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# ECONOMIC AND ENVIRONMENTAL BENEFITS OF ELECTRIC, HYBRID AND CONVENTIONAL VEHICLE TREATMENT IN LITHUANIA

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# PRESENTERS

# INTRODUCTION

Automotive recycling is playing a significant role in environmental and economic sectors as more and more End-of-Life Vehicles (ELVs) are generated worldwide. In 2019 more than every second Lithuanian resident owned a car. The use of secondary resources, promotion of ELV recycling technologies and the increasing use of recovered and recycled materials provide a promising outlook in order to gain economic and environmental advantages.

The goal of this study is to evaluate and compare the economic and environmental benefits of the treatment and bringing materials back to the market (upcycling) of a Battery Electric Vehicle (BEV), a Hybrid Electric Vehicle (HEV) and Internal Combustion Engine Vehicles (ICEVs) powered with diesel and petrol.

# THE GOAL

# METHODOLOGY

## INVENTORY ANALYSIS – ANALYSED VEHICLES

2005–2008 Volkswagen Golf plus with 1.4 petrol/1.9 diesel engine.


Nissan Leaf All 2011-2013 24 kWh

Toyota Prius 5 door hatchback 2003-2009 1,5 l, 16 kW

# METHODOLOGY. ECONOMIC PART

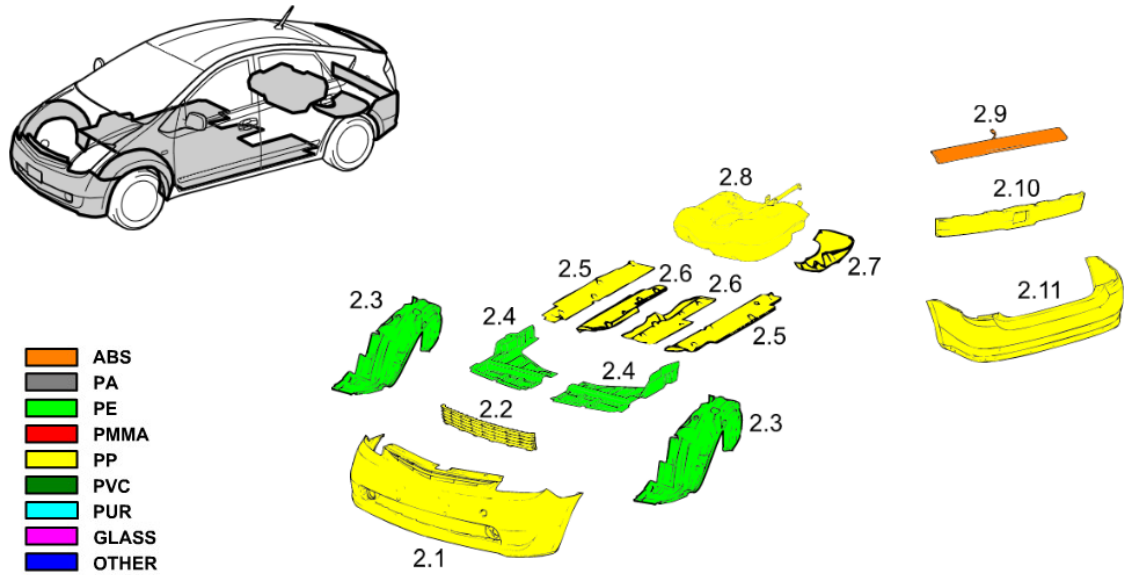
FOR VEHICLE PARTS(MATERIAL, WEIGHT AND ITS PRESENCE) ANALYSIS WAS USED INTERNATIONAL DISMANTLING INFORMATION SYSTEM (IDIS)

Step 1
Toyota

Step 2
Prius

Step 3
5-Door Hatchback (2003-2009)

Doors and Glazing | Exterior | Dash Board | Seats | Interior | Load space




COMPONENTS

2. 1 - Bumper Cover
2. 2 - Radiator Grille Finisher
2. 3 - Wheel Arch Finisher
2. 4 - Engine Under Tray
2. 5 - Under Body Finisher
2. 6 - Under Body Finisher
2. 7 - Under Body Finisher
2. 8 - Fuel Tank
2. 9 - Spoiler
2.10 - Bumper Shock Absorber
2.11 - Bumper Cover

Five local companies were interviewed to clarify the demand of each part. The parts were separated into three categories – high, low and average demand on the market.

