TREASURE

D3.2: Report on disassemblability analysis

30/04/2022 (M11)

Authors:

A.Ortego; A.Valero; R.Magdalena (UNIZAR)

M. Liendo; E. Alquezar, A. Diez (ILSSA)

M. Iglesias (SEAT)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Technical References

Project Acronym	TREASURE
Project Title	leading the TRansion of the European Automotive SUpply chain towards a circulaR future
Project Coordinator	POLITECNICO DI MILANO (POLIMI)
Project Duration	36 months as of 1 June 2021

Deliverable No.	3.2
Dissemination level [1]	PU
Work Package	WP3 - Automotive value chain digitalization
Task	3.2 - Disassemblability analysis
Lead beneficiary	UNIZAR
Contributing beneficiary(ies)	SEAT/ILSSA/MARAS
Due date of deliverable	30/04/2022
Actual submission date	29/04/2022

Document history		
V	Date	Beneficiary partner(s)
V1.0	08/04/2022	POLIMI, POLLINI, MARAS
V2.0	27/04/2022	POLIMI, POLLINI, MARAS
V3.0	29/04/2022	All

[1] PU= Public
PP= Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

DISCLAIMER OF WARRANTIES

This document has been prepared by TREASURE project partners as an account of work carried out within the framework of the EC-GA contract no 101003587. Neither Project Coordinator, nor any signatory party of TREASURE Project Consortium Agreement, nor any person acting on behalf of any of them:

a. makes any warranty or representation whatsoever, express or implied,
   i. with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
   ii. that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
   iii. that this document is suitable to any particular user's circumstance; or
b. assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the TREASURE Project Consortium Agreement, has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

EXECUTIVE SUMMARY

This deliverable shows the main outcomes of Task 3.2, about the disassemblability analysis.

The disassemblability assessment has been carried out to the three vehicles selected in Task 3.1 (SEAT Leon model II, SEAT Leon model III and SEAT Ibiza model IV). Specific critical components identified in Task 3.1 were examined.

This activity has been performed in MotorLand Aragon facilities from 1 November 2021 to 28 February 2022. During this period, the disassemblability of 24 critical components has been assessed for each vehicle. Above all (and considering the results of Deliverable 3.1 where the thermodynamic rarity by component was calculated), special attention has been paid to the following car parts: Infotainment units, combi-instruments; exterior mirrors, additional brake lightings; speed sensors; rain sensors and air quality sensors. Nevertheless, additional car parts were analysed and the collected information will be incorporated into the TREASURE platform, that is being developed in WP4.

The work developed under this task has been done under three disassemblability levels. These levels have been defined as those needed to remove parts from the car and, subsequently, to get subparts containing essential recycling fractions as pure as possible: ferrous metals; aluminium, non-ferrous metals excluding aluminium and plastics. The data collected for each selected car part was: location, extent to which it is exposed in case of an accident; whether other critical parts are broken during the disassembly process; average times during the tests; times registered in commercial databases; difficulty level; required tools; and process description.

During the activities, we stated that the average disassembly time was equal to 11 minutes. The use of non-standard tools was only needed to remove the infotainment units used in SEAT Leon model II and SEAT Leon model III. It was stated that even after undertaking the last disassemblability process (level 3), it was not possible to obtain pure fractions, because of the way car parts are designed. Instead, a mix of output fractions (i.e.: plastics plus ferrous or non-ferrous – excluding Al plus non-ferrous – Al) was left. The results of the disassemblability assessment of such components are the starting point of Task 3.3 of this project, devoted to analyse their recyclability through specific metallurgical recycling processes.

In addition to identifying the disassemblability properties of the selected car parts, we have anticipated several eco-design recommendations that could be useful to guide future designs towards improved recyclability. The outcomes of this task (3.2) and task 3.3 on the recyclability of the car parts will be the basis of Task 3.4 about Eco-design, disassemblability and recyclability guidelines and integration with CE indicators.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Index of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Index of tables

Index of Figures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

1. Introduction

Task 3.2 analyses the disassemblability potential of 5 car parts identified as critical in Deliverable 3.1, considering the *"thermodynamic rarity"* indicator. This indicator allows us to assess which specific car parts contain the most valuable metals from a physical point of view.

The following parts have been studied: **Combi instrument; Infotainment; Exterior mirrors; Additional brake lighting and Sensors (rain, speed and ABS, air quality)**. However, and with the aim to contribute as much as possible to populate the platform that will be developed in WP4, up to 24 parts have been analysed.

Moreover, the activities developed in this deliverable are helpful for WP5 (Pilot plant) to supply physical parts and part recycling fractions obtained in disassemblability Level 3 for the design of metallurgical recycling processes.

The disassemblability analysis is essential in analysing the recycling processes based on metallurgical operations. Accordingly, components or subcomponents with the highest critical raw materials concentration can be targeted, achieving improved metallurgical recovery yields.

2. Previous considerations about End-of-Life Vehicles (ELV)

Once a vehicle arrieves at the end of its life, it is sent to an authorized ELV treatment centre where hazardous parts are removed and managed. Some parts with market demand are disassembled to be sold as spare parts, and the rest of the car goes to a shredding plant.

Usually, a car arrives at its end-of-life stage because of two reasons: (1) because of obsolescence, which happens when the car's age is around 11 years[2] and (2) because of an accident, a case where reparation costs are usually higher than the car's intrinsic value.

In the second case, some parts will not be able to be disassembled, either because of damage or because of difficulty in accessing them. For this reason, statistical research has been made using an internal database from ILSSA to check the number of cars that reached the end-of-life for both reasons.

Considering a sample of ELVs managed by ILSSA from 2018 to 2021, from an overall amount of 4.483 ELVs, 170 came from accidents (3,79 %). As it has been mentioned before, in the cases of vehicle accidents, disassembly operations are complicated or even impossible. However, this is a small percentage of cases over the total.

Accordingly, the recommendations defined in this Deliverable, are focused on obsolete ELV, and should be considered the norm.

[2] The average EU vehicle age is 10,8 years according spanish automobile manufacturers association (ANFAC) data. https://anfac.com/actualidad/el-parque-automovilistico-espanol-se-situo-como-uno-de-los-mas-envejecidos-de-europa-en-2020/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

The following figure shows an overview of the state of some ELVs that come from accidents.

A vehicle that caught fire

A vehicle that had a frontal accident

A vehicle that arrived at an ELV authorised centre without the infotainment

Figure 1: Examples of the ELV states when they come from accidents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

3. Definition of terms

The following terms have been defined and adopted during the activities developed to build this deliverable:

- **Part:** a car's component with a code number. These car parts can be usually purchased in vehicles' spare part stores.
- **Subpart:** It belongs to a car part. These parts may (or may not) own code numbers, so they cannot be purchased in the after-sales market. An electronic board can be considered an example of this kind of car part.
- **Disassembly:** Group of tasks to dismantle a part from a car without breaking any other part. After this activity, any car part can be reused again.
- **Extraction:** Group of tasks to remove a component from the vehicle as quickly as possible. Through this method, any other part near the key one could be damaged during the process and, consequently, could not be reused.
- **Difficulty level:** a property of the vehicle's component describing the easiness of disassembly.

The following table shows the criteria used to assign the difficulty level.

Table 1: Difficulty level

Difficulty level	(A) Number and type of tools needed		(B) Number of parts to be disassembled before		(C) Are 2 or more persons required?
High	>5 OR unconventional	OR	>3	OR	YES
Medium	(1-5]	AND	[1-3]	AND	NO
Low	1	AND	0	AND	NO

For each level (high, medium or low), three criteria are considered. The first one, *"number and type of tools needed"* takes into consideration how many tools are required to disassemble the part and if these tools are standard or not. The second one, *"Number of parts to be disassembled before"* analyses how many parts must be disassembled before the key part. It gives an idea about the accessibility of the part. Finally, the third one, *"are 2 or more persons required?"* considers if more than one person is needed to disassemble the part.

The difficulty level is calculated as a result of these criteria and considering the logic (AND/OR) represented in table 1.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

4. Methodology

4.1. Approach

The first step in analysing the disassemblability was to get three vehicles to work with. It was not an easy task because, according to the model ages, the units in ELV treatment centres usually come from accidents and hence, are not suitable to work with them. Nevertheless, three ELV vehicles in good conditions were found for the project.

The vehicles were deposited in MotorLand Aragón facilities, where the disassemblability task was undertaken.

This analysis was divided into three different levels:

- Level 1: disassembly of main parts from the vehicle.
- Level 2: sub-disassembly of the main parts into smaller subparts (if possible[3]).
- Level 3: divide subparts achieved in level 2 into smaller fractions, with the aim to obtain as pure as possible streams: (1) Ferrous metals; (2) Non-ferrous metals [excluding Aluminum (Al)]; (3) Non-ferrous metals [Al] and (4) Plastics.

In addition, (considering the experience acquired working with similar parts and in different models), several eco-design recommendations have been identified.

Critical parts identification – Deliverable 3.1

Disassemblability analysis Deliverable 3.2

Level 1: Disassembling for the car

Level 2: From the main part to smaller subparts (if possible)

Level 3: From smaller subparts to recycling fractions (if possible)

- Ferrous metal
- Non ferrous metal (excluding Al)
- Non ferrous metal (Al)
- Plastics

Ecodesign recommendations and conclussions

Figure 2: Methodology applied in task 3.2

[3] There are cases where the subparts are joined with glue or rivets and as consequence there is not posible to be subdisassembled.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

4.2. Resources

4.2.1. Vehicles selected

The vehicles provided by ILSSA and analysed in task 3.2 were the following:

Table 2: Vehicles used in task 3.2

SEAT Leon model II	

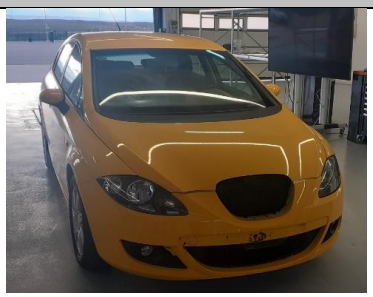



Plate number	VIN number
0610FMW	*VSSSZZZ1PZ7RD78528*
SEAT Leon model III	
	
Plate number	VIN number
7047JCW	*VSSZZZ5FZFR111108*
SEAT Ibiza model IV	
	
Plate number	VIN number
7071HDK	*VSSSZZZ6JZBR104727*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

4.2.2. Facilities

Manual activities developed with vehicles were performed in MotorLand Aragon´s facilities. The work area was constituted by a technical box of 300 m^2 equipped with specific tools. This workspace was equipped with the following materials:

- 4 x 2 m kitted workbenches (273 piece tools sets).
- Solid and liquid residue discharge modules.
- DT3600 scissor car lift.
- Sicam SBM 135L wheel balancing machine.
- Sicam Evo 628 SV1 tyre changer.
- LED lights throughout the entire workspace.
- Air compressor – 7 bar.

Figure 3: Facilities used in Task 3.2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

4.3. Information to be collected from vehicles

Developing a working standard was one of the main challenges of this deliverable. For this reason, the following templates were designed. Using these templates, the information was collected homogeneously, and conclusions were easily obtained. The templates designed for each Level are presented in the following subchapters.

