How to support the implementation of a future Extended Producer Responsibility for HD Vehicles

Synthesis | Brussels, 26th November 2025

STRAT ANTICIPATION | *Be One Step Ahead*

Our retained scope covers 78% of the HDV fleet and all vehicles over 3.5 tons, but excludes trailers from the analysis, due to a lack of available data & time constraints

Project scope

GEOGRAPHIES :
8 COUNTRIES

78 % of the total HDV fleet in the EU

PRODUCTS :
5 SEGMENTS

M2 VEHICLES :
PASSENGER TRANSPORT
- BETWEEN 3.5 & 5T

M3 VEHICLES :
PASSENGER TRANSPORT
- MORE THAN 5T

N2 VEHICLES :
FREIGHT TRANSPORT
- BETWEEN 3.5 & 12T

N3 VEHICLES :
FREIGHT TRANSPORT -
MORE THAN 12T

SPECIAL PURPOSE VEHICLES

CATEGORY O :
TRAILERS & SEMI-TRAILERS

Segments covered by the study Segments not covered by the study

HDV : Heavy-Duty Vehicle

CONTENTS

We conducted a fleet analysis in the 8 EU countries within our scope, then studied the trade flows arriving & departing from them to evaluate the volume of EOL HDVs

General Executive Summary (1/3)

CONTEXT

- Trucks, which often have multiple owners, typically end their life being exported and/or dismantled to produce parts or materials (steel, aluminum mostly)
- Buses typically have a single owner. They typically have a higher scrappage rate than trucks (4.2% vs 2.1 % on average in our 8 in-scope countries)
- Trucks and buses can be sold as-is or reconditioned, allowing them to be reused. Otherwise, they are depolluted, disassembled & shredded
- Insurers play a key role in the entry of HDVs into ELV centers, accounting for 52% of entries in France, for example

FLEET MODELING IN THE 8 IN-SCOPE COUNTRIES

- Eastern EU countries have typically older HDV fleet than Western ones : 20.7 years for trucks & 20.9 for buses versus 14.3 for trucks & 10.8 for buses in Western countries
- The EU HDV fleet is getting older because of a decreasing ratio of new registrations over total fleet in operation : last decade average Heavy-Duty Trucks age increased from 12 to 14 years and buses from 11.7 to 12.2 years
- Growth trend of the EU HDV fleet in the EU is below 1% on average per year over the last decade
- Bus age patterns differ greatly among the 8 countries, like in Poland, where 39% of buses are over 25 years old, compared to less than 1% in Germany & France
- No existing detailed statistical data is available for the HDV fleet breakdown by age --> our analysis is based on SIBYL's model output considering new registrations, fleet in operation & average fleet age over time

ANALYSIS OF TRADE FLOWS IN THE 8 IN-SCOPE COUNTRIES

- Western countries typically do more exports than imports (83% vs 17% of truck trade flows in 2023), in particular Germany, the Netherlands & Belgium, while Eastern ones typically import from them & export to third countries
- Since 2012, extra-EU HDV export flows have been reducing by 1% yearly on average, while intra-EU HDV export flows have been slowly growing at 1% per year
- Among exports, the share of extra-EU HDV exports went down from 65% to 60% in 11 years and seems to have stabilized post-COVID, but this might be a temporary effect where exports dropped following the shortage of new HDVs
- On average, on a smoothed yearly basis and across our 8 countries, 1.8% of the HDV fleet is exported outside the EU

HDV : Heavy-Duty Vehicle

We then calculated the number of vehicles scrapped in our 8 countries & described the typical processes for dismantling & shredding HDVs, as well as the HDV reman market

General Executive Summary (2/3)

ANALYSIS OF DEREGISTRATIONS IN THE 8 IN-SCOPE COUNTRIES

- Since 2012, truck exports have declined from 122 to 109k units annually, while scrappage volume has grown from 88 to 94k units annually
- Since 2012, bus exports have remained stable around 11k units per year, while scrappage volume has grown slowly from 20 to 23k units annually
- For trucks (rigids & tractors), the percentage of the fleet exported each year fell from 3% to 2.4% between 2012 and 2023, while the percentage scrapped decreased from 2.2% to 2.1% over the same period, after peaking at 2.9% in 2018
- For buses & coaches, the percentage of the fleet exported each year remained constant at 2% between 2012 & 2023, while the percentage scrapped grew from 4.1% to 4.2% over the same period, after a low point of 3.8% in 2018