Price calculation methodology: for high demand category parts was taken full price from the market, for average demand category parts was calculated half-price and for low (almost none) demand parts was calculated the price for this kind of waste treatment.

# METHODOLOGY. ECONOMIC PART

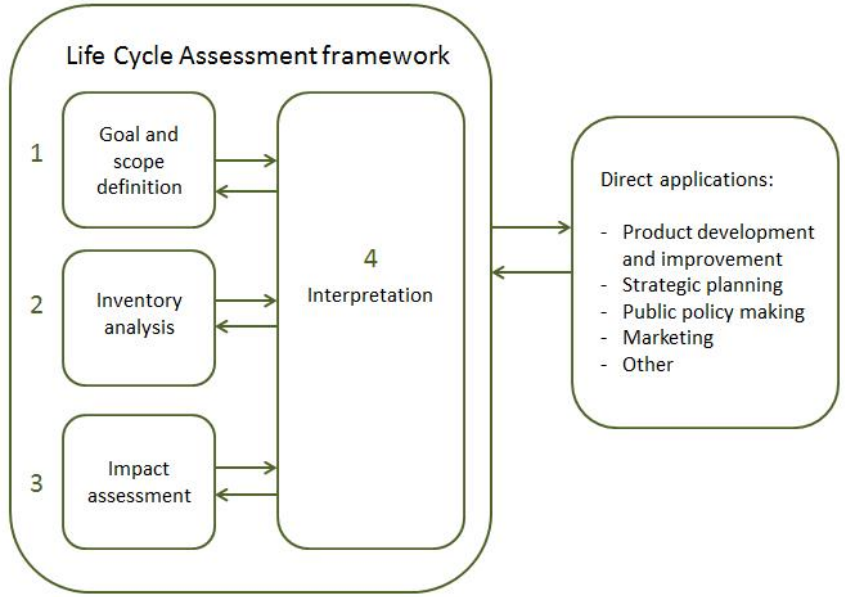
# RESULTS. ECONOMIC PART

| Part demand on the market | | |
|---|---|---|
| **High** | **Medium** | **Low/none** |
| Spoiler | Fenders | Seats and headrests |
| Grille | Front hood | Seatbelts |
| Wheel niche | Door | Inside thresholds |
| Bumper | Door window regulator | Back hood |
| body underlay trim | Engine | Windshield washer assembly |
| Engine pad | Turbocharger | Hydroisolation |
| Clutch disk | Fuel injection system | Fan clutch |
| Air conditioner compressor | Fuel pump | Starter motor |
| Wheels (set) | Pressure plate | Axle shaft |
| Catalyzer (Al) | Torque convertor | Entertainment display |
| Battery | Alternator | Air bags |
| Tires | Radiator (Al) | Brake liquid |
| Front Glass | Mirrors | Cooling liquid |
| Side, back, rooftop glass | Front lamps | Shock absorber oil |
| Carpet | Navigation system | Engine oil |
| | | Engine oil filter |
| | | Gear oil |
| | | Back lamps |
| | | Washing liquid |
| | | Brake pads |
| | | Fuel tank |
| | | Car Hulk (to scrap metal) |

| Passenger car | The share of passenger cars mass that can be sold as parts for reuse after dismantling, % | Economic benefit for dismantlers, Eur | Price of new parts, Eur | Economic benefit for consumers, Eur |
|---|---|---|---|---|
| Volkswagen Golf (ICEV-petrol) | 27 | 2,412 | 12,540 | 10,128 |
| Volkswagen Golf (ICEV-diesel) | 25 | 2,644 | 16,560 | 13,916 |
| Nissan Leaf (BEV) | 35 | 8,812 | 15,427 | 6,615 |
| Toyota Prius (HEV) | 42 | 3,835 | 20,989 | 17,154 |

