclers in the future as well as metal shredders for recycling.

C: The introduction of labelling for parts for reuse, refurbishment or remanufacturing to include the part name, Vehicle Identification Number (VIN) and ATF name.

As already mentioned, during the project we found that part names are not standardised across marques and can also be found in different part combinations. For this reason, as well as the technology being unfamiliar to ATFs, accurate labelling of parts by ATFs may not be as simple as it would first appear.

Again, good information provision to ATFs, whether that be through IDIS or the CVP, will be important to enable them to accurately label parts for sale.

D: Potential incentives to promote the reuse, remanufacturing and refurbishment of parts and components including requiring maintenance/repair operators to offer these types of parts alongside new parts.

If utilised by member states, this option has the potential to grow the reuse market impacting demand as well as remanufacturing options. Results seen in the project in relation to demand would likely improve in response to such measures.

Information from the project may also provide initial indications as to where such initiatives could be focused, for example supporting parts where there are already signs of demand, or parts where there is considered to be a remanufacturing opportunity.

Importantly this initiative has the potential to increase contributions made to reuse targets as the Regulation states that successfully remanufactured or refurbished parts should be counted towards target achievement.

E: Introduction of a Plastics Recycling Target

Article 34 in the original proposal introduces a 'yearly target for the recycling of plastics of at least 30% of the total average weight of plastics of end-of-life vehicles'.

More research is needed into the material breakdown of EV components across marques to assess the extent their reuse and recycling will contribute to target achievement. This, as discussed earlier, will apply to reuse figures, but importantly it will also impact on this plastics target.

The methodology of future Shredder Trials will be impacted by the new Regulations. Article 49 outlines that implementing acts will be used to set out the methodology for calculation and verification of the attainment of the reuse, recycling and recovery targets. Future Shredder Trials will likely need to consider both the impact of EVs as well as plastic content across a representative sample of all ELVs to allow for accurate contribution assessments. In addition, as EV volumes increase, and single stream flows of EV parts become possible, there will be demand for individual component datasets on metal and plastics content, to aid target calculation. As individual component datasets become warranted, analysis should focus on any mandatory parts removal list or parts that are economically beneficial to remove.

In summary, the proposed ELV Regulation intends to increase material recovery, by increasing the recycling of EV components and by encouraging better collection systems. It should also incentivise manufacturers to design EVs for easier disassembly and recycling, including through the provision of information. This should help maximise the reuse of valuable components and materials, thus contributing to the circular economy.

Batteries Regulation

REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC

In July 2023 a new EU Batteries Regulation was adopted. The Regulation applies to all batteries, but in relation to an EV, the following categories are relevant:

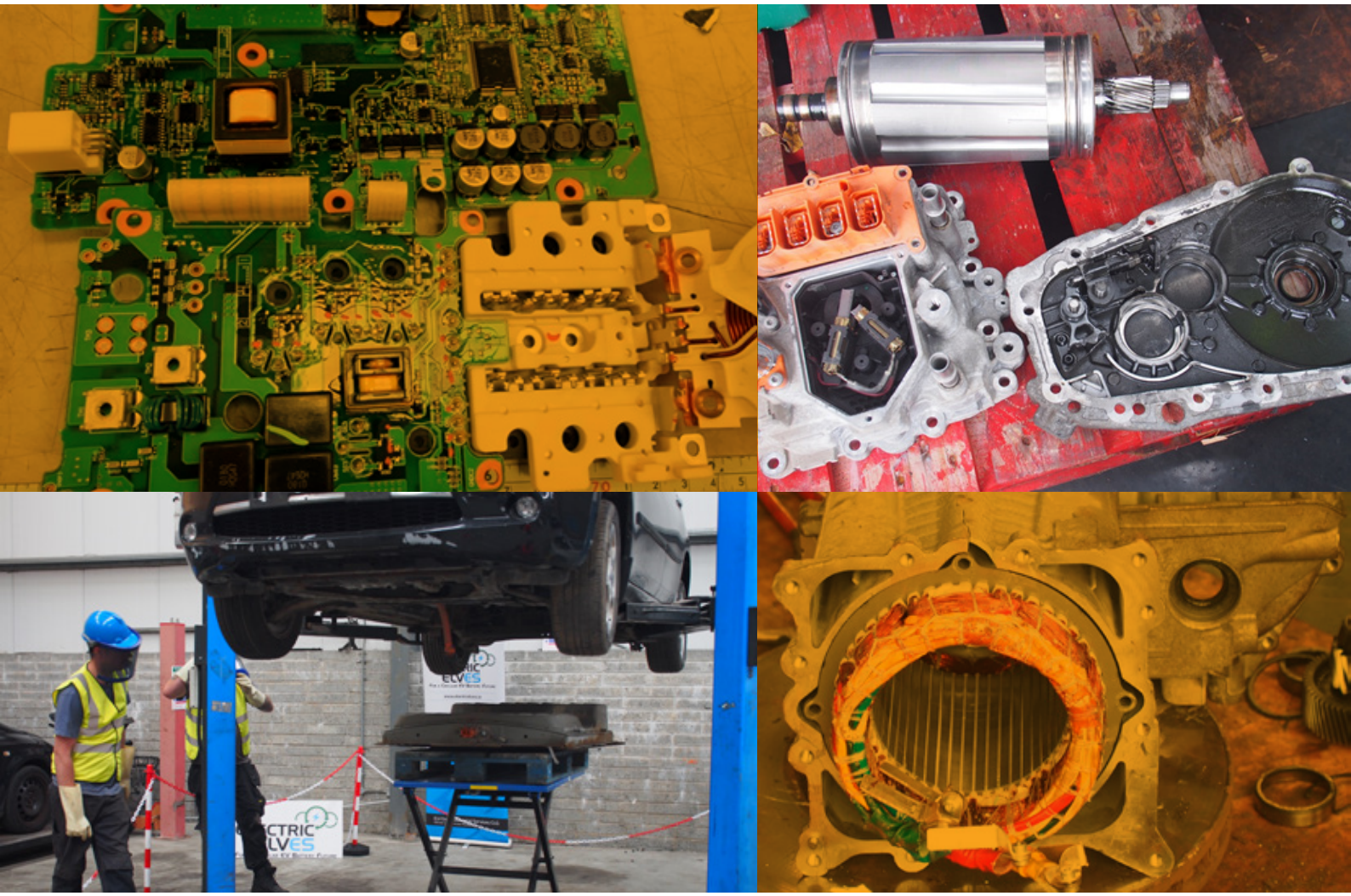
- Electric Vehicle - Those from M, N, O, & L (over 25kg) category vehicles.
- Starter, Lighting and Ignition (SLI).
- Portable (under 5kg).

Once removed from ELVs, EV batteries fall under the remit of the Batteries Regulation which specifies:

- Batteries are to be removed from ELVs in accordance with the ELV Directive.
- Producers have Extended Producer Responsibility for batteries and must provide for their free collection and recycling.
- ATFs and Distributors will have to hand over waste batteries to a Waste Management Operator (WMO) that is contracted to a Producer/Producer Responsibility Organisation (PRO).
- Batteries should be labelled with specified information, in addition EV batteries will have a Battery Passport.
- Higher recycling efficiency targets for li-ion and Lead Acid Batteries.
- Battery material recycling targets including for cobalt and lithium.
- A framework for the reuse and repurposing of EV batteries. This specifies that the economic operator placing a repurposed battery on the market for the first time is considered the Producer of that battery with the product and Extended Producer Responsibility obligations that implies.

Implications for reuse and recycling value

The Batteries Regulation will formalise the handling of EV batteries by ATFs with a framework for their reuse and repurposing. Under the Regulation, the ATF will be required to hand over the waste battery to a WMO contracted with a Producer or PRO. Any Economic Operator placing an EV battery back on the market following preparation for reuse or preparation for repurposing will become its new Producer, with manufacturer and Extended Producer Responsibility obligations.



This is a significant change to current practice, and it is unknown exactly what impact this will have on the economics of EV battery reuse and repurposing. Therefore, although the EV battery sold well and quickly during the project, the €2,000 resale value achieved is not an indicator of the future value of EV batteries for ATFs.

The impact of increased recycling efficiency targets for li-ion batteries, and for their elemental materials, is difficult to predict but may positively affect battery recycling value once recycling technologies are fully established. The Regulation aims to increase target achievement on recycling and the use of recycled content, to facilitate the circularity of materials for EU battery manufacturing.

This said, with no battery recycling facilities within the island of Ireland and the difficulties in achieving the economies of scale to warrant them, transport costs will likely remain the biggest contributor to battery recycling costs.

Appendix A: How the Research was Carried Out

Developing the Parts List

The first stage of the project was to research the key parts of an electric vehicle. This was done though a mixture of desk-based research and feedback from project stakeholders including vehicle manufacturer representatives, ATFs, metals recyclers, the EPA and DECC.

