Theory and Practice in Plastic Recycling in the Selected European Union Member Countries and in Canada from 1999 to the Present

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3. **Recyklace jako způsob využití odpadu**
4. **Specifika recyklace plastového odpadu**
5. **Druhy recyklace v závislosti na materiálu**
6. **Popis různých procesů využívaných při recyklaci**
7. **Finální výrobky a jejich aplikace**
8. **Zásady Evropské unie**
9. **Recyklace v praxi v Čeaké republice**
10. **Recyklace v praxi ve Velké Británii**
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ABSTRAKT

Cílem této bakalářské práce je stručně uvést problematiku spojenou s odpady obecně a s trendy v nakládání s odpady. Zvláštní pozornost je věnována PE, PP, PS, PVC a PET. Autorka přistupuje k tématu z ekonomického a ekologického hlediska a nabízí náhled do nakládání s odpady ve tředh různých zemích. Za účelem této bakalářském práce byly vybrány následující země: Česká republika, Velká Británie a Kanada. Za účelem získání širšího rozhledu na věc je nastudována politika Evropské Unie. Jsou zde popsány znovu zpracované plasty a finální produkty, které jsou používány v mnoha směrech. Výhody důležitého odpadového hospodářství, zejména tedy recyklace plastů, jsou zdůrazňovány v celé práci.

Klíčová slova: recyklace, plastové materiály, plasty

ABSTRACT

The aim of the presented thesis is to briefly introduce the problems connected with waste in general and with the trends in its disposal with specific attention being paid to PE, PP, PS, PVC and PET. The author approaches the topic from economical and ecological points of view and offers an insight into the waste management in three chosen countries. For the purpose of this bachelor thesis, there are chosen the following states: the Czech Republic, the Great Britain and Canada. In order to get a broader view of the subject, the European Union policy is studied. Reprocessed plastics and final products used in various applications are described. The advantages of responsible waste management, namely of plastic recycling, are accentuated throughout this work.

Keywords: recycling, plastic materials, plastics

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CONTENTS

INTRODUCTION

pplications range from food packaging to heavy-duty machine parts, from highly specialized ones, for example transplants used in medicine, to commodity products. As their production and popularity increases, so does the emphasis on their ecological processing, utilization and waste management. The potential of the ecological waste management of plastics lies mainly in the possibility to recycle them. Recycling is a process of recovering and reprocessing the waste into new useful products. When compared to other recyclable waste materials, plastics have their specifics. Recyclable plastics include polyethylene PE, polypropylene PP, polyvinyl chloride PVC, polystyrene PS and polyethylene terephthalate PET. Millions of tons of polyethylene terephthalate are generated yearly in a form of soft drink bottles. Recycling of PET bottles may be the best known example of the ecological approach.

People buy soft drinks in plastic bottles and then the empty bottles are thrown into the waste. They are made of a kind of plastics called polyethylene terephthalate, shortly PET. PET bottles represent the biggest part of the household waste that must be recycled because their consumption has been increasing.

Some households begun to sort their waste but it is only a minor part of the total households

The amount of plastics usage has been still increasing and society has to deal with one big problem – what to do with used plastics. Scientists and researchers are inventing new techniques and possibilities of recycling of those materials which were not possible to be recycled in past.

1 INTRODUCTION TO WASTE GENERATION AND GENERATION OF PLASTIC WASTE

All countries have to deal with a problem of waste and its recycling. Let us define the term "waste" first.

"Waste consists of every movable thing which the holder discards, or intends to discard or is obligated to discard and which belongs in one of the groups referred to in Annex No. 1 to Act No. 185/2001 Coll." (1)

In our country, there were about 24.6 million tons of waste generated in 2006 (it is 1% less than in 2005). It means that about 2.5 tons of waste were generated by every single citizen. The biggest amount of the waste was transported to and deposited at waste dumps in our country or abroad; another part of the waste was used as fuel for energy production and only 4.3 million tons were recycled.

In general, the amount of total waste in our country is declining. These data were published on the web pages of Ekolist.cz (2) and were elaborated by the Czech Statistical Office. It is good information for our country because now may be the time to do something for our environment and especially for its future.