# RESULTS OF ECONOMIC BENEFIT FOR VEHICLE DISMANTLERS AND CONSUMERS

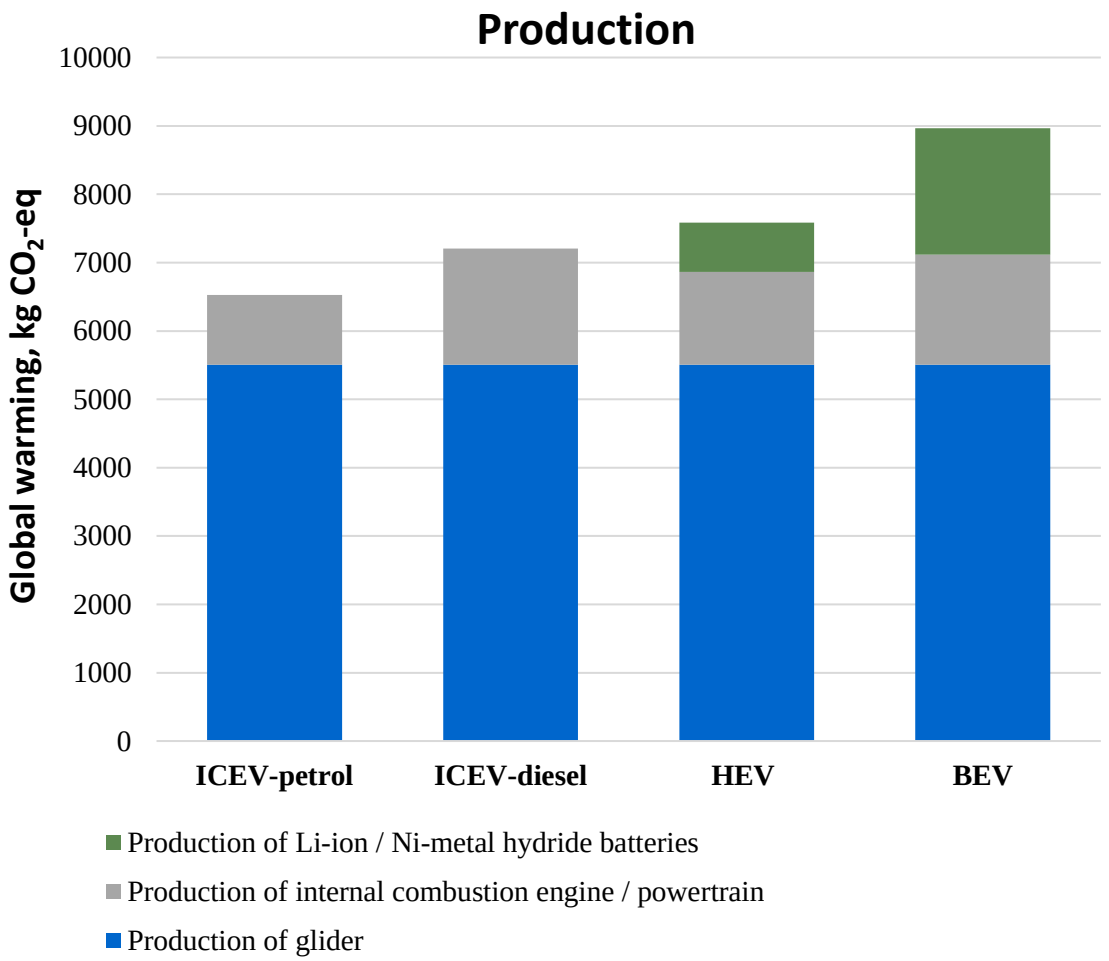
- Lice Cycle Assessment (LCA) methodology was used;
- The goal of this LCA study is to evaluate the environmental impacts throughout the electric, hybrid and conventional vehicles' production and end-of-life stages;
- The ReCiPe method at the midpoint level was used to perform the impact assessment of global warming indicator;
- Database Ecoinvent 3.5;
- SimaPro 9.1. software.