4.3.1. Information collected in Level 1

Table 3: Template used to collect information from disassemblability Level 1

Description	
Location	It describes the vehicle zone (inside, outside, front, lateral, rear) where the part is placed.
Is it very exposed in case of an accident?	This information is essential to know if this part can also be recovered in case an ELV comes from an accident.
Parts to be disassembled before	It is used to determine the accessibility of the part. It gives information about the disassembly difficulty level.
Are other critical parts broken in case of extraction instead of disassembly?	It is used to know if any other critical part can be damaged if the part is quickly extracted instead of carefully disassembled.
Average time in a real case (min)	It is calculated according to results achieved in MotorLand´s lab.
Average time in ideal conditions (min)	It is calculated using commercial software used by garages, insurance companies or vehicle repair centers[4].
Difficulty level	Considering difficulty levels defined in table 1.
Required tools	It shows not only how many tools are required but also if they are standard or not. It gives information about the disassembly difficulty level.
Process description	It is a narrative description of the main operations developed to disassemble the part. This information will be helpful to describe the process in the TREASURE platform developed in WP4.

[4] This information was provided by Centro Zaragoza (https://web.centro-zaragoza.com/en). Centro Zaragoza is a spanish research center with experience assessing disassemblability processes for insurance repairation report purposes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

4.3.2. *Information collected in Level 2*

Table 4: Template used to collect information from disassemblability Level 2

Description	
Average time (min)	It represents the time needed to subdisassemble the main part into as many as possible subparts. It was measured in MotorLand´s lab.
Difficulty level	Considering difficulty levels defined in table 1.
Required tools	It shows not only how many tools are required, but also if they are standard or not.
Process description	It is a narrative description of the main operations developed to disassemble the part into smaller subparts. This information will be helpful to describe the process in TREASURE platform developed in WP4.

4.3.3. *Information collected in Level 3*

Table 5: Template used to collect information from disassemblability Level 3

Ferrous metals	Non-ferrous metals – excluding Al	Non-ferrous metals - Al	Plastics
Images about the components in the recycling fraction	Images about the components in the recycling fraction	Images about the components in the recycling fraction	Images about the components in the recycling fraction

The information provided in Level 3 will be helpful to assess the optimal metal recovery yields that could be achieved when advanced recycling operations are put in place (during task 3.3).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

5. Selected parts

An overview of the composition and the metal's price contained in each of the selected parts obtained from Task 3.1 is summarised in the following table.

Table 6: Information about studied parts

Part	Model	Weight (g)	Plastic weight		Metal weight		Main valuable metals from a thermodynamic rarity point of view												Part value (€)
Infotainment	Leon model II	1.973,99	507,61	25,72%	1.466,38	74,28%	Ta		Pd		Au		Cu		Ag		Ru		1.010,00
							0,6850	57,05%	0,0532	26,21%	0,0626	7,03%	87,2700	5,21%	1,0040	1,54%	0,0019	0,95%	
	Leon model III	1.394,82	940,51	64,72%	454,31	32,57%	Ta		Au		Pd		Cu		In		Zn		942,00
							0,7133	64,34%	0,1515	18,41%	0,0102	5,46%	76,4400	4,94%	0,0288	1,95%	27,4762	1,00%	
	Ibiza model IV[5]	1.750																	---
Combi Instrument	Leon model II	829,89	750,54	90,44%	79,35	9,56%	Au		Ta		Pt		Cu		Ag		In		823,90
							0,5588	53,49%	0,5101	36,24%	0,0148	6,21%	27,8100	1,42%	0,8115	1,06%	0,0114	0,61%	
	Leon model III	733,43	661,27	90,16%	72,16	9,84%	Ta		Au		Pd		Cu		Sn		Ag		642,00
							0,0422	76,15%	0,0346	8,42%	0,0060	6,42%	42,0866	5,44%	6,6046	1,11%	0,3017	1,00%	
	Ibiza model IV	585,56	528,59	90,27%	56,26	9,73%	Au		Ta		Pt		Pd		Cu		In		466,00
							0,3335	45,52%	0,3073	31,12%	0,0269	16,14%	0,0043	2,62%	34,7900	2,25%	0,0085	0,65%	
Exterior mirrors	Leon model II	928,38	514,62	55,43%	413,75	4,57%	Zn		Cu		Ni		Mg		Sn		Sb		189,64
							123,4000	60,79%	39,5300	34,45%	0,8235	1,56%	2,4400	0,89%	0,5499	0,62%	0,2121	0,26%	
	Leon model III	1.156,13	737,10	63,76%	419,02	36,24%	Cu		Ta		Zn		Co		Ni		Au		192,84
							34,8600	44,26%	0,0120	21,42%	21,2000	15,22%	0,1102	4,42%	1,4700	4,08%	0,0013	3,26%	
	Ibiza model IV	711,92	475,87	66,84%	236,04	33,16%	Cu		Mg		Zn		Ni		Sn		Mn		177,96
							14,0900	77,28%	2,3800	5,46%	1,6500	5,13%	0,3598	4,29%	0,3366	2,39%	1,1500	1,32%	

[5] Infotainment metal composition was not calculated in D3.1 so its thermodynamic rarity value is not shown.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Part	Model	Weight (g)	Plastic weight		Metal weight		Main valuable metals from a thermodynamic rarity point of view												Part value (€)
Additional brake lighting	Leon model II	85,55	84,01	98,46%	1,31	1,54%	Au		Ta		Pt		Cu		Ag		Sn		80,00
							0,0144	53,25%	0,0137	37,64%	0,0004	6,22%	0,6448	1,26%	0,0168	0,85%	0,1608	0,41%	
	Leon model III	88,40	81,23	91,89%	7,17	8,11%	Ta		Au		Pd		Cu		Sn		Ag		81,10
							0,0476	73,92%	0,0039	8,21%	0,0007	6,23%	4,5575	5,06%	2,0807	3,00%	0,0756	2,15%	
	Ibiza model IV	89,50	70,14	78,38%	19,35	21,62%	Cu		Cr		Mn		Zn						61,60
							1,4400	79,63%	2,8800	18,70%	0,0900	1,04%	0,0192	0,60%					
Speed sensor	Leon model II	11,69	10,11	86,50%	1,57	13,50%	Au		Cu		Ag		Pd		Sn		Zn		86,28
							0,0005	31,07%	0,8300	26,30%	0,3001	24,47%	0,00004	12,53%	0,0888	3,66%	0,0722	1,29%	
	Leon model III	10,08	7,01	69,48%	3,07	30,52%	Au		Cu		Pd		Sn		Ag		Zn		86,28
							0,0063	91,40%	0,5163	3,95%	0,0001	3,84%	0,0323	0,32%	0,0009	0,19%	0,0328	0,14%	
	Ibiza model IV	9,69	6,53	67,38%	3,16	32,62%	Au		Cu		Pd		Sn		Ag		Zn		86,28
							0,0063	90,40%	0,6467	4,90%	0,0001	3,80%	0,0411	0,40%	0,0009	0,19%	0,0341	0,15%	
Rain sensor	Leon model II	10,88	9,79	91,65%	0,91	8,35%	Au		Ta		Pt		Cu		Ag		Sn		106,00
							0,0099	53,06%	0,0094	37,50%	0,0002	6,21%	0,4640	1,32%	0,0171	1,25%	0,1579	0,58%	
	Leon model III	16,52	11,22	67,90%	5,30	32,10%	Ta		Cu		Au		Pd		Ni		Ru		194,80
							0,0109	73,08%	1,5500	7,47%	0,0007	7,16%	0,0001	6,17%	0,2921	3,05%	0,0000	0,93%	
	Ibiza model IV	This model cannot be equipped with a rain sensor																	
Air quality sensor	Leon model II	This model cannot be equipped with an air quality sensor																	
	Leon model III	14,19	13,22	93,15%	0,97	6,85%	Ta		Au		Pd		Cu		Ru		Sn		76,04
							0,0077	76,97%	0,0005	7,69%	0,0001	6,47%	0,7953	5,63%	0,0000	1,05%	0,0926	0,85%	
	Ibiza model IV	This model cannot be equipped with an air quality sensor																	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

6. Example about the disassemblability process – The case of combi instrument

An example based on the combi instrument is included for a better understanding about the disassemblability process carried out in this deliverable. The information for the rest of the parts analysed is included in Annex I.

6.1. SEAT Leon model II

Level 1: Disassembling from the car

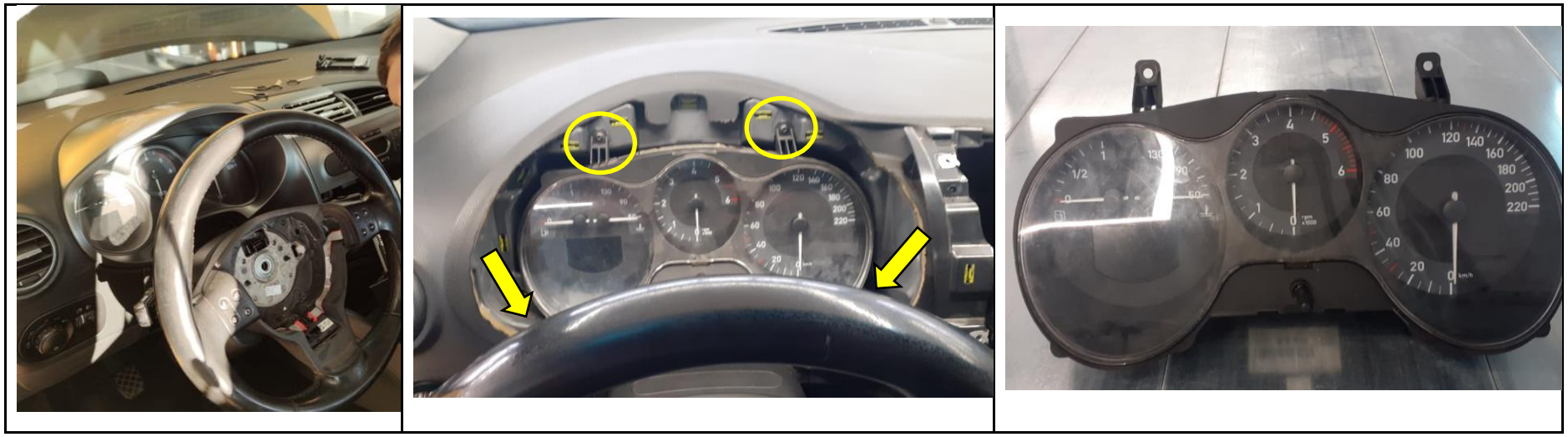


Figure 4: Combi Instrument level 1 disassembly process – SEAT Leon model II

The image on the left shows the combi instrument location and the plastic case that covers the screws. In the central image, the plastic case has been removed, and the four torx screws are accessible. The image on the right shows the part extracted from the car.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

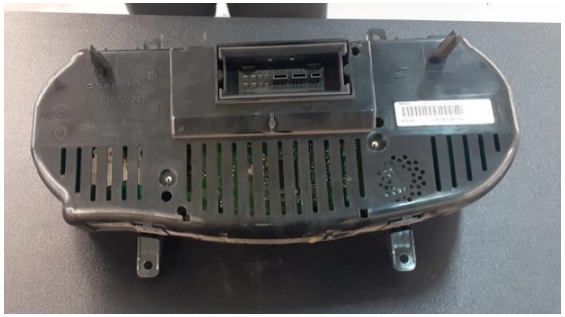


Figure 5: Combi Instrument level 2 disassembly process – SEAT Leon model II

Description	
Average time in real case	< 5 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx and flat screwdriver.
Process description	The first step is to remove the torx screws that join the combi instrument's main body. Subsequently, plastic cases can be separated. Afterwards the indicators can be unclipped, and finally, the different parts are separated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

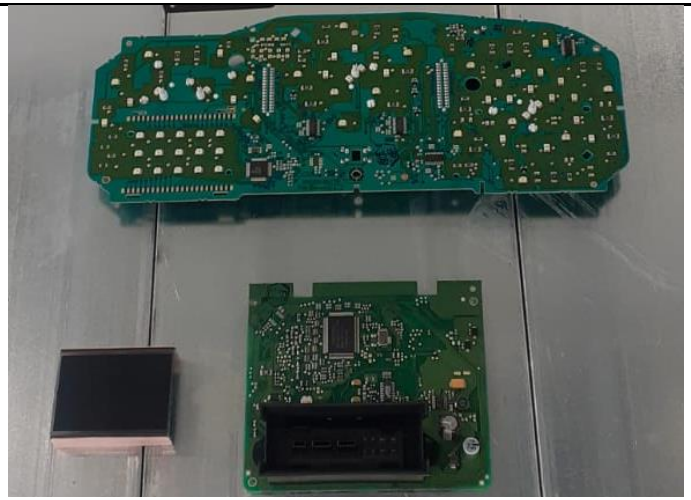
Plastics	Non-ferrous metals-excluding Al	Ferrous metals
		

Figure 6: Combi Instrument level 3 disassembly process – SEAT Leon model II

The three fractions obtained are: 1) the cases which are made of plastics; 2) the electronics which mainly contains non-ferrous metals (excluding Al); and 3) the display structure which is made of ferrous metals.