TYPICAL PROCESSES IN HDV DISMANTLING & SHREDDING

- An HDV will typically undergo 4 major stages of treatment at an ELV center: preparation of the vehicle & depollution, body removal & disassembly, cabin removal & disassembly, chassis & powertrain disassembly
- Afterwards, the cut chassis is sent to the shredder, and this may also be the case for certain bodies, such as tippers. The cab is usually sent to the shredder in one piece, potentially compacted/compressed
- At the shredder, the cabin enters a wider flow of light automotive scrap, the main result of which will be E40 steel
- The chassis and axles must be cut at the ELV center or at the shredder, then sheared at the shredder to produce plate & structural steel scrap due to thicker steel
- At the shredder, the engine & gearbox, if not resold for parts, are usually processed by a dedicated stream, which produces high-value E40 and non-ferrous metals

REMANUFACTURING MARKET FOR HDVs

- Repairable or remanufacturable parts for HDVs mainly fall into 6 component categories: Engine, Drivetrain & Steering, Electrical, Air/Brake, Fuel, & Exhaust/Cooling
- Within these categories, we have described the parts that are more or less suitable for remanufacturing and repair, based on technical and economic considerations (part value)
- Our observation is that remanufacturing is much more developed in the HDV sector than in the automotive sector. Several families of parts exceed hundreds of thousands units remanufactured per year at the European level, which is considerable for a fleet that is smaller than that of passenger cars

HDV : Heavy-Duty Vehicle

We described the new modules to be handled with electrification, and we have described the end-of-life economics for vehicles, parts, bodies & materials

General Executive Summary (3/3)

NEW MODULES TO BE ADDRESSED DUE TO ELECTRIFICATION

- With the increasing adoption of electrified HDVs, our baseline scenario projects a reman volume of approximately 3,600 e-motors by 2035
- The market for the sale of reman E-Motors is estimated at 35 M€ by 2035 & 153 M€ by 2040
- The baseline scenario projects an annual reman volume of approximately 1,822 battery units by 2035
- The market for the sale of remanufactured battery packs is estimated at 47 M€ by 2035 & 223 M€ by 2040
- The new electrified modules will generate additional reman & repair activity, but volumes will remain low until 2035, as the penetration rate in the fleet is still low

ECONOMICS FOR VEHICLES, PARTS, BODIES & MATERIALS

- For a 4X2 tractor, there is a crossover in median values over the 15-20-year period, which means that it is more profitable to resell the truck as parts rather than as a whole
- All body types that we considered potentially have value even after 20 years of use, but it does not systematically mean that 100% of those bodies have a resale value
- There is a profit to expect from the base vehicle treatment in most cases, yet it is uncertain when there is no part revenue
- Aluminium tippers & food & beverages tanks are the only cases where base vehicle + body is mostly profitable, even though the base vehicle is almost always a net value

HDV : Heavy-Duty Vehicle

For trucks, there is a significant contrast between Western countries, which are more export-oriented, and Eastern countries, which are more import-oriented

8 EU Countries - Truck fleet - Summary

NUMBER OF TRUCKS IN THE FLEET | In k units, 2024

	1 015 k
	952 k
	745 k
	648 k
	684 k
	220 k
	232 k
	195 k

YEARLY IMPORTS/EXPORTS OF TRUCKS | In k units & % of the 2023 fleet, 2021-2023 Average

	Imports	Exports
	8 k (0.9%)	**53 k** (5.4%)
	5 k (0.5%)	**7 k** (0.8%)
	17 k (2.3%)	**14 k** (1.9%)
	1 k (0.2%)	**20 k** (3.1%)
	5 k (0.8%)	**6 k** (0.9%)
	2 k (1.1%)	**0.2 k** (2.0%)
	1 k (0.5%)	**5 k** (2.1%)
	4 k (2.0%)	**3 k** (1.6%)

YEARLY SCRAPPAGE OF TRUCKS | In k units & % of the 2023 fleet, 2021-2023 Average

	19 k (2.0%)
	23 k (2.4%)
	16 k (2.3%)
	18 k (2.7%)
	5 k (0.8%)
	5 k (2.1%)
	4 k (1.5%)
	5 k (2.6%)