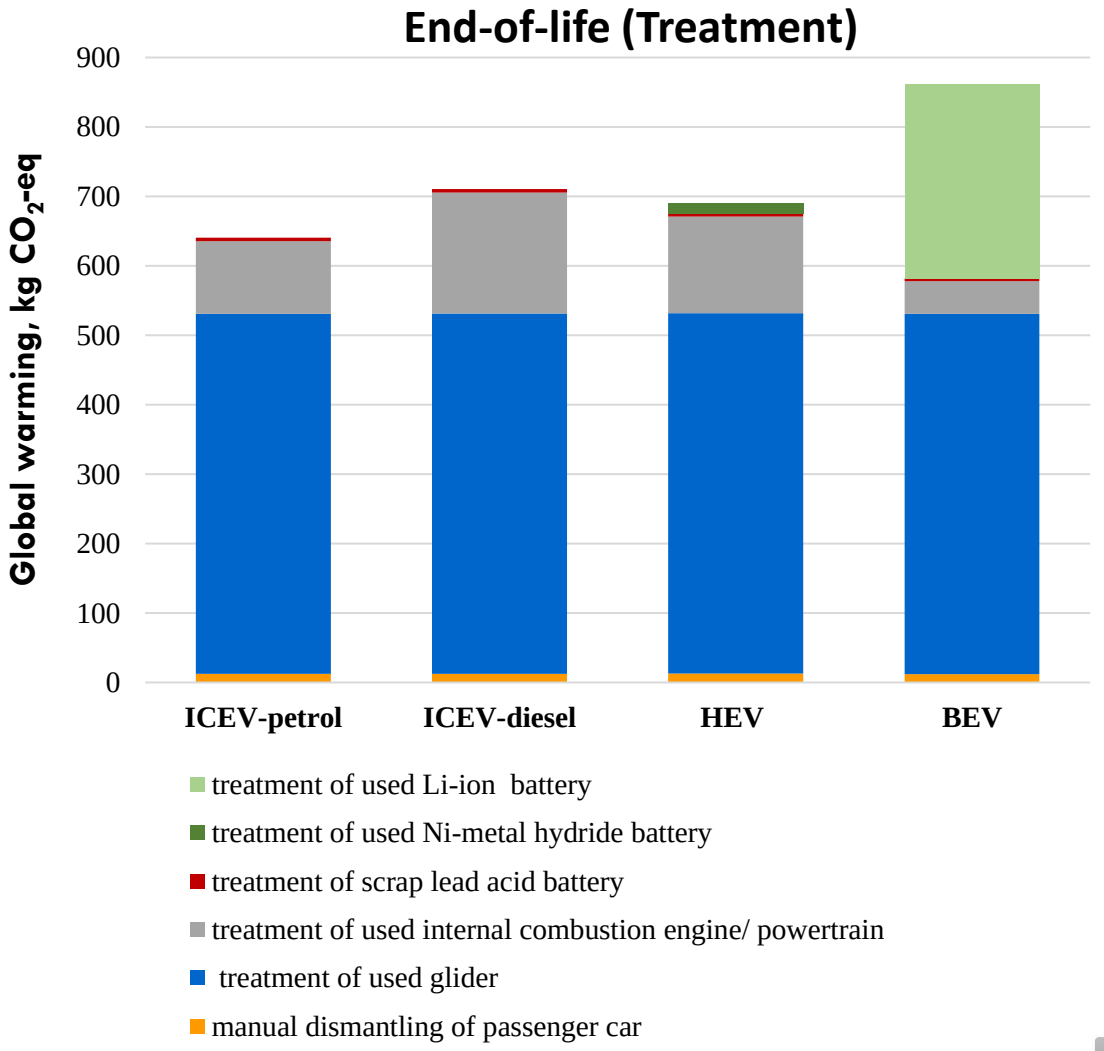



*(Source: ISO 14040 and 14044:2006, 2006)*

# METHODOLOGY. ENVIRONMENTAL PART

# The LCA results in terms of global warming of analysed vehicles' production and treatment stages



| Vehicle parts | ICEV-petrol | | ICEV-diesel | | HEV | | BEV | |
|---|---|---|---|---|---|---|---|---|
| | *Production, kg $CO_2$-eq* | *Treatment, kg $CO_2$-eq* | *Production, kg $CO_2$-eq* | *Treatment, kg $CO_2$-eq* | *Production, kg $CO_2$-eq* | *Treatment, kg $CO_2$-eq* | *Production, kg $CO_2$-eq* | *Treatment, kg $CO_2$-eq* |
| Glider | 5,507 | 519 | 5,507 | 519 | 5,507 | 519 | 5,507 | 519 |
| Internal combustion engine/ powertrain | 1,018 | 105 | 1,697 | 174 | 1,358 | 139 | 1,610 | 47 |
| Batteries | n/a | 5 | n/a | 5 | 719 | 20 | 1,851 | 284 |
| **Total** | **6,525** | **629** | **7,204** | **698** | **7,584** | **678** | **8,968** | **850** |

# RESULTS OF GLOBAL WARMING ASSESSMENT DURING VEHICLE PRODUCTION AND TREATMENT STAGES

Impact category: Global warming

| Contribution | Process |
|---|---|
| 100.00% | market for glider, passenger car \| glider, passenger car \| APOS, U - GLO |
| 100.00% | glider production, passenger car \| glider, passenger car \| APOS, U - GLO |
| 28.47% | market for reinforcing steel \| reinforcing steel \| APOS, U - GLO |
| 23.01% | market group for electricity, medium voltage \| electricity, medium voltage \| APOS, U - GLO |
| 08.34% | market for used glider, passenger car \| used glider, passenger car \| APOS, U - GLO |
| 08.27% | market for printed wiring board, mounted mainboard, desktop computer, Pb free \| printed wiring board, moun... |
| 05.18% | market for steel, low-alloyed, hot rolled \| steel, low-alloyed, hot rolled \| APOS, U - GLO |
| 04.25% | market for sheet rolling, steel \| sheet rolling, steel \| APOS, U - GLO |
| 02.81% | market for polyurethane, flexible foam \| polyurethane, flexible foam \| APOS, U - GLO |
| 02.35% | market for synthetic rubber \| synthetic rubber \| APOS, U - GLO |
| 01.95% | market for polypropylene, granulate \| polypropylene, granulate \| APOS, U - GLO |
| 01.93% | market for steel, chromium steel 18/8, hot rolled \| steel, chromium steel 18/8, hot rolled \| APOS, U - GLO |
| 01.73% | market for coating powder \| coating powder \| APOS, U - GLO |
| 01.48% | market for epoxy resin, liquid \| epoxy resin, liquid \| APOS, U - GLO |
