

collection, dismantling, recycling
end-of-life vehicles (ELV), Upper Silesia area

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**LOGISTICS SYSTEM OF COLLECTION, DISMANTLING AND
RECYCLING OF END-OF-LIFE VEHICLES**

Summary. In the paper it is presented system for collection, dismantling and recycling of end-of-life vehicles. There are discussed framework of the system based on ELV European directive and Polish act. It is presented profitability of recycling of typical vehicles in Poland and methods of effective preparation of wrecks for shredding and further steel production. Examples are presented for Upper Silesia area.

**LOGISTYKA ZBIÓRKI, DEMONTAŻU I RECYKLINGU ZUŻYTYCH
POJAZDÓW SAMOCHODOWYCH**

Streszczenie. W artykule przedstawiono logistykę zbiórki demontażu i przetwarzania złomu zużytych pojazdów samochodowych w oparciu o obowiązujące prawodawstwo. Omówiono aktualny stan funkcjonowania systemu w Polsce ze wskazaniem efektywności działania systemu i najlepszych metod przetwarzania i sortowania złomu powstałego z wraków samochodowych.

1. SYSTEM AND PROCEDURES OF DISMANTLING VEHICLES IN POLAND

End-of-life vehicles became serious problem for environment in the last years. It required important solutions not only on regional level but in entire European Union. First important act was issued in September 2000 [1]. In 2005 after Poland entered EU new ELV law was issued in Poland [2]. The main frames of these acts focus on creation of system including requirements for vehicles collection, dismantling and recycling. Effectiveness of the system was described in [12]. There are three levels of responsibility for disused vehicles: producers, dismantling and recycling plants. Also there are indicated levels of recovery level for 2006 and 2015 fig. 1 [1].



Fig. 1. Required level of recovery – 85% in 2006 and 95% in 2015

Rys. 1. Wymagane poziomy odzysku – 85% w 2006 i 95% w 2015

The guidelines help to create a system minimizing negative influence for environment and saving resources. Example of energy saving in production of raw materials obtained from recycling and from primary resources is presented in table 1 [6]. It is significant energy saving is higher than 50 % and in Aluminum production it reaches 95%.

Table 1

Energy savings for different raw materials applied in vehicles

Raw materials	Energy savings in %
Aluminium	95
Copper	85
Iron	74
Lead	65
Thermoplastic polymers	60
Zink	60

2. COLLECTION AND DISMANTLING OF VEHICLES

The framework of the logistic system is based on network of dismantling stations and vehicles collection centers. The appropriate number of these firms is presented for Poland and Silesian provinces in the figure 2. In the area of 312 685 km² it should be about 80 – 100 vehicle collecting stations in Poland [3].

The logistic chain called also reverse logistics chain [13] is created by the following objects:

- customers – end life vehicle suppliers,
- collection points,
- dismantling centers,
- material recycling plants,
- incineration plants,
- landfill points,
- transportation companies.

The number of dismantling stations and collecting centers is presented in the figure 2 (data collected in 06.2009)