From the global point of view the worldwide consumption of plastic materials is 100 million of tons nowadays. In the Last century, for example in 1950s, it was only 5 million tons. These data give the alarming prove for the recycling importance. (3)

There are various areas of human activity which produce waste. Those with the highest amount of waste are as follows:

- Agriculture, hunting and related service activities,
- Manufacture of food products and beverages,
- Electricity, gas, steam and hot water supply
- Construction
- Collection, purification and distribution of water
- Manufacture of wood, wood products and cork, except of furniture; manufacture of articles of straw and plaiting materials
- Manufacture of rubber and plastic products. (3, 4)

Year	**2002**	**2003**	**2004**	**2005**	**2006**
Total production (1000 tones/year)	37 969	36 087	38 705	29 802	28 066
Production per capita (kilograms per capita)	3 718	3 522	3 786, 9	2 907	2 728

Table 1: Total waste production in the Czech Republic in the period 2002 – 2006 (Ref. 5)

The total production of waste (including waste from various industries etc.) has a decreasing tendency. Comparing the years 2002 and 2006, the drop of the total produced waste was 9 903 mil. tones. The outcome in the production of waste per capita is virtuous: 990 mil. tones.

In the chart, the total production and production of waste per capita includes also the municipal waste.

According to the analysis from 2006, municipal waste produced was 296 kg per capita. In the same year about 20 % of municipal waste was recycled.

A very favourable trend is in sorting of waste. While in 2002 the amount of sorted waste was only 24.4 kg per capita, in 2006 it was almost 43.6 kg per capita. It means almost an 100%-increase in waste sorting. (6)

Region	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Capital City of Prague	12 968 375	8 897 626	7 552 314	7 839 401	6 023 583	5 129 008
Olomoucký	1 355 309	440 203	1 135 813	1 165 881	583 928	642 917
Zlínský	1 038 486	594 620	621 429	664 893	672 185	774 210

Table 2: Waste production according to the region in tones (Ref. 7-11)

Table 2 shows the waste production according to the regions where the waste was produced. I have chosen three regions of the Czech Republic which I wanted to compare. The first one is the capital city of Prague. As the capital and the most populated city in our country, it is interesting to compare it with other regions.

The second region is Olomoucký where I have been living since my birth. So I was naturally interested in the facts how this region goes along among the others. The last selected one is the Zlínský region, because it is the seat of our University.

The biggest difference has occurred in the capital city. Waste production decreased dramatically in the set period. This difference is represented by a decrease of 7.839.367 tons. It is hard to compare the capital city and other two regions because of density of population. There live 1.204.897 citizens in Prague, in Olomoucký region there are 641.006 citizens and in Zlínský region there live 590.482 citizens. These data were actualized as to the date September 30, 2007.

Table 3 shows the waste production per capita in the above mentioned regions as counted to the number of citizens of September 30, 2007.

Region	**2001**	**2006**
Capital City of Prague	10,76 t	4,25 t
Olomoucký	2,11 t	1,00 t
Zlínský	1,75 t	1,31 t

Table 3: Waste production per capita in chosen regions (Ref. 7, 11)

In all regions, the waste production has been decreasing. In Prague, the outcome is much higher because of higher number of companies producing waste. So it naturally increases the production per capita. Other two regions have similar outcomes as well as a decreasing tendency in waste production.

Production of hazardous waste

Hazardous waste is included in the above mentioned. The amount of hazardous waste has fallen steadily from 1998 – 2002. According to the Czech Statistical Office the total production of hazardous waste decreased from 3.9 to 2.4 million of tons in the 1998 – 2002 period. In 2006, there was about 1.3 million of tons of hazardous waste. (12)

Even though a decline in the waste amount was experienced, our country suffers from a much higher production of hazardous waste than other European Union countries.

Plastic waste

Tires, products with PVC content or waste from packing materials can be included into this category. The amount of waste from manufacture of rubber and plastic products in the Czech Republic rises steadily – it was 1,798 in 1999 and 2,157 tons in 2000. (13)

2 MEANS OF WASTE MANAGEMENT

"Waste management means are the accumulation, aggregation, collection, purchase, sorting, shipment and transportation, storage, treatment, utilization and disposal of waste." (14)

Waste management begins in the households where the waste should be sorted. If the waste is not sorted in households, its further sorting is not possible.

People can sort paper, glass and plastic materials. These three groups have specially colored containers in every town. In addition, we can bring different metals, electrotechnics, building waste or waste suitable for composting to the collection points. After collecting, waste must be properly final-sorted on special sorting units of different companies.