| 01.33% | market group for heat, district or industrial, natural gas \| heat, district or industrial, natural gas \| APOS, U - GLO |
| 01.23% | market for viscose fibre \| viscose fibre \| APOS, U - GLO |
| 01.11% | market for road vehicle factory \| road vehicle factory \| APOS, U - GLO |
| 00.99% | market for copper \| copper \| APOS, U - GLO |
| 00.70% | market for magnesium \| magnesium \| APOS, U - GLO |
| 00.62% | market for polyethylene, low density, granulate \| polyethylene, low density, granulate \| APOS, U - GLO |
| 00.60% | market for flat glass, uncoated \| flat glass, uncoated \| APOS, U - GLO |
| 00.60% | market for light emitting diode \| light emitting diode \| APOS, U - GLO |
| 00.52% | market for nylon 6 \| nylon 6 \| APOS, U - GLO |
| 00.41% | market for aluminium, cast alloy \| aluminium, cast alloy \| APOS, U - GLO |
| 00.38% | market for acrylonitrile-butadiene-styrene copolymer \| acrylonitrile-butadiene-styrene copolymer \| APOS, U - ... |
| 00.37% | market for aluminium, wrought alloy \| aluminium, wrought alloy \| APOS, U - GLO |
| 00.36% | market for polyvinylchloride, suspension polymerised \| polyvinylchloride, suspension polymerised \| APOS, U - G... |
| 00.22% | market for waste plastic, industrial electronics \| waste plastic, industrial electronics \| APOS, U - GLO |
| 00.12% | market for zinc \| zinc \| APOS, U - GLO |
| 00.11% | market group for heat, district or industrial, other than natural gas \| heat, district or industrial, other than natura... |
| 00.11% | market for lead \| lead \| APOS, U - GLO |
| 00.10% | market for tempering, flat glass \| tempering, flat glass \| APOS, U - GLO |
| 00.09% | market for polyethylene terephthalate, granulate, amorphous \| polyethylene terephthalate, granulate, amorpho... |
| 00.08% | market for lubricating oil \| lubricating oil \| APOS, U - GLO |
| 00.06% | market for sheet rolling, aluminium \| sheet rolling, aluminium \| APOS, U - GLO |
| 00.05% | market for wire drawing, copper \| wire drawing, copper \| APOS, U - GLO |
| 00.03% | market for glass fibre reinforced plastic, polyester resin, hand lay-up \| glass fibre reinforced plastic, polyester r... |
| 00.03% | market group for tap water \| tap water \| APOS, U - GLO |
| 00.01% | market for aluminium scrap, new \| aluminium scrap, new \| APOS, U - RoW |