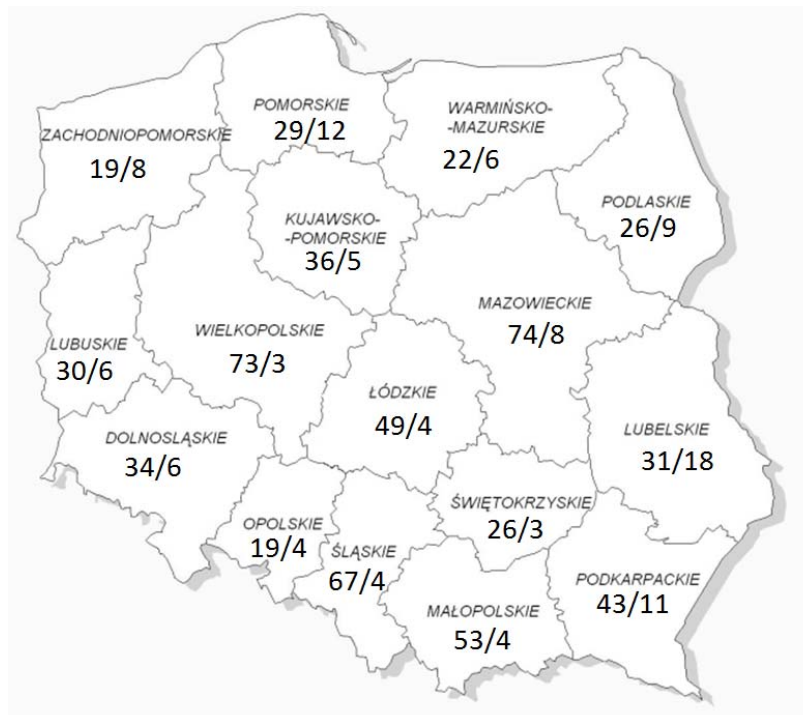


Fig. 2. Number of dismantling and vehicle collecting centers in Poland

Rys. 2. Liczba i rozmieszczenie stacji demontażu i punktów zbierania pojazdów w Polsce

3. LOGISTIC SYSTEM FRAMEWORK

Dismantling stations are responsible for the tasks presented in the figure 3. The main purpose is to remove after storing all liquids and dangerous materials. On this stage it is possible to dismantle and evaluate subassemblies and assemblies in good technical condition for sale or refurbishment [11]. It can be used database systems available online could be used like IDIS or ARES [4, 14].

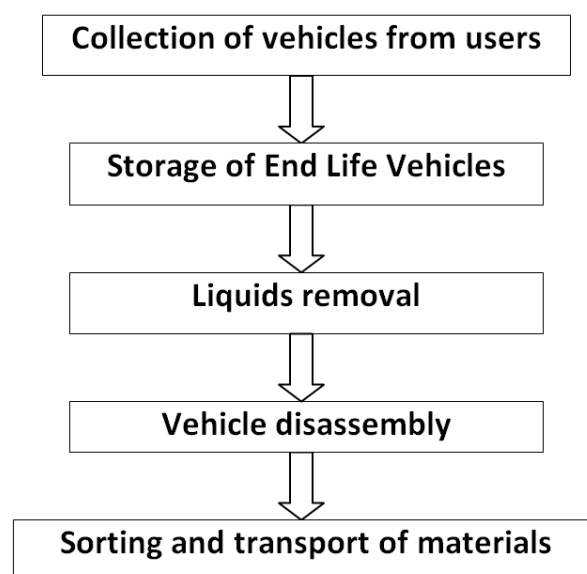


Fig. 3. Procedures after collecting end life vehicles

Rys. 3. Procedury wykonywane w stacji demontażu pojazdów

Type of vehicle, parts and assemblies to be recovered and quantity of raw materials determines economic efficiency of the process [12]. Average dismantling time of a single vehicle varies from 1 hour to 3 hours for four person's team. In the table 2 there is presented benefit from dismantling two the most popular vehicles (it is assumed raw materials recovery with no spare parts sale) [7]. The profit from dismantling Fiat 126p reaches 330 PLN per vehicle and in case of FSO Polonez it is about 640 PLN.

Table 2

Comparison of profits from dismantling Fiat 126 and FSO Polonez

	Fiat 126p	FSO Polonez
Profit after dismantling	450 PLN	825 PLN
Cost of labour (11PLN/hour per person)	88 PLN	132 PLN
Amortization and plant costs (50PLN/Mg for dismantled vehicle)	30 PLN	56 PLN
Final profit	332 PLN	637 PLN

The tasks realized by dismantling stations are very important for separation of different materials like metals, glass, plastics (tab. 3). With high level of separation it is easier to sell the raw materials to recycling companies. The biggest task is to work on foams, textiles recovery which usually is transported to landfill in Poland.

Table 3

Procedures after dismantling for individual materials

Material	Type of parts or assembly	Procedures after dismantling			
		Material recycling	Incineration	Spare parts (refurbishment)	Landfill
Steel	Body, chassis, suspension, drive unit	+		+	
Non-ferrous metals	Battery, electric motors, electronic units, gear box housing, wires, cooler	+		+	
Plastics	Interior, exterior parts	+	+	+	+
Rubber	Tyres, seals	+	+	+	
Glass	Wind screens	+		+	+
Liquids	Oil, braking, cooling liquids	+	+		
Other, ASR	Foams, thermoplastics, textiles				+

In the figure 4 it is presented mass of individual materials presented for two the most frequently dismantled vehicles last year in Silesian region stations. Total mass of FSO Polonez was 1130 kg and for Fiat 126 – 600 kg.