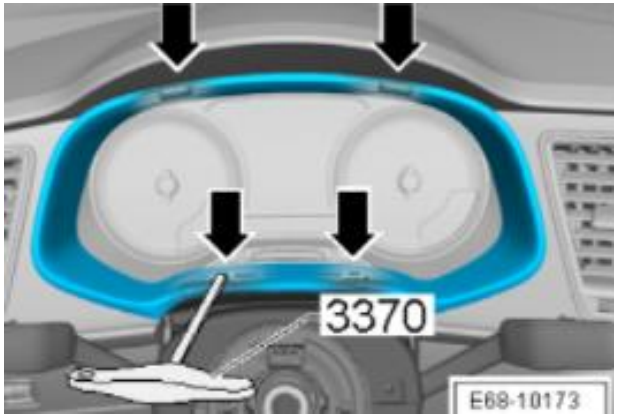
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

6.2. SEAT Leon model III

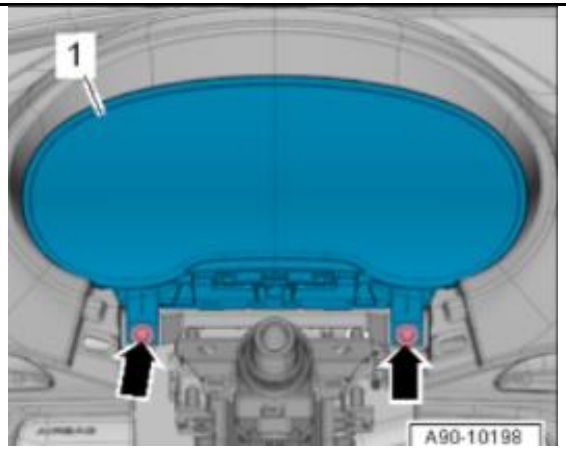
Level 1: Disassembling from the car

(1)

(2)



(3)



(4)

Image 1 shows the extraction of the plastic case. The case is fastened through 4 union clips as shown in image 3. Once the plastic case is removed two torx screws are accessible to be unscrewed, and the combi instrument can be disassembled (images 2 and 4).

Figure 7: Combi Instrument level 1 disassembly process – SEAT Leon model III

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

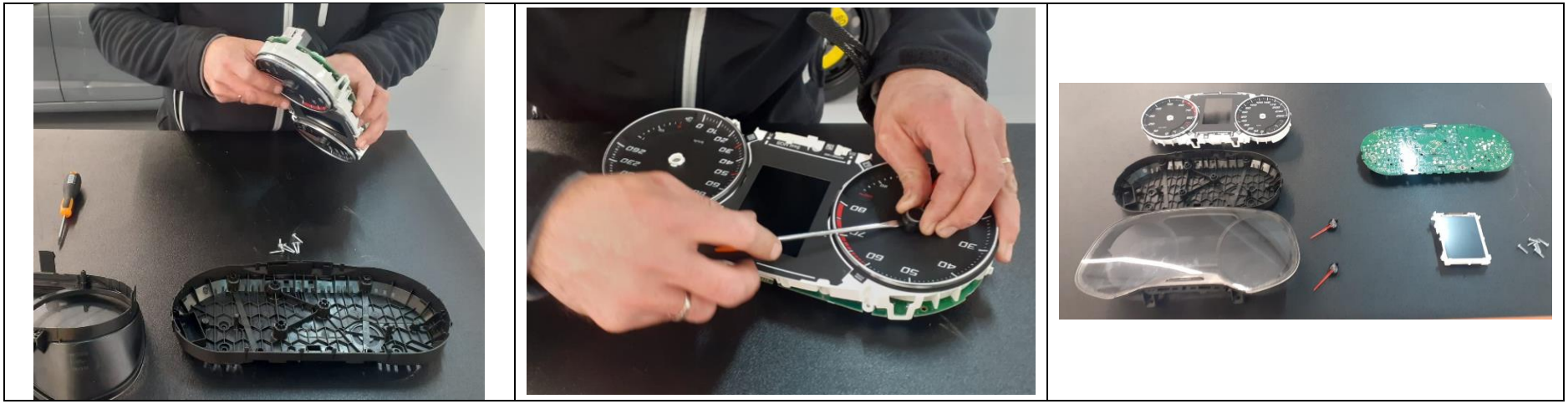


Figure 8: Combi Instrument level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 5 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx and flat screwdriver.
Process description	The first step is to remove the torx screws that join the combi instrument. Subsequently, the plastic cases are separated. Afterwards the indicators can be unfastened, and finally, the different parts are separated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

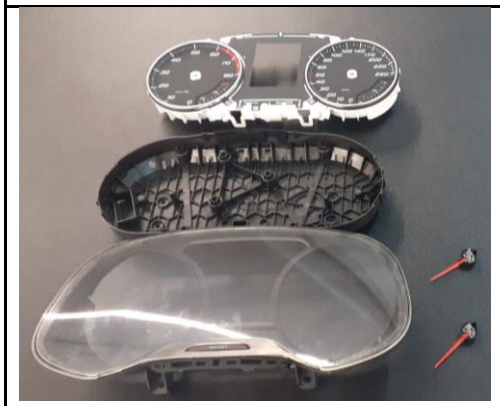
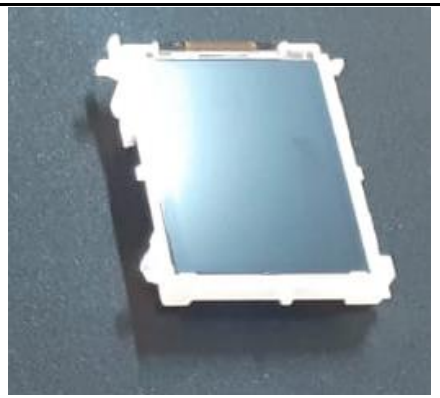
Plastics	Non-ferrous metals-excluding Al	Non-ferrous metals-Al + Non-ferrous metals-excluding Al	Ferrous metals
			

Figure 9: Combi Instrument level 3 disassembly process – SEAT Leon model III

The four fractions obtained are: 1) The cases which are made of plastics; 2) the electronics which mainly contains non-ferrous metals (excluding Al); 3) the display which has non-ferrous metals; and 4) the screws which are manufactured with ferrous metals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

6.3. SEAT Ibiza model IV

Level 1: Disassembling from the car

Figure 10: Combi Instrument level 1 disassembly process – SEAT Ibiza model IV

The left image shows the combi instrument location and the plastic case that covers the screws. In the central image shows when the plastic case has been removed, and the three torx screws are accessible. The image on the right shows the part extracted from the car.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

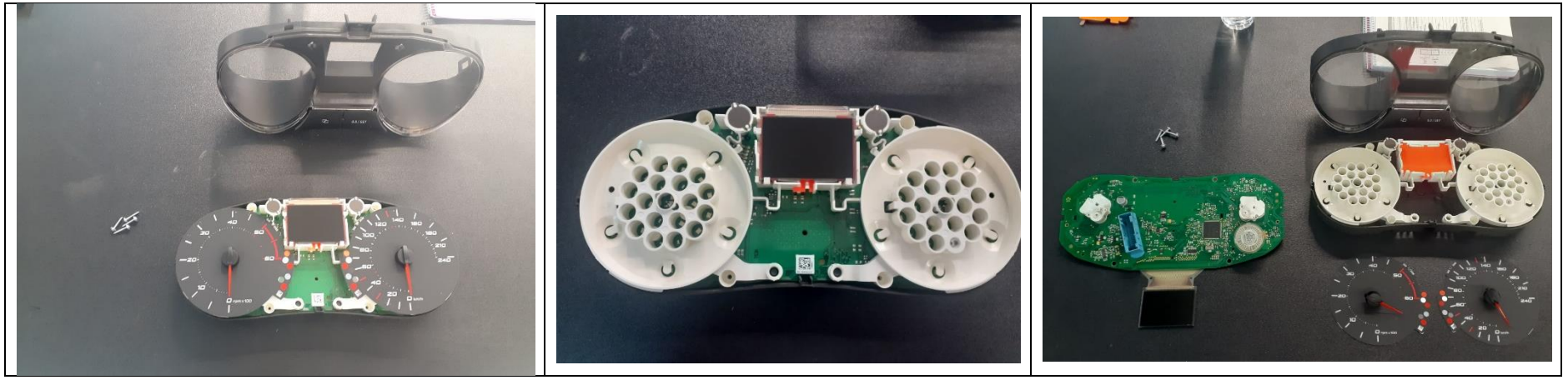


Figure 11: Combi Instrument level 2 disassembly process – SEAT Ibiza model IV

Description	
Average time in real case	< 5 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx and flat screwdriver.
Process description	The first step is to remove the torx screws that join the combi instrument. Subsequently, plastic cases are separated. Afterwards, the indicators can be unfastened, and finally, the different parts are separated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