## Glider production

| Contribution, % | Materials |
|---|---|
| 28.47 | reinforcing steel |
| 5.18 | steel |
| 2 | chromium steel |
| 1 | copper |
| **36.65** | Total |

# RESULTS OF GLOBAL WARMING ASSESSMENT DURING VEHICLE PRODUCTION

# CONCLUSION

- The results showed the economic benefits for dismantling companies and passenger car owners/consumers. Around 42% of ELV-hybrid car mass can be sold in parts that would save up to 3,835 Eur as an economic benefit for the dismantlers and 17,153 Eur for the consumers. Besides, 35% of ELV-electric car mass can be sold in parts for reuse and it can bring 8,812 Eur for the dismantling company, while the consumers would save up to 6,614 Eur when buying used parts for their car repair. Next, an ELV-petrol car and ELV-diesel car can be sold in parts 27% and 25%, respectively. An ELV-petrol car can bring 2,412 Eur economic benefit for the dismantlers and 10,127 Eur for the consumers, while an ELV-diesel car can bring 2,644 Eur economic benefit for the dismantlers and 13,915 Eur for the consumers.
- When performing the LCA analysis, the lack of the data of separate automotive materials were occurred. Only three options of the automotive parts (glider, internal combustion engine/powertrain and batteries) could be chosen.
- The results of LCA showed that the end-of-life stage (treatment) of the glider, the internal combustion engine/powertrain, Li-ion (from BEV) and Ni-metal (from HEV) batteries account for only 10% of the environmental impact of the production of all these car parts.
- The LCA results in terms of global warming showed that treatment of ELV parts can save $CO_2$ emissions caused by metal extraction needed for the production of the analysed vehicle parts. As a result, secondary resource recovery can save 23–44% $CO_2$-eq needed for the primary metal extraction.

# THANK YOU FOR YOUR ATTENTION!

## COMMENTS AND SUGGESTIONS ARE WELCOME!

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