FOR TRUCKS, DEPENDING ON THE COUNTRY CONSIDERED, THE SCRAPPAGE RATE RANGES FROM 0.8% TO 2.7% OF THE FLEET

Source : Sybil model - EMISIA, Strat Anticipation research & analysis

For buses, the West/East contrast for imports/exports also applies, but there are greater disparities than for trucks in terms of the % of the fleet scrapped

8 EU Countries - Bus fleet - Summary

NUMBER OF BUSES IN THE FLEET | In k units, 2024

	84 k
	100 k
	117 k
	91 k
	63 k
	24 k
	22 k
	48 k

YEARLY IMPORTS/EXPORTS OF BUSES | In k units & % of the 2023 fleet, 2021-2023 Average

	Imports	Exports
	2 k (2.8%)	**4 k** (4.9%)
	4 k (3.7%)	**3 k** (3.2%)
	0.5 k (0.5%)	**0.8 k** (0.7%)
	0.7 k (0.8%)	**2 k** (1.7%)
	5 k (7.9%)	**0.3 k** (0.5%)
	0.8 k (3.5%)	**0.1 k** (0.6%)
	0.2 k (1.1%)	**0.5 k** (2.4%)
	1 k (2.9%)	**0.2 k** (0.4%)

YEARLY SCRAPPAGE OF BUSES | In k units & % of the 2023 fleet, 2021-2023 Average

	2 k (2.2%)
	3 k (3.6%)
	2 k (1.5%)
	6 k (6.4%)
	7 k (10.8%)
	1 k (5.5%)
	0.5 k (2.5%)
	2 k (3.2%)

FOR BUSES, DEPENDING ON THE COUNTRY CONSIDERED, THE SCRAPPAGE RATE RANGES FROM 1.5% TO 10.8% OF THE FLEET

Source : Sybil model - EMISIA, Strat Anticipation research & analysis

CONTENTS

We have described the size & age structure of the fleet for rigids, tractors, buses & coaches by deriving age distribution curves from average ages published by ACEA

Fleet modeling in the 8 in-scope European countries - Executive Summary

FINDINGS ON THE 8 EUROPEAN COUNTRIES IN SCOPE

- Eastern EU countries have typically older HDV fleet than Western ones : 20.7 years for trucks & 20.9 for buses versus 14.3 for trucks & 10.8 for buses in Western countries
- The EU HDV fleet is getting older because of a decreasing ratio of new registrations over total fleet in operation : last decade average Heavy-Duty Trucks age increased from 12 to 14 years and buses from 11.7 to 12.2 years
- Growth trend of the EU HDV fleet in the EU is below 1% on average per year over the last decade
- Bus age patterns differ greatly among the 8 countries, like in Poland, where 39% of buses are over 25 years old, compared to less than 1% in Germany & France

COUNTRY-SPECIFIC FINDINGS

- The German articulated truck fleet is the youngest with 65% of it being under 10 years, whereas the Greek fleet is the oldest with 80% of it being over 25 years
- For rigids over 7.5t, among the 8 countries, France has the most balanced age distribution across the age categories, while Greece has the most unbalanced with 86% aged over 25 years
- For rigids under 7,5t, the German fleet age distribution is balanced, while the Greek, Czech & Polish fleets are heavily dominated by older trucks
- 4 countries each have more than 80k buses in operation : Germany, France & Spain with a high share of coaches, and Poland with a predominance of buses

LIMITATIONS

- No existing detailed statistical data is available for the HDV fleet breakdown by age --> our analysis is based on SIBYL's model output, considering new registrations, fleet in operation & average fleet age over time

HDV : Heavy-Duty Vehicle

Among exports, the share of extra-EU HDV exports went down from 65% to 60% in 11 years, but seems to have stabilized post-Covid, so this trend could reverse