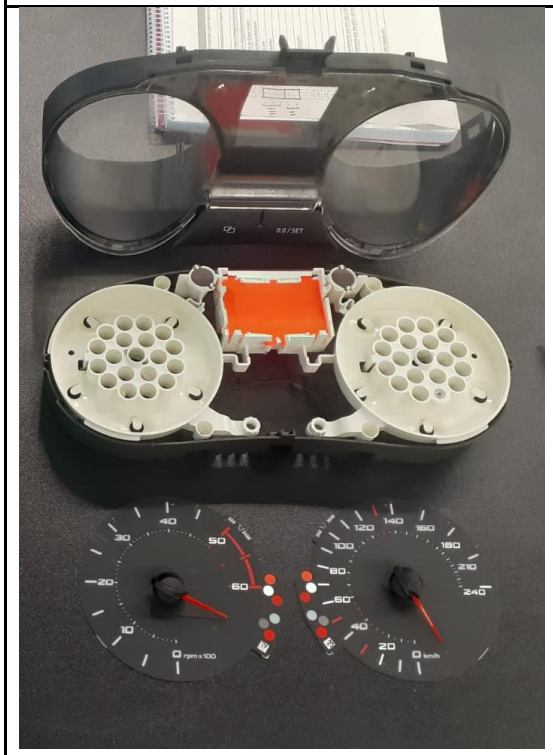
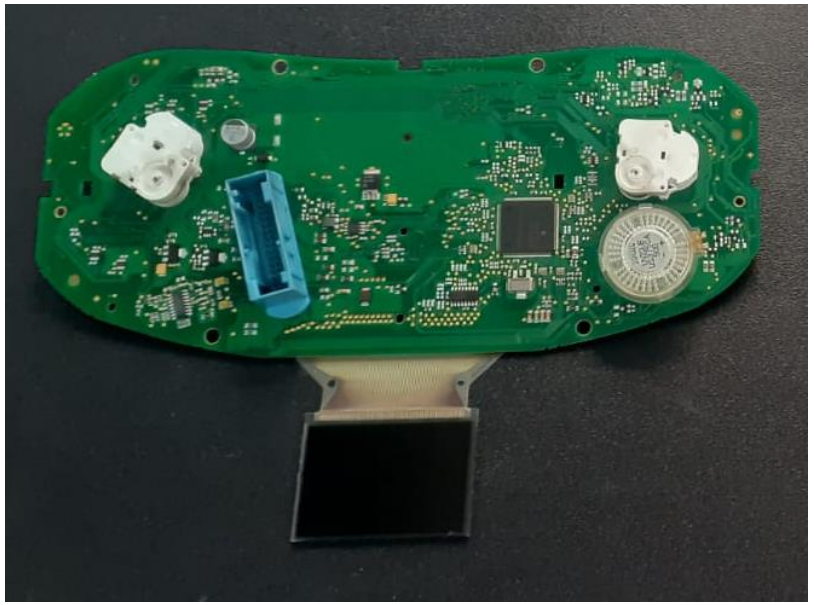
Plastics	Non-ferrous metals-excluding Al	Ferrous metals
		

Figure 12: Combi Instrument level 3 disassembly process – SEAT Ibiza model IV

The three fractions obtained are: 1) The cases which are made of plastics; 2) the electronics and the central display which mainly contain non-ferrous metals (excluding Al); and 3) the screws which are made of ferrous metals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

7. Main results

7.1. Disassembly Level 1

The following table summarises the results obtained in Level 1 disassembly process. Such cases where variable values are counterproductive for disassemblability purposes are marked in red.

Table 7: summary of results obtained for Level 1 disassembly process

		Is it very exposed in case of an accident?	Parts to be disassembled before	Are other critical parts broken in case of extraction instead of disassembling?	Average time in real case	Average time in ideal conditions	Difficulty level	Required tools
Infotainment	Leon model II	NO	NO	NO	10 min	6 min	High	Non-standard
	Leon model III	NO	NO	NO	10 min	6 min	High	Non-standard
	Ibiza model IV	NO	NO	NO	10 min	6 min	Medium	Standard
Combi-Instrument	Leon model II	NO	YES	NO	9 min	9 min	Medium	Standard
	Leon model III	NO	YES	NO	9 min	9 min	Medium	Standard
	Ibiza model IV	NO	YES	NO	9 min	9 min	Medium	Standard
Exterior mirrors	Leon model II	YES	YES	NO	50 min	45 min	Medium	Standard
	Leon model III	YES	YES	NO	12 min	21 min	Medium	Standard
	Ibiza model IV	NE	NE	NE	NE	NE	NE	NE
Additional brake lighting	Leon model II	NO	NO	NO	5 min	6 min	Low	Standard
	Leon model III	NO	NO	NO	5 min	6 min	Low	Standard
	Ibiza model IV	NO	NO	NO	5 min	6 min	Low	Standard
Speed sensor	Leon model II	NO	YES	NO	10 min	6 min	Low	Standard
	Leon model III	NO	YES	NO	10 min	9 min	Low	Standard
	Ibiza model IV	NO	YES	NO	10 min	6 min	Low	Standard
Rain sensor	Leon model II	NE	NE	NE	NE	NE	NE	NE
	Leon model III	NO	YES	NO	---	6 min	Medium	Standard
	Ibiza model IV	NA	NA	NA	NA	NA	NA	NA
Air quality sensor	Leon model II	NA	NA	NA	NA	NA	NA	NA
	Leon model III	NO	YES	NO	21 min	20 min	Medium	Standard
	Ibiza model IV	NA	NA	NA	NA	NA	NA	NA

NE Not equipped in the model used in the project

NA Not-available in this model

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Relevant outcomes:

- There is only one part (exterior mirror) that is usually exposed in case of an accident. The other parts are protected and should be available for subdisassembly.
- There were several car parts that needed to be removed in order to access the selected critical part. However, none of the parts that had to be removed were classified as critical in Deliverable 3.1.
- The average disassembly time is 11 min. There is only one part in SEAT Leon model II with a quite high disassembly time (exterior mirrors – 50 minutes). This is a consequence of the front lift motor location. Removing exterior mirrors requires the disassembly of door panels in any model. Nevertheless, in this model the lift motor is located inside the door plastic panel instead of inside the door metal body. As a result, removing the door panel is more complicated than in the other cases.
- Only one part (infotainment used in SEAT Leon model II and SEAT Leon model III) requires non-standard tools for the disassembly process.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

7.2. Disassembly Level 2

Table 8 summarises the results obtained during level 2 disassembly process.

Table 8: summary of results obtained for Level 2 disassembly process

		Average time in real case?	Difficulty level	Required tools
Infotainment	Leon model II	< 10 min	Low	Standard
	Leon model III	< 10 min	Low	Standard
	Ibiza model IV	< 10 min	Low	Standard
Combi-Instrument	Leon model II	< 5 min	Low	Standard
	Leon model III	< 5 min	Low	Standard
	Ibiza model IV	< 5 min	Low	Standard
Exterior mirrors	Leon model II	< 5 min	Low	Standard
	Leon model III	< 5 min	Low	Standard
	Ibiza model IV	NA	NA	NA
Additional brake lighting	Leon model II	< 1 min	Low	Standard
	Leon model III	< 1 min	Low	Standard
	Ibiza model IV	< 1 min	Low	Standard
Speed sensor	Leon model II	NP	NP	NP
	Leon model III	NP	NP	NP
	Ibiza model IV	NP	NP	NP
Rain sensor	Leon model II	NE	NE	NE
	Leon model III	< 1 min	Low	Standard
	Ibiza model IV	NA	NA	NA
Air quality sensor	Leon model II	NA	NA	NA
	Leon model III	< 1 min	Low	Standard
	Ibiza model IV	NA	NA	NA

NE Not equipped in the model used in the project
NA Non-available in this model
NP Not possible to be subdisassembled

Relevant outcomes:

- There is only one part (speed sensor) that cannot be subdisassembled into smaller subparts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

7.3. Disassembly Level 3

Table 9 summarises the results obtained during level 3 disassembly process.

Table 9: summary of results obtained in Level 3 disassembly process

		Non-ferrous metals - excluding Al	Non-ferrous metals - Al	Ferrous metals	Plastics	Mix of fractions
Infotainment	Leon model II	X	X	X	X	
	Leon model III	X		X	X	fm+p+nfm
	Ibiza model IV	X	X	X		
Combi-Instrument	Leon model II	X		X	X	
	Leon model III	X		X	X	nfm(ex Al)+nfm
	Ibiza model IV	X		X	X	
Exterior mirrors	Leon model II			X	X	nfm+p+fm
	Leon model III			X	X	nfm+p & nfm (ex Al)+p
	Ibiza model IV	NA	NA	NA	NA	NA
Additional brake lighting	Leon model II	X			X	
	Leon model III	X		X	X	
	Ibiza model IV	X			X	
Speed sensor	Leon model II					fm+nmf+p
	Leon model III					fm+nmf+p
	Ibiza model IV					fm+nmf+p
Rain sensor	Leon model II	NE	NE	NE		
	Leon model III	X		X	X	
	Ibiza model IV	NA	NA	NA		
Air quality sensor	Leon model II	NA	NA	NA		
	Leon model III	X			X	
	Ibiza model IV	NA	NA	NA		

NE	Not equipped in the model used in the project
NA	Non-available in this model
fm	ferrous metal
nfm	non ferrous metal
nfm (ex Al)	non-ferrous metal excluding Al
p	plastic

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Relevant outcomes:

- Only one part (speed sensor) cannot be subdisassembled into the required recycling fractions.
- In the rest of the cases, different subparts can be subdisassembled. Nevertheless, the separation degree achieved for the different fractions varies according to the given car part.
- For example, the infotainment used in SEAT Leon model II has a subcomponent (CD reader) that cannot be subdisassembled. Consequently, a mix of ferrous, non-ferrous metals and plastics is left.
- In the case of the combi instrument used in SEAT Leon model III, the information displayed is joined with the metallic cover, and as a consequence, there are fractions of non-ferrous metals with and without Al that cannot be separated.

8. Valuable insights towards Eco-design recommendations

We anticipate the following eco-design recommendations based on the manual disassembly processes that took place during this Task. Further eco-design recommendations will be gathered during Task 3.3 and all will be collected for deliverable 3.4.

- The use of glues to join some parts is very extended. For example, glue is used in the front lighting to join the transparent front case with the main lighting body. Consequently, these two components cannot be separated, and all metals used in the reflector must be sent to recycling with the plastics case.
- Thermal rivets are also very extended and should be avoided when possible. For example, in the case of on board units, the electronic boards are joined to the plastic cases using this union method. This fact makes the separation of the two main fractions (non-ferrous metals excluding Al and plastics) non-feasible.
- The case of the LEDs used in rear lighting must also be improved. The SEAT Ibiza model IV was equipped with rear LED lights, and this unit cannot be subdisassembled. As a result, the recycling fraction is a mixology of non-ferrous metals and plastics. On the other hand, this design does not allow any reparation possibility.
- Sometimes, the designs have evolved in suh a way as to hinder repairability. The case of the front window lifting mechanism is a clear example. In SEAT Leon model II, the door panel contains the electrical engine and the driving mechanism. Consequently, an easy task as removing the door panel needs near about 1 hour of work. This fact highly hinders the disassembly of valuable parts such as exterior mirrors, door units or lift motors.
- In SEAT Leon model III, the door unit was separated from the engine. This makes its electronics to be easily disassembled.
- In SEAT Leon model II the front window cleaner system needs two engines. This is a consequence of a design that is more oriented towards aesthetical reasons than performance reasons. In this model, the wiper arms are moved in opposite directions, and two engines are needed. In the following model (SEAT Leon model III), the design with a single motor was adopted, reducing thereby the number of critical parts.
- Electronic units are usually accessible as ECUs or onboard units. However, the accessibility of airbag units should be improved. These units are placed under the dashboard, requiring around 20-30 minutes of disassembly time.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

- Another positive fact stated has been the design of the combi instrument. In the past, it was the norm that the steering wheel and the airbag had to be removed before accessing the combi instrument. However, in the studied models, this operation was reasonably straightforward.
- The use of non-standard tools was only required in the disassembly of infotainment units used in SEAT Leon model II and SEAT Leon model III. It is recommended to apply a system similar to the SEAT Ibiza model IV where torx screws are used.