After the sorting of waste, there are several means of waste management.

Means of waste management are as follows:

1. mechanical and chemical processes:
   a) thermal processes:
   - waste combustion
   - pyrolysis technology
   - pressure carburation
   - hydrogenation processes

   b) pitching of waste
   c) solidification
   d) composting
2. biological processes
3. waste disposal (15)

Thermal processes which belong to the mechanical and chemical processes are used for hazardous waste (as biological medical waste), but they are also commonly used for disposal of common household waste. After the combustion the waste transforms into the heat, ash, gas or other materials.

Composting is used for biological waste and waste from households. This waste must be sorted properly in order not to affect the quality of its final product – organic fertilizer.

The most widespread and oldest way of waste management is waste disposal. This way of waste management is considered to be the cheapest one, on the other hand it is the most dangerous way for environment.

Waste can be re-exploited, and in this case the recycling is used. Recycling saves the natural resources and it bounds the amount of harmful substances in the environment. (15) Recycling is the most environmentally friendly means of waste treatment.

3 RECYCLING AS A WAY OF WASTE RECOVERY

The problem of recycling the plastic materials is quite new. It is because of the fact that plastics belong to the new materials which were invented and firstly produced during the Second World War. In the 1970s the big boom of plastic packaging occurred. In comparison to the invention of the steel food containers (tins) which were invented in 1800s, the plastic packaging is a very innovative way with possibility of recycling and reuse.

It could be said that plastic recycling technology is in its development phase. Some processes of recycling are known, but nowadays people are looking for new ways of recycling or reuse of the plastics as well. (16)

Recycling is considered to be the most effective way of waste management. There are many advantages of recycling. These may teach the population about the importance of waste sorting and subsequent recycling. The biggest boom in waste sorting has been noted at plastics in the last 15 years. These have replaced other materials such as glass and paper especially as packaging materials.

The effectiveness of recycling can be seen in many areas:

- it saves non-renewable resources of fuels, energies and raw materials
- it saves energy and manpower
- it saves expenses on production development and it also saves expenses at using of secondary materials
- it saves haulage expenses
- it reduces a negative impact on the environment to a large extent
- it saves the investment on new production factories (17)

Every process of recycling is thought to be very expensive. Many teams of researchers are searching for new ways and possibilities how to make recycling cheaper, more effective and also how to recycle materials which are not possible to be recycled in these days.

Usage of recycling process prevents mainly the exploitation of non-renewable resources of fuels, energies and raw materials. Protection of environment is closely connected with recycling. Any production process may be very dangerous for environment and nature when causing high pollution of water, air or soil. Every recycling company must obey the

rules set by government on environment and so companies must prevent damage to environment.

Companies must also consider the costs spent on recycling. Earnings must be higher than expenses. Only in one case it is possible to have the expenses higher– when a company begins to recycle a new material. But this must change in some period.

It is necessary to mention that each material has its specific properties and must be recycled in different way. Some materials are not suitable for recycling at all, so they must be disposed of by other means.

There are several ways of recycling division. The first one is primary, secondary and tertiary recycling.

Primary recycling means that the recycled product is used for production of the same or similar product (e. g. bottle to bottle recycling – from used PET bottles the new ones are made).

Secondary recycling brings a new product with different qualities – from PET bottles a fiber is made.

Tertiary recycling enables getting chemicals or energy from utilizable waste – there are solvents in electrotechnics which are distilled and then reused.

Another possible division is *pre-consumption* and *post-consumption recycling*. The first one is another term for primary recycling. The second one – the post-consumption recycling – means reusing of materials which were get from households and firms (e. g. newspaper, plastic and glass bottles, etc.). (18)

Recycling of particular materials

It is possible to recycle almost every material, but the most frequently recycled ones are glass, paper, plastic material, aluminium and different metals.

Recycling of glass – it is easily recyclable material and its quality after recycling process is the same as before it. An important fact is that it is necessary to sort the white and color glass. One bottle can be in afloat for thirty times and this fact shows the importance of reversible glass bottles. The biggest advantage of glass recycling is saving of raw materials and energy.

Recycling of paper – people can support recycling of paper by sorting it and also by buying products made of recycled paper. The average consumption of paper is in the Czech Republic 90kg per person per year. Recycling of paper saves our woods, energy and quality of water.