Analysis of trade flows in the 8 in-scope countries - Executive Summary

FINDINGS ON THE 8 EUROPEAN COUNTRIES IN SCOPE

- Western countries typically do more exports than imports (83% vs 17% of truck trade flows in 2023), in particular Germany, the Netherlands & Belgium, while Eastern ones typically import from them & export to third countries
- Since 2012, extra-EU HDV export flows have been reducing by 1% yearly on average, while intra-EU HDV export flows have been slowly growing at 1% per year
- Among exports, the share of extra-EU HDV exports went down from 65% to 60% in 11 years and seems to have stabilized post-COVID, but this might be a temporary effect where exports dropped following the shortage of new HDVs
- On average, on a smoothed yearly basis and across our 8 countries, 1.8% of the HDV fleet is exported outside the EU

COUNTRY-SPECIFIC FINDINGS

- Among our 8 countries, Germany is by far the largest exporter, with most export flows directed outside the EU (84% in 2023)
- Compared to its fleet, Italy is a small exporter, with 10k units exported in 2023 and limited flows to other EU countries
- Poland has been expanding its export activity, rising from 10k units in 2010 to over 20k since 2021, with the vast majority directed to non-EU markets
- Relative to its fleet size, Greece's exports are minimal, with less than 1,000 vehicles exported between 2017 and 2023
- Czechia exports mostly within the EU, with over 60% of shipments intra-EU & overall its exports are trending upward

LIMITATIONS

- Imported/exported 2nd hand HDVs are not uniformly reported : in Eurostat data, we have only HD Trucks that weigh more than 5 tons & buses are not differentiated between new & used imports/exports for all powertrains
- There are unrealistic spikes in exported/imported 2nd hand HDVs due to wrong reporting
- There is a great problem with NL/BE/DE data due to 2nd hand HDVs exported to third countries via NL/BE/DE ports
- We validated COMEXT data with national sources (often customs), where possible
- We corrected number of imported/exported HDVs based on average weight extracted from Eurostat & deregistrations
- We assumed that imported vehicles share a similar age distribution to the fleet
- We assumed that exports follow a similar age distribution to deregistrations

HDV : Heavy-Duty Vehicle

We calculated the number of vehicles to be scrapped, by doing the difference between the deregistrations from EMISIA's SIBYL model and exports from the Comext database

Analysis of deregistrations in the 8 in-scope countries - Executive Summary

FINDINGS ON THE 8 EUROPEAN COUNTRIES IN SCOPE

- Since 2012, truck exports have declined from 122 to 109k units annually, while scrappage volume has grown from 88 to 94k units annually
- Since 2012, bus exports have remained stable around 11k units per year, while scrappage volume has grown slowly from 20 to 23k units annually
- For trucks (rigids & tractors), the percentage of the fleet exported each year fell from 3% to 2.4% between 2012 and 2023, while the percentage scrapped decreased from 2.2% to 2.1% over the same period, after peaking at 2.9% in 2018
- For buses & coaches, the percentage of the fleet exported each year remained constant at 2% between 2012 & 2023, while the percentage scrapped grew from 4.1% to 4.2% over the same period, after a low point of 3.8% in 2018

COUNTRY-SPECIFIC FINDINGS

- Between 2019 & 2023, in Germany, annual exports ranged from 46k to 66k trucks and annual scrappage between 4.7k to 42.1k trucks
- Between 2019 & 2023, in Poland, annual exports ranged from 5.3k to 9.2k trucks and annual scrappage between 13.9k and 26.8k trucks
- Between 2019 & 2023, in Greece, annual exports ranged from 0.2k to 0.3k trucks and annual scrappage between 2.0k and 5.6k trucks
- Between 2019 & 2023, in Spain, annual exports ranged from 0.2k to 1.4k buses and total scrappage between 5.0k and 7.7k buses per year

LIMITATIONS

- There is no detailed data available for deregistrations : we evaluated them from EMISIA SIBYL's model output, based on new registered HDVs, 2nd hand imports & HDVs in operation
- There is no detailed data either for scrapped HDVs : we calculated them as the difference between total deregistrations & exports
- We treated the number of imported/exported HDVs based on the reported HDV weight by Eurostat & deregistrations from SIBYL

HDV : Heavy-Duty Vehicle

The treatment of an EOL HDV is handled by an ELV center & a shredder, involves significant variations in processes, and leads to the resale of both parts & materials