- Generators and starters are two critical parts because of the high content of copper and rare earths. It would be advisable to remove both parts from the car before shredding. Both parts could be retrofitted and used again in new cars or aftersales markets. Finally, the location in the engine area makes the disassemble task more difficult than for other parts located elsewhere. However, there is still room for improvement. For instance, the generator should be in the upper part of the accessory belt instead of the lower part.

- In the case of exterior mirrors, which are very valuable from a material point of view, the design should be oriented towards disassemble them from the exterior side instead of from the interior, where the interior door panel needs to be disassembled. This situation also happens with front lights. As it is now, bumpers or wheel covers need to be removed, making this operation unfeasible from a recyclability point of view.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

9. Conclusions

When cars arrive at the end-of-life, they are sent to a shredder, where all car parts become mixed. Recycling processes that follow are very effective in managing high volumes of ELVs and recovering steel and aluminium alloys. However, they are not suitable for recovering minor metals like those used in electronics.

As a result of the activities performed for the three selected cars, we can conclude the following:

- From a disassemblability point of view, vehicles are designed so that the largest part of the components can be substituted with new ones in case of fault. Nevertheless, in these cases, the repairing process has an owner that assumes repairing costs. On the contrary, in ELV, the residual value of the vehicle is very small, and disassembly processes need to be much faster and straightforward to facilitate a proper recycling of critical raw materials.

- Considering the analysed parts, they are not frequently repaired. Although there are still professionals who repair combi-instruments or generators, repairability is not cost-effective in most cases. This fact makes that such parts are not designed to be subdisassembled. As a result, it is not easy to obtain recycling fractions rich in high critical raw material concentrations so that specific metallurgical recycling processes can be applied.

- Most of the electronic car parts frequently use fast join methods such as glues or thermal rivets, because manufacturing costs are considerably reduced. However, this is very counterproductive from a repairability and recyclability point of view as subdisassemblability is often hindered.

In short, vehicle design focuses on fast and cheap manufacturing processes. However, this often works against the disassemblability and recyclability of the product. The current transition to new types of vehicles (electric, connected) must seriously rethink design, given the supply chain problems and the scarcity of raw materials recently faced by the car manufacturing industry. This new design should be oriented towards reusability, repairability and recyclability to prevent the further loss of 25 % of the mineral capital used in vehicles[6].

[6] Ortego A, Valero Al, Valero A, Iglesias M. Downcycling in automobile recycling process: A Thermodynamic assessment. Journal of Resources, Conservation and Recycling. September 2018. https://doi.org/10.1016/j.resconrec.2018.04.006

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10. Annex I – Disassemblability process description

10.1. Infotainment

10.1.1. SEAT Leon model II

Level 1: Disassembling from the car

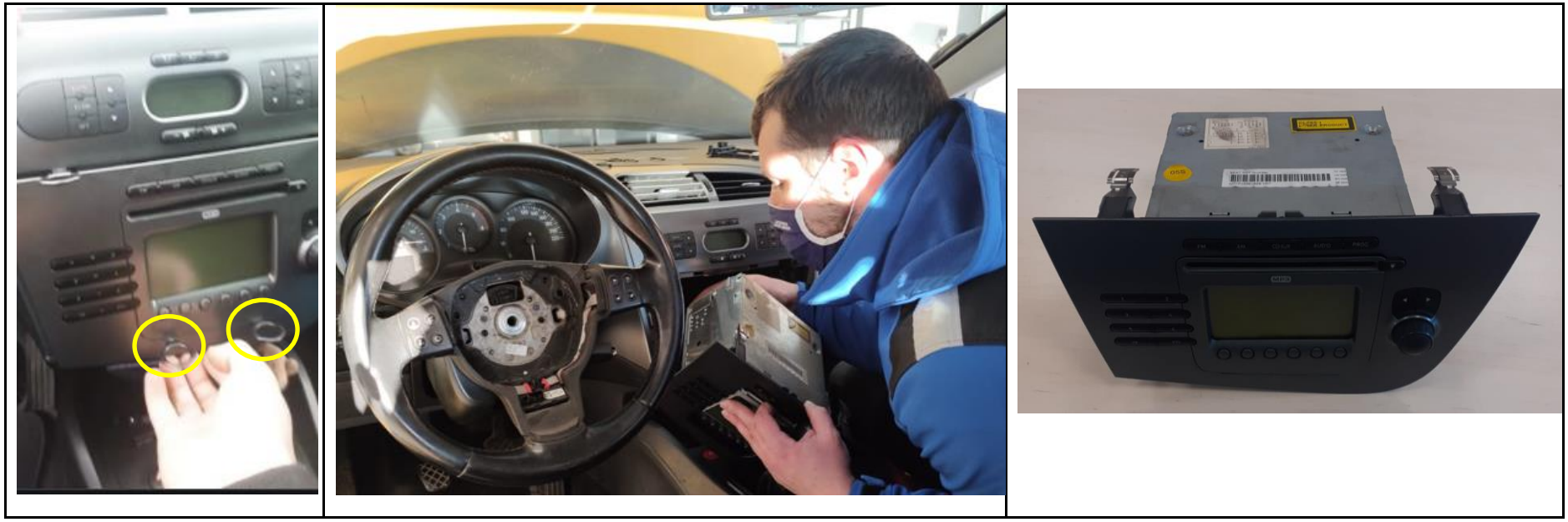


Figure 13 Infotainment level 1 disassembly process – SEAT Leon model II

The left image shows the four flat tools needed to unlock the infotainment clipping system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 14: Infotainment level 2 disassembly process – SEAT Leon model II

Description	
Average time in real case	< 10 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx
Process description	All the subparts of the main structure are joined using screws so the part can be subdisassembled into small subparts: main electronic boards, frontal cover and structure. Nevertheless, it must be highlighted that an electronic board placed in the bottom part of the main body is welded to it and, as a consequence, it cannot be separated.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

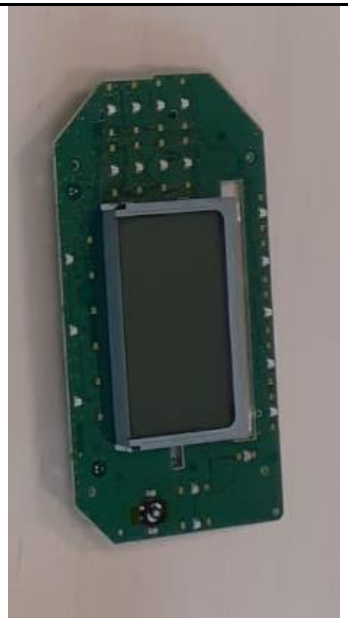
Plastics	Non-ferrous metals-excluding Al	Ferrous metals – Non-ferrous metals-excluding Al	Ferrous metals
			

Figure 15: Infotainment level 3 disassembly process – SEAT Leon model II

Four different fractions are obtained in this part. The cover, which is made of plastics. The electronic and the front display that are mainly built with non-ferrous metals (excluding Al). The main body with the CD reader which is mainly manufactured with ferrous and non-ferrous metals (excluding Al) and finally the metallic covers with are made of ferrous metals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.1.2. SEAT Leon model III

Level 1: Disassembling from the car

Figure 16: Infotainment level 1 disassembly process – SEAT Leon model III

The left image obtained from SEAT garage manual shows the location of the four flat tools. These tools are needed to unlock the infotainment clipping system. In our case, we manufactured four tools *ad hoc.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

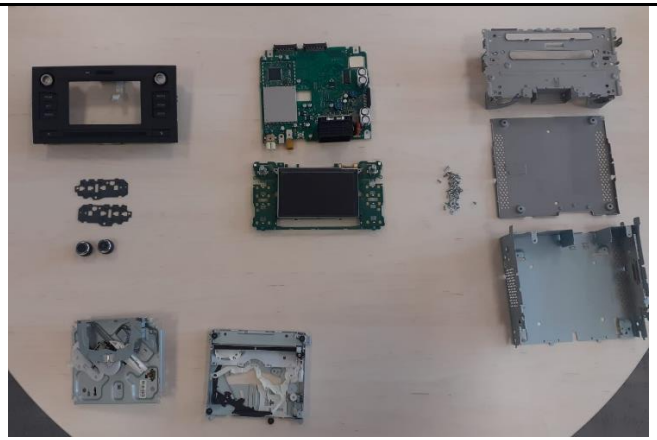


Figure 17: Infotainment level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 10 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx
Process description	All the subparts of the main structure are joined using screws so the part can be subdisassembled into small subparts: main electronic boards, frontal cover and structure.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

Plastics	Non-ferrous metals-excluding Al	Ferrous metals – Plastics – Non-ferrous metals	Ferrous metals
			

Figure 18: Infotainment level 3 disassembly process – SEAT Leon model III

Four different fractions are obtained in this part. The cover is made of plastics, the electronics which is mainly built with non-ferrous metals (excluding Al), the main body with the CD reader that is mainly manufactured with ferrous and plastics and finally, the metallic covers are made of ferrous metals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.1.3. SEAT Ibiza model IV

Level 1: Disassembling from the car

Figure 19: Infotainment level 1 disassembly process – SEAT Ibiza model IV

The image on the left shows that the infotainment is installed with the frontal cover. The image in the middle shows the infotainment without the plastic cover and the location of the four torx screws . Finally, the image on the right shows the infotainment unit out of the car.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 20: Infotainment level 2 disassembly process – SEAT Ibiza model IV

Description	
Average time in real case	< 10 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx
Process description	All the subparts of the main structure are joined using screws so the part can be subdisassembled in small subparts: main electronic boards, frontal cover and structure.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

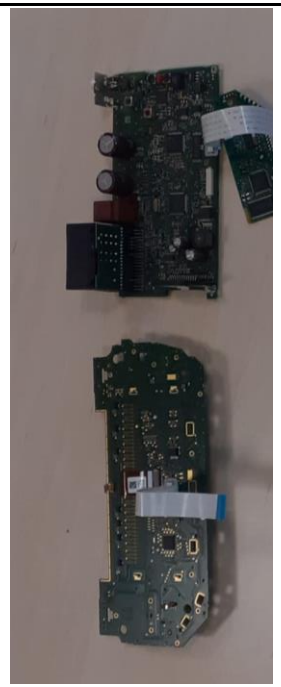
Plastics	Non-ferrous metals-excluding Al	Ferrous metals
		

Figure 21: Infotainment level 3 disassembly process – SEAT Ibiza model IV

Three different fractions are obtained in this part. The cover which is made of plastics, the electronics which is mainly built with non-ferrous metals (excluding Al), and the main body structure which is made of ferrous metals.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.2. Exterior mirrors[7]