A car parts list was created, based on BEV related parts identified and the existing car parts list used for the reporting of reuse data for ELV target achievement. List creation focused on BEV specific parts, although many parts would also be found in HEVs and PHEVs. The list was then provided to the stakeholder group requesting feedback on the classification of parts and on the potential metrics to be measured. The stakeholders were asked to add any BEV parts we had not yet identified.

The parts list was categorised based on whether the parts were:

O: Only found in BEVs, HEVs or PHEVs

D: Different in a BEV to an ICE vehicle

M: Maybe different in a BEV to an ICE vehicle (depends on marque/model)

S: Is the Same in an ICE compared to a BEV

I: Only found in an ICE vehicle and not in a BEV

The dismantling initially focused on the parts identified as O or D. Further refinement using manufacturer input resulted in the use of another category: M - Maybe different in a BEV to an ICE vehicle (depends on marque/model). This was relevant to parts like PTC heaters that in the majority of EVs are high voltage but in some marques are powered by the 12v battery and would therefore be the same in ICE vehicles.

Once the BEVs had been chosen for dismantling, further extensive feedback on the parts list was gained from representatives of Nissan Ireland and Renault Ireland in relation to the cars being dismantled.

Sourcing an Electric Vehicle and an ATF to undertake the dismantling.

In parallel to parts list development, communications were sent out to the ELVES ATF Network seeking expressions of interest to be the host ATF for the dismantling. An ATF that specialises in parts reuse was chosen from those that responded, with other ATFs also being given the opportunity to participate in the project by being part of the ATF

FocusGroup. A fortnight before the dismantling, two staff from the host ATF were able to attend Electric Vehicle dismantling training through the Electric ELVES programme. Both technicians also familiarised themselves with the relevant vehicle dismantling documents available on IDIS.

A review of popular BEV marques and models was undertaken using data from Motorstats.ie as well as a review of potential second hand BEVs that were available for sale within the project budget. Communications were sent out to vehicle manufacturer contacts, in case any were able to assist in the sourcing of a BEV for dismantling.

Following the research, it was decided to purchase a 2015 Renault Zoe for dismantling. In response to our communication to our ATF Network, the project was also offered a 2012 Nissan Leaf for dismantling under the project. This enabled us to dismantle the BEV specific parts from two electric vehicles, rather than the originally intended one. This was undertaken within budget, with significant benefit to the resulting dataset.

Dismantling the vehicles

The dismantling of the two vehicles occurred over three consecutive days in June 2023 at Autotowing Ltd, Limerick. Two ATF staff were on hand, initially working together to shut down the vehicle and remove the batteries, and then to complete the rest of the depollution and remove the parts identified in our parts list. ELVES staff photographed the removed parts and weighed them. Weights were also taken of the depollution materials as they were removed from the vehicles.

Recording of reuse, recycling and remanufacturing metrics.

Once the parts were removed from the vehicles, they were listed for sale on the Autotowing website and on eBay. The vehicles for 'breaking' were also listed on DoneDeal and an ad placed in the Recycled Parts section of Autobiz magazine. A representative of eBay advised the project team on how best to advertise the parts (for example the importance of using a white background) and how to retrieve sales data from their system.

Initially recyclers were asked for their input and provided with photographs, weights and measurements for the parts removed. However, feedback from them suggested more information on material content was really needed for them to make more accurate assessments of value. To aid recycling assessment two activities were undertaken. Firstly, two of the BEV parts that had been damaged on removal (a motor and an inverter) were disassembled, the materials were assessed and weighed, including sending some samples to the UK for assessment. Secondly for parts destined for reuse, these were assessed by staff from Oran Metal recycling using an XRF gun. The data from these assessments and any additional information from desk research was added to the reuse and recycling matrix and provided to recyclers for value assessment.

To assess remanufacturing opportunities a survey was created for companies currently involved in remanufacturing. This asked information on where they operated (for example do they source from Ireland) whether they currently remanufacture any of the BEV specific parts identified or whether they think there may be an opportunity to do so in the future. Vehicle manufacturers and ATFs were also asked as part of the second round of consultation if they knew of any remanufacturing opportunities for these parts.

The process, analysis, and data gathering resulted in the final EV Data Matrix.