Typical processes in HDV dismantling & shredding - Executive Summary

OVERALL PROCESS

- An HDV will typically undergo 4 major stages of treatment at an ELV center: preparation of the vehicle & depollution, body removal & disassembly, cabin removal & disassembly, chassis & powertrain disassembly
- Afterwards, the cut chassis is sent to the shredder, and this may also be the case for certain bodies such as tippers. The cabin is usually sent to the shredder in one piece, potentially compacted/compressed
- At the shredder, the cabin enters a wider flow of light automotive scrap, the main result of which will be E40 steel
- The chassis and axles must be cut at the ELV center or at the shredder, then sheared at the shredder to produce plate & structural steel scrap, due to the thicker steel
- At the shredder, the engine & gearbox, if not resold for parts, are sometimes processed in a dedicated stream, which produces high-value E40 and non-ferrous metals

DISMANTLING PROCESS

- The dismantling steps that are always or almost always carried out at ELV centers are : depollution, separation of the cabin from the chassis, removal of the powertrain & axles
- Others may be carried out depending on economic considerations, most often for parts that have resale value (e.g., a door), but also sometimes for upstream separation of materials (e.g., rims for their aluminum)
- This economic trade-off is made using the ELV center's learning curve, assessed either by the operator himself or by a software system providing dismantling instructions based on sales history

SHREDDING PROCESS

- There are several process options for treating light automotive scrap cabins at the shredder, depending on the level of CAPEX invested by the latter
- The basic option consists of magnetic sorting, induction sorting, and flotation to obtain E40 steel, Zorba, and non-ferrous metals
- To this, it is possible to add several sorting steps to separate plastics and the light fraction of shredding, in order to avoid landfilling/incineration
- Some players have advanced technologies such as LIBS, which will allow the Zorba to be re-sorted to obtain Twitch, a much purer aluminum stream

HDV : Heavy-Duty Vehicle

Circular economy is a well-developed business in the HDV industry since decades, around reuse, repair & reman, and in greater proportions than the automotive sector

Remanufacturing market for HDVs - Executive Summary

DEFINITIONS

- There are 3 different business models in the automotive circular economy (apart from recycling & eco-design) : reman, batch repair and 1 to 1 repair
- Reman is based on collection from standard exchange or ELV materials, and consists in an industrial process to ensure the part retreated has similar quality & reliability as a new product
- One-to-one repair is a B2B2C process taking a defective component/module/system from a vehicle, repairing it, and putting it back in the same vehicle in a short loop of a few days, requiring it to be a local & capillary activity
- Batch repair is a B2B process returning a batch of faulty products to a condition where they can fulfill their intended use, with a view to their subsequent resale

CONCERNED PARTS & VOLUMES FOR HDVs

- Repairable or remanufacturable parts for HDVs mainly fall into 6 component categories : Engine, Drivetrain & Steering, Electrical, Air/Brake, Fuel & Exhaust/Cooling
- Within these categories, we have described the parts that are more or less suitable for remanufacturing & repair, based on technical & economic considerations (part value)
- Our observation is that remanufacturing is much more developed in the HDV sector than in the automotive sector. Several families of parts exceed hundreds of thousands units remanufactured per year at the European level, which is considerable for a fleet that is smaller than the passenger car one

EXISTING HDV MANUFACTURING FOOTPRINT

- To ensure these volumes, the various players, OEMs & OES & pure players, have a significant number of industrial sites in Europe, with at least several dozen sites
- The players have also already begun to position themselves in the remanufacturing of new electrified modules (E-motors, Power Electronics & Batteries), despite their low penetration in the fleet to date

HDV : Heavy-Duty Vehicle

The new electrified modules will generate additional reman & repair activity, but volumes will remain low until 2035, as the penetration rate in the fleet is still low

New modules to be addressed due to electrification - Executive Summary (1/2)

VOLUME OF E-MOTORS TO BE ADRESSED

- For a typical HDV, e-motor costs range from €3,000 to €29,000, accounting for 4% to 11% of the truck's total price
- To size the e-motor market, we use the evolutive failure rate, the accidentology rate and the reman at the end of first life probability, and apply them to the fleet per age & segment
- With the increasing adoption of electrified HDVs, the baseline scenario projects a remanufacturing volume of approximately 3,700 e-motors by 2035
- At the global level, the market for the sale of remanufactured E-Motors is estimated at 35 M€ by 2035 & 153 M€ by 2040