10.2.1. SEAT Leon model II

Level 1: Disassembling from the car

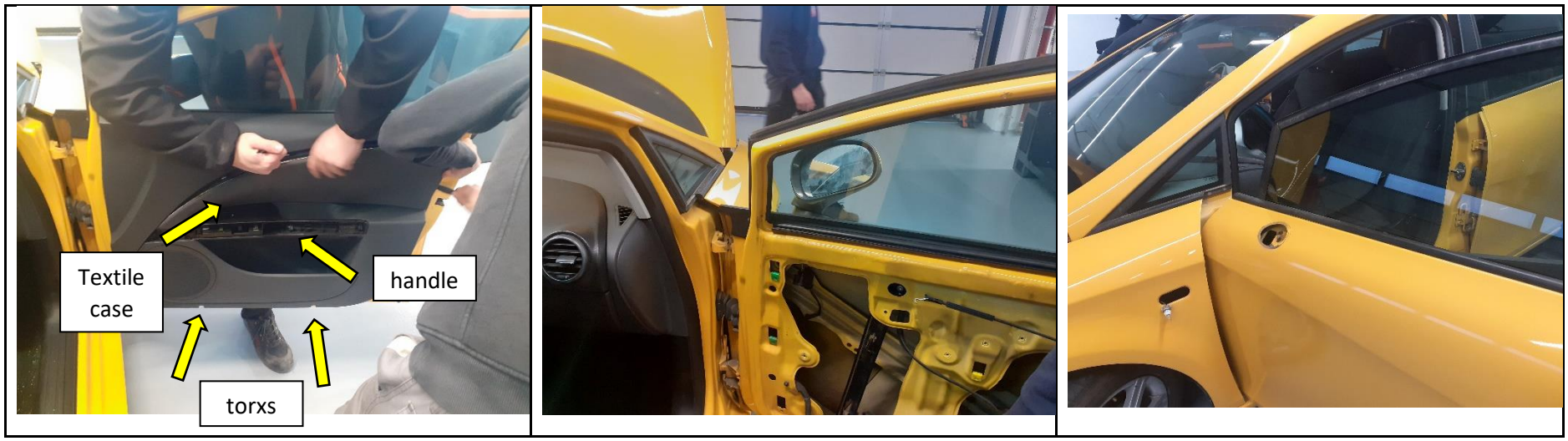


Figure 22: Exterior mirror level 1 disassembly process – SEAT Leon model II

To disassemble the mirrors it is necessary to remove the inner door panel. To do it, there are two torx screws in the lower part (as it is shown in the image on the left). Subsequently, the plastic case of the handle must also be removed to unscrew several screws. Besides, the speaker cover must also be removed using a flat screwdriver. Once this is done, it is possible to remove another torx screw. The textile case must then be removed and all torx screws can be unscrewed. The image on the left represents this process. In the central image, the door without the door panel is shown. To disassemble the mirror, it is necessary to unplug the electrical connector and once the torx screw is removed, the mirror can be separated from the door.

[7] In SEAT Ibiza model IV case, the vehicle provided had manual regulation system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 23: Exterior mirror level 2 disassembly process – SEAT Leon model II

Description	
Average time in real case	< 5 minutes
Difficulty level	High/Medium/**Low**
Required tools	Conventional: torx / flate screwdriver
Process description	The first step is to remove the mirror. It can be done by pulling it out because it is clipped. Next, the front cover can be separated from the main body by clicking it out. After that the mirror engine can be unscrewed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

Plastics	Non-ferrous metals + plastics + ferrous metals	Ferrous metals
	  	

Figure 24: Exterior mirror level 3 disassembly process – SEAT Leon model II

Three different fractions are obtained in this part. The case is only made of plastics, and the screws are made of steel. However, three parts (main body, mirror adjustment system and the mirror) cannot be divided into further subparts even if they are manufactured with different fractions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.2.2. SEAT Leon model III

Level 1: Disassembling from the car

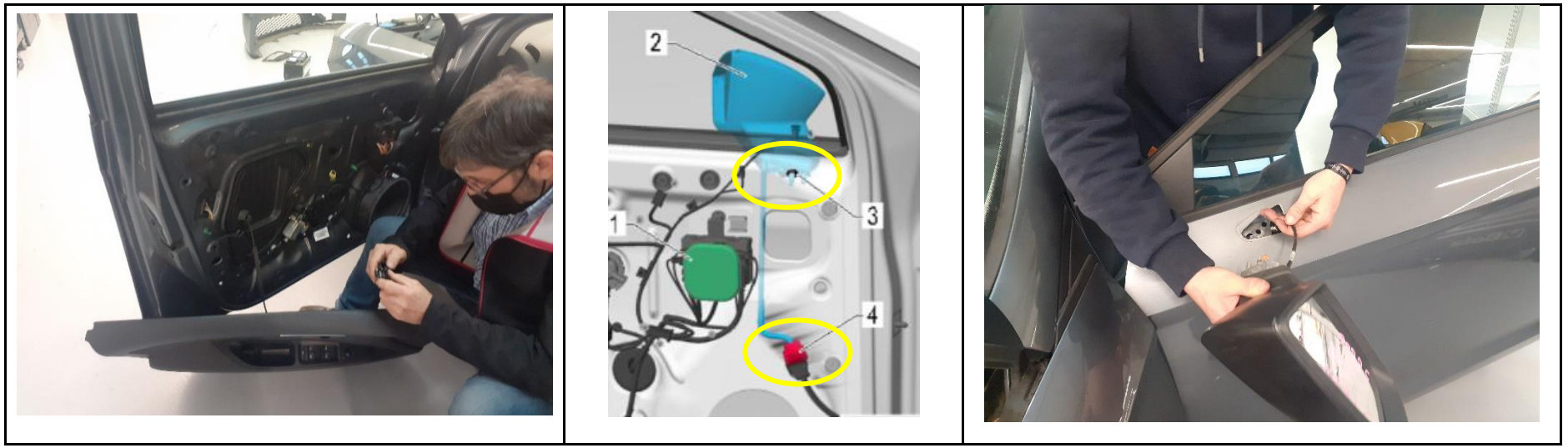


Figure 25: Exterior mirror level 1 disassembly process – SEAT Leon model III

To disassemble the mirrors it is necessary to remove the inner door panel. In this case, the panel removal process is easier than before because the panel has fewer screws. To unscrew all of them the plastic handle cases need to be removed. Once this is done, the panel can be unclipped using a flat screwdriver. Next, as shown in the central image, it is necessary to unplug the electrical connector and remove the torx nut. The image on the right shows how the mirror is disassembled.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 26: Exterior mirror level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 5 minutes
Difficulty level	High/Medium/Low
Required tools	Conventional: torx / flate screwdriver
Process description	The first step is to remove the mirror. It can be done by pulling it out because it is clipped. Next, the front cover can be separated from the main body by clicking it out. After that the LED can be disassembled by slacking three nuts. The engine that adjusts the mirror can now be disassembled by slacking the central screw.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

Plastics	Non-ferrous metals (excluding Al) + plastics	Non-ferrous metals (Al) + plastics	Ferrous metals
			

Figure 27: Exterior mirror level 3 disassembly process – SEAT Leon model III

Four different fractions are obtained in this part. The case is only made of plastics, and the screws are made of steel. However, the main body is an aluminium and plastic mix and the wiring, LED, mirror adjustment system and the mirror are a mixology of non-ferrous metals (excluding Al) plus plastics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.3. Additional brake lighting

10.3.1. SEAT Leon model II

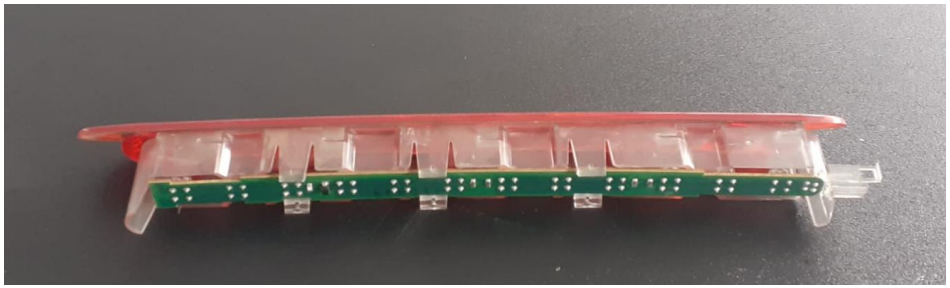
Level 1: Disassembling from the car

Figure 28: Additional brake lighting level 1 disassembly process – SEAT Leon model II

The first step is to unsettle the part to disassemble the rear additional braking system. It can be done using a flat screwdriver or even manually. Once the part is removed, the wiring needs to be unplugged. The image on the right shows the part removed from the car and the joining systems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts



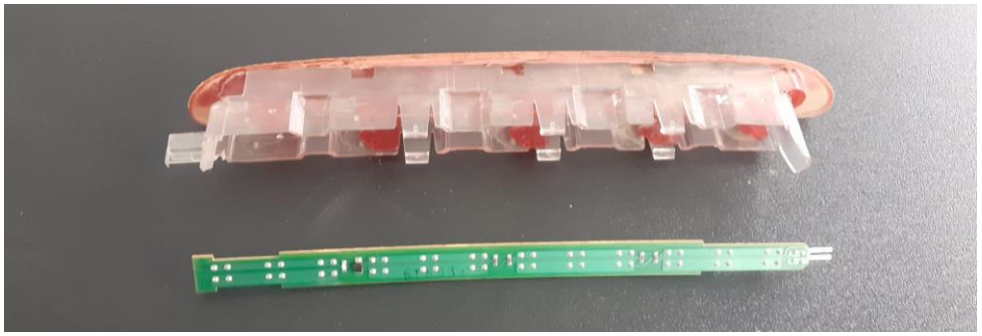


Figure 29: Additional brake lighting level 2 disassembly process – SEAT Leon model II

Description	
Average time in real case	< 1 minute
Difficulty level	High/Medium/**Low**
Required tools	Flat screwdriver
Process description	The main LED and electronic device are clipped with the light cover to facilitate a manual separation or using a plate screwdriver. Moreover, the metal clips joining the light to the body can also be removed using a flat screwdriver.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

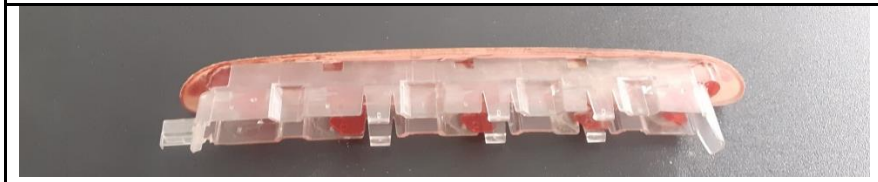
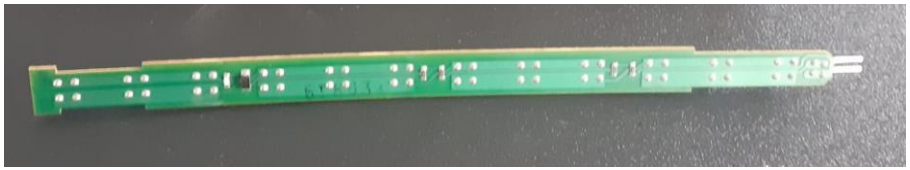
Plastics	Non-ferrous metals (excluding Al)
	

Figure 30: Additional brake lighting level 3 disassembly process – SEAT Leon model II

There are two recycling fractions, the first one with the plastic case and the second one with the LED and electronics, which are non-ferrous metals (excluding Al).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.3.2. SEAT Leon model III