Recycling of aluminium – recycling of existing aluminium is very important because of the expenses invested in its production. On the other hand, recycling of aluminium is not considered as ecologically friendly as that of other materials because of high emissions produced during the recycling.
The best way how to avoid unecological recycling is to reduce purchase and consumption of aluminum packages.

Recycling of plastic materials – this recycling is the most difficult one because of a high number of various plastic materials and their different composition. Following chapters are devoted to specifications of plastic waste recycling and I will describe and mention the most important facts about this kind of recycling there. (19)

4 SPECIFICATIONS OF PLASTIC WASTE RECYCLING

Plastic materials are famous for their wide range of usage. These materials can be found in every sphere of industry and in general, they are a common part of everyday life of an average citizen. We find them in households, at workplaces, simply everywhere. There is hardly any area or sphere of industry where plastic materials do not play an important role or where they are not necessary.

Differentiation of plastic materials

Many different materials are included in plastic waste. There are almost 50 different groups of plastics with hundreds of different varieties. To make sorting and thus recycling easier there is special marking of plastics.

	**PET**	**Clear PET** - fizzy drinks, clear mineral water, cooking oils, oven-ready meal trays **Coloured PET** - mostly light or dark green, dark blue, red etc.	**Polyethylene terephthalate**
	**HDPE**	**HDPE natural –** milk bottles **HDPE coloured –** washing-up liquids, detergents, cleaning fluids, hair care, bath and shower bottles **HDPE mixed =** HDPE natural and HDPE coloured	**High-density polyethylene**
	**PVC**	**Clear PVC and Coloured PVC** - food trays, cling film, bottles for squash, mineral water and shampoo.	**Polyvinyl chloride**

	**LDPE**	Carrier bags and bin liners	**Low density polyethylene**
	**PP**	Margarine tubs, microwaveable meal trays	**Polypropylene**
	**PS**	Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.	**Polystyrene**
	**OTHER**	**Any other plastics** that do not fall into any of the above categories. - An example is melamine, which is often used in plastic plates and cups.	

Table 4: Marking of plastics (Ref. 20, 21)

This table shows marking of particular types of plastics and their abbreviations. Marking from 1 to 7 is printed on all labels of plastic products. All products listed in this chart are commonly used in everyday life.

Some of them are differentiated according to colours used in their production. This kind of differentiation is most common at PET bottles.

Thermoplastics and thermosets

Thermoplastics and thermosets are two groups of plastic materials. Let us define their recycling possibilities.

Thermoplastics can be mechanically recycled by thermal processes and transformed into new products.

Thermosets cannot be mechanically recycled; they can be used in energy recovery processes. They can also be feedstock recycled or ground and used as fillers. (22)

Plastic waste

As said above, the consumption of plastic materials has been continually increasing. Consequently, the amount of plastic waste has been increasing as well. The problem of plastic waste lies in the question how to deal with such a big amount of waste.

Firstly, this waste must be divided because there are several forms of plastic waste.

1. plastic waste from production – this is high quality and clean waste with no need of sorting
2. processing plastic waste – high quality waste, but at this kind there is need of sorting
3. consumer plastic waste – the most difficult kind of plastic waste. It has poor quality because it contains many additives which are actually polluting the pure material at this stage. Along with that, plastic wraps are soiled by the remnants of their original content Therefore, sorting of this group of waste is a highly complex problem. (23)

Durability of plastic waste

As every other material or waste, plastic waste has its life as well. It changes its appearance and sometime also its properties. The main parts of life of plastic waste are as follows:

1. generation of plastic waste – the result of a consumption or production process
2. collection/collecting – generally held in households where the generation is the highest one
3. processing - during this period plastic waste is changed into the secondary material
4. consumption – processing for production of new products according to their functions (23)

Nevertheless, not all plastics are recyclable. The following ones are commonly recycled – polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC). (23)

Special properties of plastics

There are also plastics with some unique properties. One of these properties is so called *biodegradability*. This term refers to such property when the plastics need not to be recycled or processed in various ways, but they simply decompose. Starch, cellulose or some plastics with synthetic base as crude oil are ranked among these.

5 RECYCLING TYPES DEPENDING ON THE MATERIAL

5.1 Chemical recycling

5.1.1 Chemical recycling of mixed plastic waste

A. the polymer cracking process – this process is suitable for plastic packaging waste and its advantage is in very low emissions produced during recycling

B. conversion process – a method used for PVC in packaging waste

C. blast furnaces – use of mixed plastic waste for production of iron ore or steel, in this case plastic waste is used as a reducing agent because it has a lower sulphur content than coal.