Appendix B: EV Specific Parts - Further Information on Function and Presentation

EV Battery

The EV Battery may be air cooled or use coolant. The Battery Management System maybe in the battery pack or external. Likely to contain one or more control modules.

Electric Motor

The Electric Motor in an EV takes the place of the engine. There may be up to four per vehicle, for example one on each axle, or one per wheel. According to the Joint Research Centre, all HEV and PHEV e-drive motors are Rare Earth Permanent Magnet (REPM) Motors. For BEVs, 77% use REPM Motors, the rest use REPM Free motors. The magnets in motors can affect the operation of electrical devices including pacemakers, mobile phones, smart watches etc.

Reducer/Gearbox

The Reducer in an EV takes the place of a gearbox or transmission in an ICE vehicle; it may be separate to the motor or combined as one part. A Reducer is similar to a gearbox but would normally only have one speed/gear. It would normally include the differential.

Converter

A Converter changes voltage up or down. For example, the DC DC Converter (also known as Auxiliary Power Module) converts DC from the battery pack to lower voltage for use in lower voltage applications (e.g. lights, power steering).

Inverter

An Inverter changes AC to DC or DC to AC. AC to DC Inverters are also known as Rectifiers.

An example would be the Onboard Charger (OBC). The OBC converts AC power from external sources, such as residential outlets, to DC power to charge the vehicle battery pack. The OBC is not used for DC Charging (high speed charging) and would not be found in a hybrid (as no external charging).

A Traction Motor Inverter would change DC power from the battery to AC power for the electric motor.

Junction Box

Many EVs have a part called the Junction Box, this is an enclosed unit that houses and protects the electrical components and connections. Examples of components often combined in EVs: Combined Charging Unit (CCU) or Power Control System (PCS) - DC DC Converter with Onboard Charger Inverter with Converter – DC DC converter with the motor inverter. Charger Assembly with Junction Box - the Onboard Charger with the Junction Box.

EV Specific Control Modules

There can be various control modules within a vehicle. These operate like small computers receiving signals and controlling some of the vehicle functions. Some of these are only found in EVs.

Examples of EV specific ones are the Battery Management Controller, Vehicle Control Module/Unit, Vehicle Sound Pedestrian Control Unit.

Charging Cable

The external charging cable for connecting charge points to the EV. Some EVs may come with more than one for connection to different types of charge point.

Charging Socket

Charging Socket would include socket and cables.

High Voltage Cables

In vehicle for carrying voltage to battery and from battery out to other functions. High Voltage Cables (over 60 volts DC or 30 volts AC) are coloured orange.

AC Compressor or Heat Pump

In an EV this is a high voltage component, powered by the battery. An EV would have an AC Compressor or a Heat Pump, with both parts looking similar. An AC Compressor would provide cooling, a Heat Pump both heat and cooling.

Coolant Lines

Due to the nature of what needs to be cooled within an EV (battery, potentially other HV components) Coolant Lines will be different in an EV to an ICE vehicle.

ABS Unit/Pump/Controller

Similar to ICE but more efficient in an EV and not interchangeable.

Axle

May be different in an EV to an ICE due to varying weight and components in the vehicle.

PTC (Positive Temperature Coefficient) Heaters

Provides heat in an EV - as there is no engine to provide thermal energy. PTC heaters can be found in all types of vehicle. In the marques surveyed, in BEVs they tended to be high voltage and as such different to ICE Vehicles. In some HEV/PHEVs they may be low voltage e.g. 12v systems.

Power Steering Boxes/Steering Motor

May or may not be different in EVs. In some EVs it is different to account for the additional weight inherent in BEVs.

Brake Pads, Shoes and Callipers

Some EVs may have specific pads & shoes, in others they would be the same as that found in ICE vehicles. Some EVs do not have Brake Shoes.

Brake Master Cylinder

In some BEVs the Brake Master Cylinder is the same as in an ICE vehicle, in others it will be different. An iBooster (Vacuum-independent electromechanical brake booster) takes the place of control module, master cylinder and brake booster, it will be common in EVs, although not EV specific.

Heating Resistor

Same part as used in ICE for the majority of marques surveyed. Kia differed in that a control module is employed where a field effect transistor would be used in their ICE vehicles.

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Company Information

ELV Environmental Services CLG.
Unit 15-4, Workspace Centre,
Mayoralty Street, Drogheda,
Co. Louth, Ireland.

Telephone: + 353 (0) 41 98 35 55 0
Email: info@elves.ie
Web: www.elves.ie

Design: 360 Design info@360design.ie