Level 1: Disassembling from the car

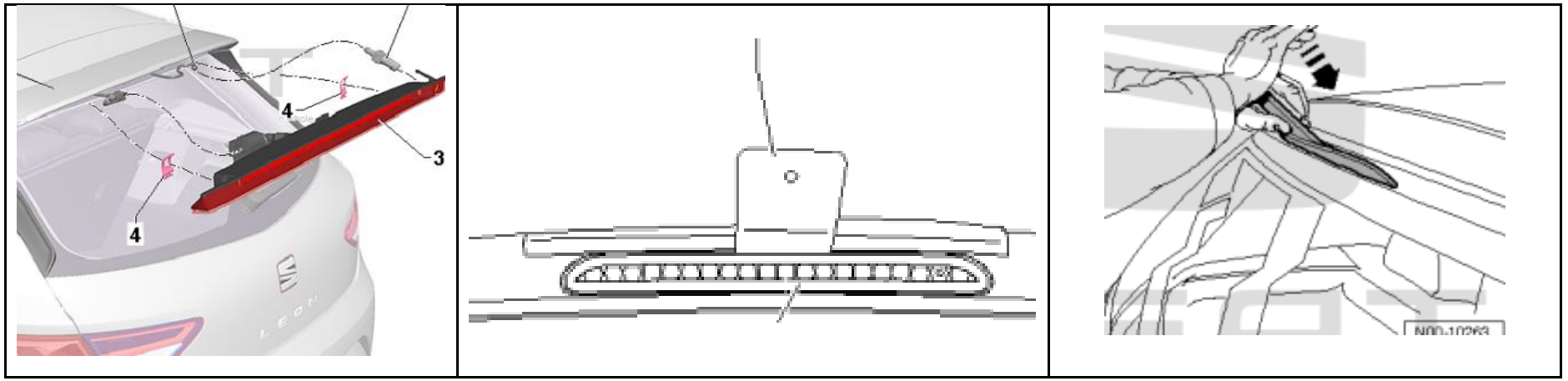
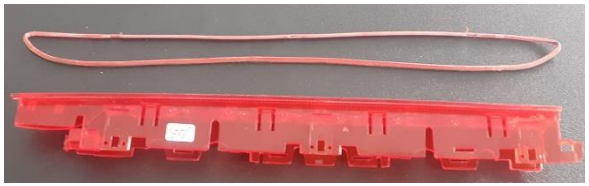


Figure 31: Additional brake lighting level 1 disassembly process – SEAT Leon model III

The first step to disassemble the rear additional break lighting is to unsettle the part. It can be done using a flat tool. This process is shown in the central and right images. Once the part is moved from the car, the wiring needs to be unplugged.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts



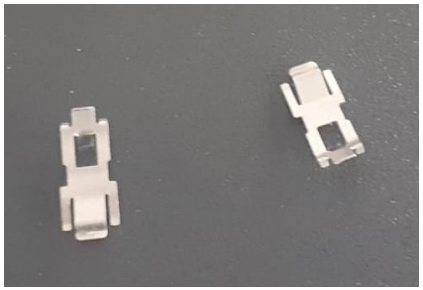


Figure 32: Additional brake lighting level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 1 minute
Difficulty level	High/Medium/**Low**
Required tools	Flat screwdriver
Process description	The main LED and electronic device are clipped with the light cover to facilitate manual separation or using a plate screwdriver. Moreover, the metal clips joining the light to the body can also be removed using a flat screwdriver.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

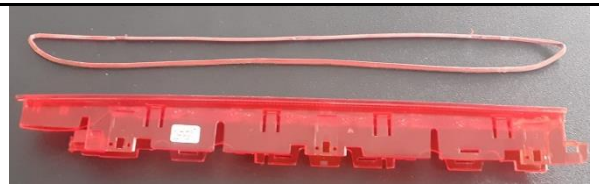
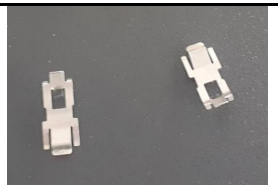
Plastics	Non-ferrous metals (excluding Al)	Ferrous metals
		

Figure 33: Additional brake lighting level 3 disassembly process – SEAT Leon model III

There are three recycling fractions, the first one with the plastic case, the second one with the LED and electronics, which are non-ferrous metals (excluding Al) and finally, the clips made of steel.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.3.3. SEAT Ibiza model IV

Level 1: Disassembling from the car

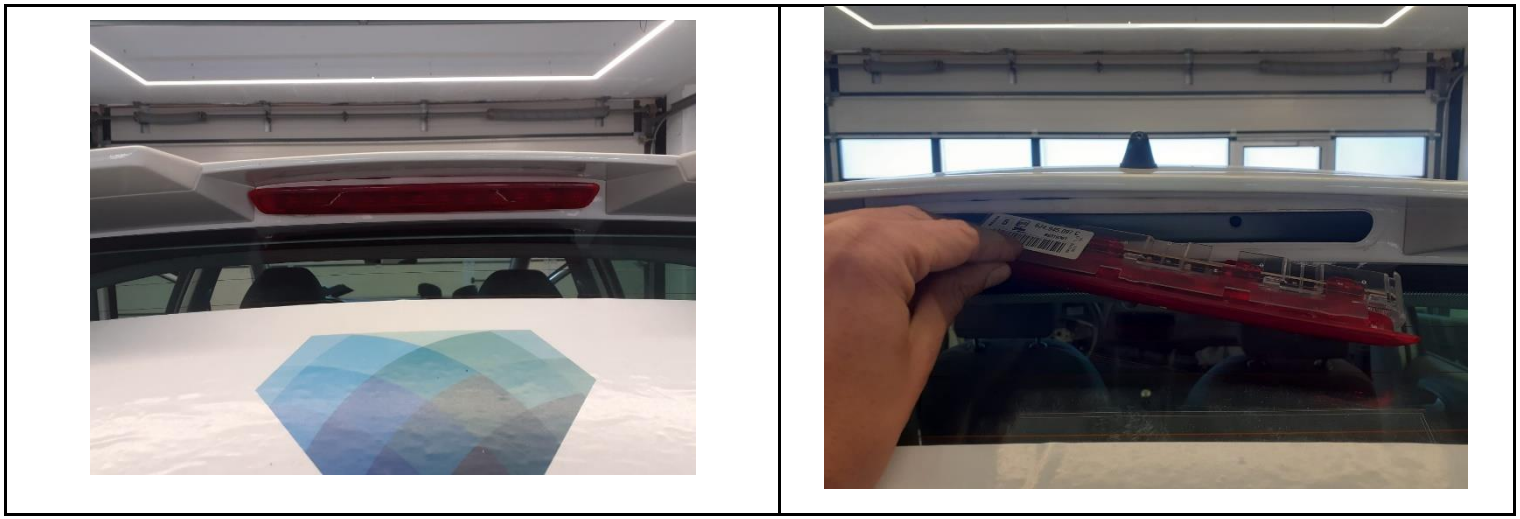


Figure 34: Additional brake lighting level 1 disassembly process – SEAT Ibiza model IV

To disassemble the rear additional braking light, the first step is to unsettle the part. It can be done using a flat tool. The image on the right shows this process. Once the part is removed from the car, the wiring needs to be unplugged.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 35: Additional brake lighting level 2 disassembly process – SEAT Ibiza model IV

Description	
Average time in real case	< 1 minute
Difficulty level	High/Medium/**Low**
Required tools	Flat screwdriver
Process description	The main LED and electronic device are clipped with the light cover to facilitate a manual separation or using a plate screwdriver. Moreover, the metal clips joining the light to the body can also be removed using a flat screwdriver.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

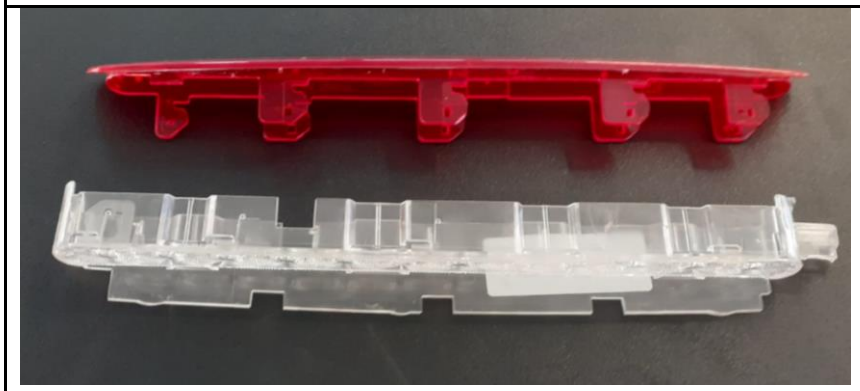
Plastics	Non-ferrous metals (excluding Al)
	

Figure 36: Additional brake lighting level 3 disassembly process – SEAT Leon model III

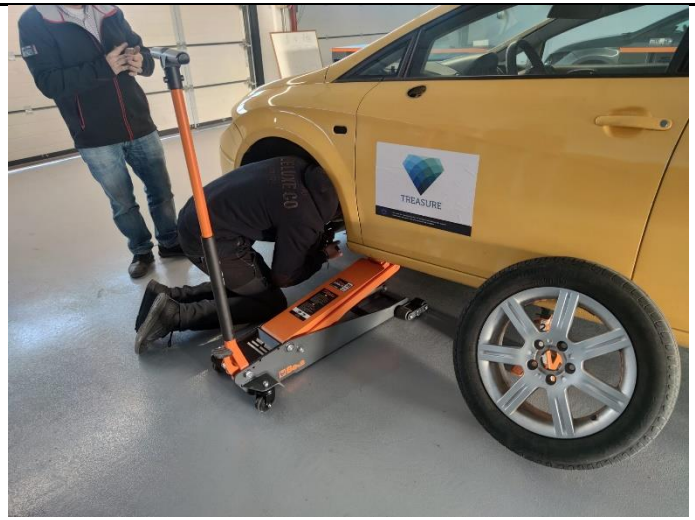
There are two recycling fractions, the first one with the plastic case, the second one the LED and electronics, which are non-ferrous metals (excluding Al).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.4. Speed sensor

10.4.1. SEAT Leon model II

Level 1: Disassembling from the car



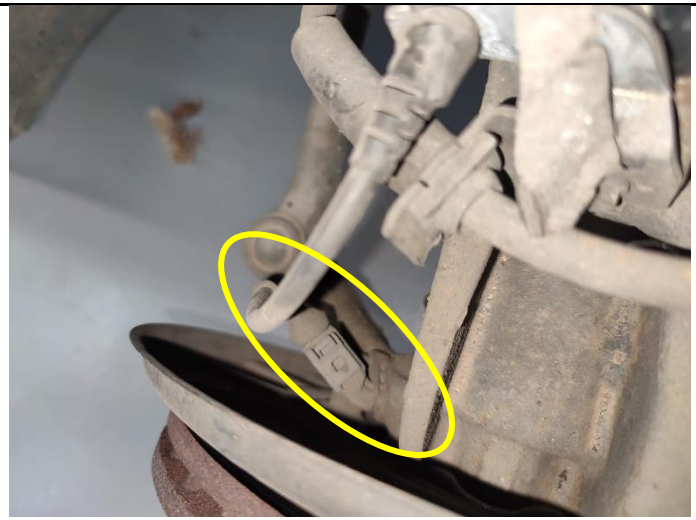


Figure 37: Speed sensor level 1 disassembly process – SEAT Leon model II

To disassemble the sensor, it is necessary to remove the wheel, as shown on the left image. The right image represents the sensor located next to the breaking disc.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts & Level 3: From smaller subparts to recycling fractions