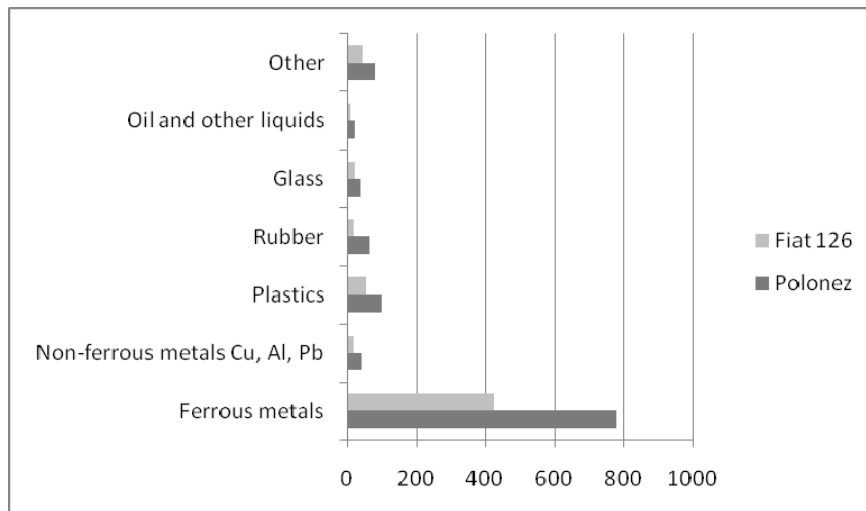


Fig. 4. Comparison the mass of individual raw materials after dismantling Fiat 126 and Polonez
Rys. 4. Porównanie masy materiałów konstrukcyjnych Fiata 126 i Poloneza

However at this stage not all parts could be separated. It is connected with neglecting dismantling of hard to remove parts or removing components with higher market value – like ferrous and non ferrous metals. Also at this stage the wrecks must be specially prepared for transportation to other chains in logistics systems. At this stage for vehicle bodies should be pressed for transportation purposes [5].

4. EFFECTIVE METHOD OF VEHICLES RECYCLING – SHREDDING

Dismantled vehicles bodies and chassis are transported to shredding plants. In the Silesia area there is one big general purpose shredder in CMC Zawiercie where ELV can be send. The machine has big capacity 300 t/h and is intended to prepare material for steel plant located in the neighborhood. The entire process enables separate different materials like ferrous, non ferrous metals and ASR.

There are test done after receiving shred from dismantling plants. The results of one of these tests are presented in the figure 5 [8]. The test indicates relatively high level of impurities reaching 20% of total mass of shredded vehicles.

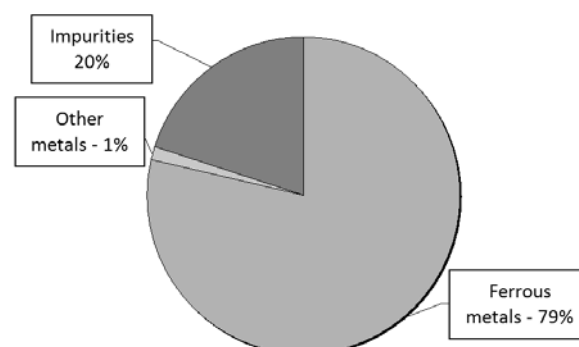


Fig. 5. Percentage of different materials after shredding test of vehicles
Rys. 5. Procentowy udział poszczególnych frakcji z próby

The results indicated relatively high level of impurities. The contents of impurities are rests of rubber, plastics, stones, ground and others. This rate is relatively high due to low quality of vehicle dismantling process and dishonesty of customers.

The materials are brought into plant by means of road and rail transport. Further process of shredding and separation guarantees high quality with all types of separations method. In this case it is possible to separate copper wires, aluminum, stainless steel and some environmentally dangerous parts like capacitors [9]. All the separated materials are properly used. Non-ferrous metals are sent to external plants, after shredding residues is transported into waste dump and main material ferrous steel is recycled on site.

5. CONCLUSIONS

ELV directive prepares solid base to create effective system of ELV management. There are some important steps taken in Silesia region to fulfill requirements of such system and to comply with environmentally conscious treatment of disused vehicles. The capacity of shredder located in Zawiercie is high enough to prepare separated materials from vehicles delivered from Silesian provinces and neighboring areas. The quality of disassembling vehicles and materials removal, especially hazardous should be improved. For separation of parts for refurbishment data base online systems could be used.

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