VOLUME OF POWER ELECTRONICS MODULES TO BE ADRESSED

- For a truck with a GVWR above 40 tons, the power electronics are assumed to cost between 11 & 19+ k€. The overall range is between a few k€ and 20k€
- To size the power electronics market, we use the evolutive failure rate, the accidentology rate, and apply them to the fleet per age & segment, and then use price per segment to assess value
- With the increasing adoption of electrified HDVs, the baseline scenario projects a remanufacturing volume of approximately 5,500 units by 2035
- At the global level, the market for the sale of remanufactured Power Electronics Modules is estimated at 30 M€ by 2035 & 71 M€ by 2040

VOLUME OF HV BATTERIES TO BE ADRESSED

- For a truck with a GVWR above 40 tons, the battery is assumed to cost between 37 & 78+ k€. This will represent between 21 & 26% of the truck value
- To size the HV battery market, we use the evolutive failure rate, the accidentology rate and the reman probability at the end of the first life, and apply them to the fleet per age & segment
- The baseline scenario projects an annual remanufacturing volume of approximately 1,822 battery units by 2035
- At the global level, the market for the sale of remanufactured battery packs is estimated at 47 M€ by 2035 & 223 M€ by 2040

HDV : Heavy-Duty Vehicle

These new modules will also require significant investment from ELV centers, to be able to handle them, which we estimate at around €33,000 per center

New modules to be addressed due to electrification - Executive Summary (2/2)

NEED FOR CAPEX & NON-DIRECT ECONOMIC IMPACTS RELATED TO NEW MODULES

- ELV centers will have to adapt their treatment chain significantly at several stages, to handle properly new electrified modules in general : unloading, storage & diagnosis
- The ELV center is at the heart of the battery distribution at the end of its life, and must perform at least the disassembly, diagnosis & storage
- Most investments should be made by ELV centers, apart from investments related to safe transport for batteries, that leave the center to the recycling points
- This adaptation of ELV centers requires many prerequisites in terms of surface area & CAPEX investments, estimated at around €33,000 per center

HDV : Heavy-Duty Vehicle

For bodies, only aluminum tippers, food & beverages tanks are most often profitable to recycle, even counting the profit made with the base vehicle

Economics for vehicles, parts, bodies & materials - Executive Summary

RESIDUAL VALUE OF USED VEHICLES & MAIN SPARE PARTS

- We conducted an analysis of truck part prices based on their age on the main EU resale platforms, enabling us to get a range of total resale potential depending on age
- We focused on those with the highest value: engine unit, gearbox, cabin, axles, fuel tank, catalytic converter, radiator
- We analyzed the evolution of vehicle prices over time in the same way, separating rigid & articulated trucks and considering different axle configurations
- From 16-20 years of service life onwards, there is a crossover in the median values for part & vehicle prices for tractors regardless of axle configuration, which typically corresponds to their scrappage age within the EU

RESIDUAL VALUE OF BODIES & RESALE MARKET BREAKDOWN

- The main types of bodywork in registrations are tippers, flatbeds, refrigerated boxes, sliding curtains & tanks : these are the ones we considered for this analysis
- In Western Europe, tippers, when resold separately from the complete vehicle, tend to be resold within the first 10 years of lifetime, while flatbeds tend to be resold between 11 & 20 years and sliding curtains after 15 years
- In Eastern Europe, tippers tend to be resold between 16 & 25 years old, while for tanks and refrigerated boxes, sales are mainly between 6 & 15 years old
- All body types considered potentially have value even after 20 years of use, but it does not systematically mean that 100% of those bodies have a resale value

PROFITABILITY OF RECYCLING A BODY OR A COMPLETE VEHICLE

- By combining the costs for the base vehicle & for the bodywork, we obtain the total costs for the complete vehicle, to be compared with the total scrap value generated during the process
- We analyzed two cases for the profitability of recycling a rigid base vehicle and a tractor : removal of key parts before shredding or recycling of the entire vehicle
- There is a profit to expect from the base vehicle treatment in most cases, yet it is uncertain when there is no part revenue
- Aluminium tippers & food & beverages tanks are the only cases where base vehicle + body is mostly profitable, even though the base vehicle is almost always a net value

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