Figure 38: Speed sensor level 2-3 disassembly process – SEAT Leon model II

This part cannot be subdisassembled into smaller subparts, and as a consequence, the main fraction is a mixology of ferrous and non-ferrous metals plus plastics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.4.2. SEAT Leon model III

Level 1: Disassembling from the car

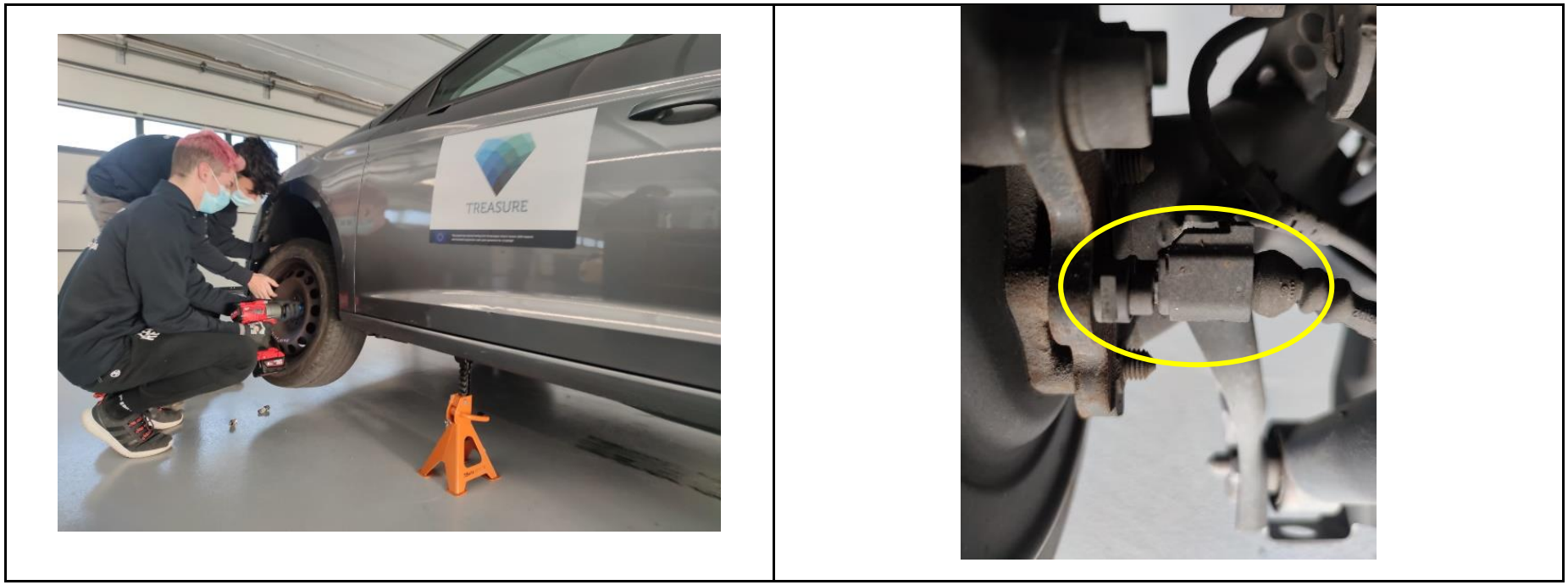


Figure 39: Speed sensor level 1 disassembly process – SEAT Leon model III

To disassemble the sensor, it is necessary to remove the wheel, as shown on the left image. The right image represents the sensor located next to the breaking disc.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts & Level 3: From smaller subparts to recycling fractions

Figure 40: Speed sensor level 2-3 disassembly process – SEAT Leon model III

This part cannot be subdisassembled into smaller subparts, and as a consequence, the main fraction is a mixology of ferrous and non-ferrous metals plus plastics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.4.3. SEAT Ibiza model IV

Level 1: Disassembling from the car

Figure 41: Speed sensor level 1 disassembly process – SEAT Ibiza model IV

To disassemble the sensor, it is necessary to remove the wheel, as shown on the left image. The right image represents the sensor located next to the breaking disc.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts & Level 3: From smaller subparts to recycling fractions

Figure 42: Speed sensor level 2-3 disassembly process – SEAT Ibiza model IV

This part cannot be subdisassembled into smaller subparts, so the main fraction is a mix of ferrous and non-ferrous metals plus plastics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.5. Rain sensor[8]

10.5.1. SEAT Leon model III

Level 1: Disassembling from the car

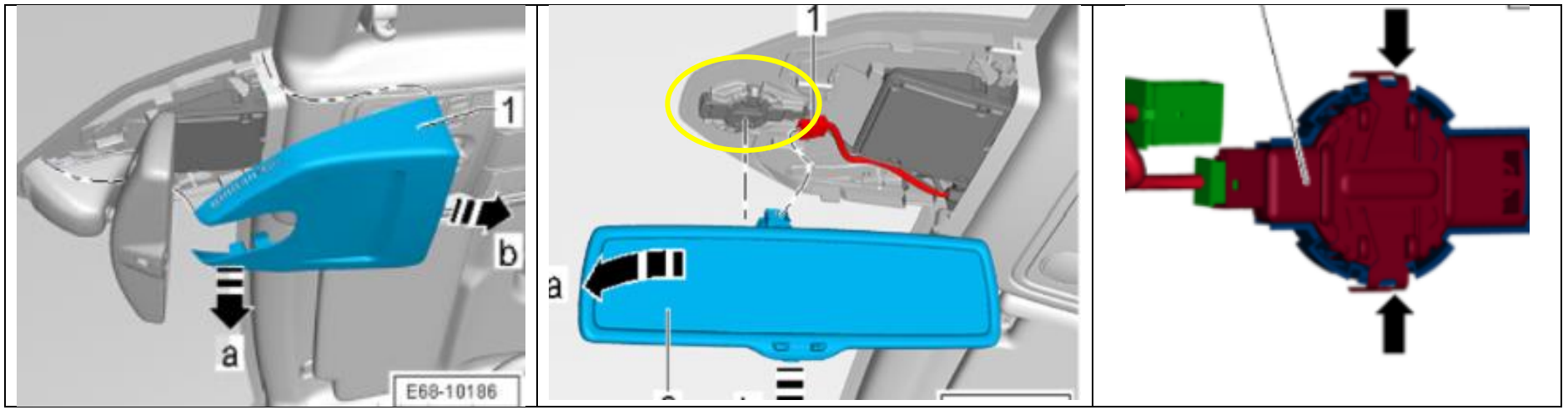


Figure 43: Rain sensor level 1 disassembly process – SEAT Leon model III

The first step is to remove the plastic case to disassemble the sensor. This task can be done using a flat screwdriver. Next, the mirror needs to be unclipped by pulling it down. Its location is shown in the central image.

[8] SEAT Leon model II provided in the Project had not rain sensor. In the case of SEAT Ibiza model IV it was not equipped with rain sensor.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

Figure 44: Rain sensor level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 1 minute
Difficulty level	High/Medium/**Low**
Required tools	Flat screwdriver
Process description	Subparts are joined using clip systems. The first step is to unclip the metal clamp. Next, the plastic cover can be unclipped and separated. Finally, the electronic board is accessible and can be removed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

Plastics	Non-ferrous metals (excluding Al)	Ferrous metals
		

Figure 45: Rain sensor level 3 disassembly process – SEAT Leon model III

There are three recycling fractions, the first one with the plastic cases, the second one with the electronics, which are non-ferrous metals (excluding Al) and finally, the fixation system.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

10.6. Air quality sensor[9]

10.6.1. SEAT Leon model III

Level 1: Disassembling from the car

Figure 46: Air quality sensor level 1 disassembly process – SEAT Leon model III

The first step is to remove the plastic case to disassemble the sensor. This task can be done using a flat screwdriver. Next, the mirror needs to be unclipped by pulling it down. Its location is shown in the central image.

[9] SEAT Leon model II and SEAT Ibiza model IV were not equipped with air quality sensor.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 2: From the main part to smaller subparts

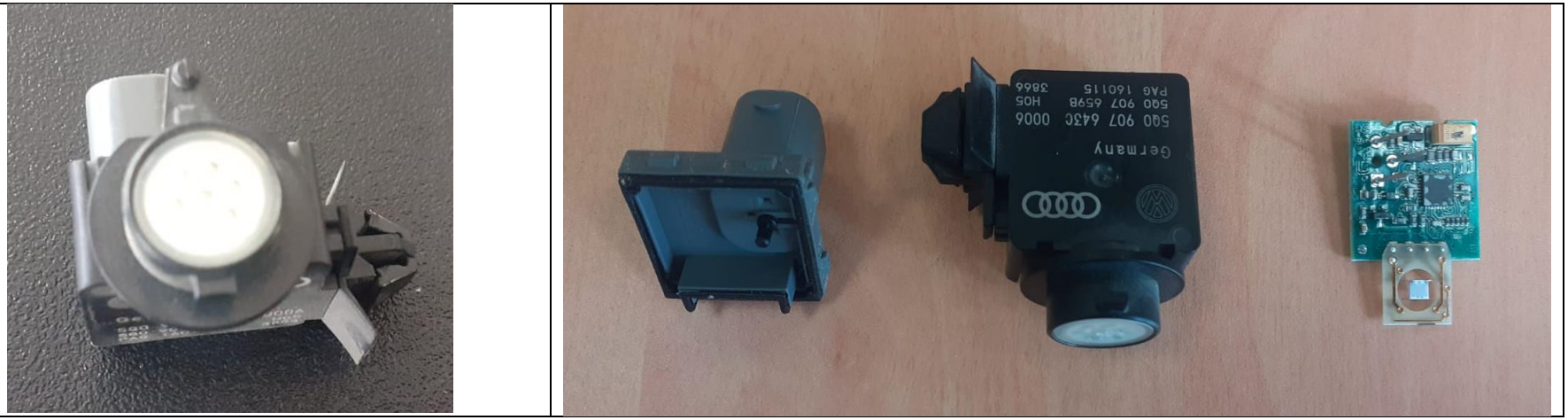


Figure 47: Air quality sensor level 2 disassembly process – SEAT Leon model III

Description	
Average time in real case	< 1 minute
Difficulty level	High/Medium/**Low**
Required tools	Flat screwdriver
Process description	Subparts are joined using clip systems. The first step is to unclip the metal clamp. Next, the plastic cover can be unclipped and separated. Finally, the electronic board is accessible and can be removed.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587

Level 3: From smaller subparts to recycling fractions

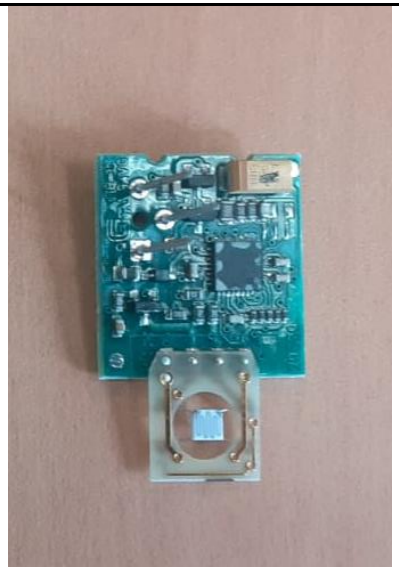
Plastics	Non-ferrous metals (excluding Al)
	

Figure 48: Air quality sensor level 3 disassembly process – SEAT Leon model III

There are two recycling fractions, the first one with the plastic cases and the second one with the electronics, which are non-ferrous metals (excluding Al).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003587