D. gasification process – plastic waste is transformed into gas, methanol and electricity

5.1.2 Chemical recycling of PVC-rich waste

A. Incineration process – process which produces high quality HCl, steam and inert slag

B. Steam gasification process – PVC-rich waste is converted with steam into fuel gas, HCl and residual tar. It is possible to get 0.21 tons of HCl and 0.9 tons of gas from 1 ton of PVC.

C. Pyrolysis process – chemical and thermal degradation of PVC in a reactor under low pressure and moderate temperature. Products of this process are calcium chloride, coke, metal concentrate and organic condensate.

The above mentioned processes can be used for different types of plastic materials. There are many factories specializing in chemical PET, PVC, PE or PP recycling. (24)

5.2 Mechanical recycling

Mechanical recycling or physical recycling refers to those recycling processes where the material is treated mechanically – melted, shredded or granulated.

This kind of recycling is suitable for great amounts of homogenous materials which were sorted precisely and this recycling produces the same or very similar products to the original ones. The chemical composition of recycled material does not change at all.

The main method of mechanical recycling of plastics is so called reclamation. Plastics are chopped into flakes and then they are washed to remove contaminants. The next necessary step is to dry the material, and in some cases it is followed by regranulation. This material is then sold to producers of final products. The melted and chopped material obtains a new shape in the producer's factory. (25, 26)

In mechanical recycling it is essential to provide the sufficiency of heat and mechanical energy and also some additives like colourants or stabilizers.

Materials recycled mechanically

- bottles
- floorings
- pipes

6 FINAL PRODUCTS AND THEIR APPLICATION

A recycling process may produce various types of final products. They are purchased from recycling companies by producers of final products using recycled plastic waste as a secondary raw material in their further production.

1. Crushed materials – these are made by crushing and grinding of plastics in special recycling machines. Crushed materials are made in various sizes (from 6mm to 15mm). The small pieces of this material are called “flakes”. Flakes are commonly divided into two groups – washed and unwashed. It is possible to make many products from these flakes such as textile fibres, packaging material or bottles.

Figure 1: Washed PET flakes (Ref. 27)

Figure 2: Unwashed PET flakes (Ref. 28)

2. Sinter (agglomerate) – sinter is made from plastic films and it is used for manufacturing of grass concretes. Sinters may have various colours.

Figure 3: Sinter (Ref. 29)

Figure 4: Sinter (Ref. 29)

3. Regranulates - regranulation is the final process of material recycling and this process is used for production of regranulates. The regranulate is the basic material in manufacturing of bags, floorings, benches, bins,

Figure 5: Regranulate (Ref. 30)

4. Grass Concretes – are made from sinter of polyethylene. Grass concretes can be used almost everywhere, from green parking sites to road fortification or application on grass-covered roofs. (32)

Fig. 6: Grass concrete (Ref. 31)

7 WASTE MANAGEMENT POLICY OF THE EUROPEAN UNION

The Czech Republic as a member of the European Union has to deal with plastic waste and plastic recycling according to the policy and laws of the European Union.
This organization sets various targets which must be achieved in a particular time frame. In spite of a large area of the EU and of a very high number of citizens, each country has to obey given rules – this holds true not only in the waste management policy.
All member countries have to follow the waste management according to the Council Directive 2006/12/EC on waste. This directive set the most important rules of the waste management and categories of waste.

Our society is thought to be consumption oriented, people earn more money than they had in past, hence they spend more. The logical consequence of this process is that they produce more waste. A problem of each member state is how to deal with this waste.
In general, the European Union waste in total is treated as:

- landfill – 49%
- incineration – 18%
- recycling and composting – 33% (33)

The highest percentage is deposited at landfills. This number should get lower and, on the other hand, that of recycling should raise, otherwise the countryside of the EU will inevitably become full of dangerous and non-ecological landfills. Although this is true, these numbers are taken as an average of the entire EU. There are also some states with 10% of landfill, 25% of energy recovery and 65% of recycling. On the contrary, we can find those who have 90% of landfill and only 10% of recycling and energy recovery.
The target of the European Union policy is to reach the same percentage of recycling throughout all member states. Furthermore, the required percentage should be the highest possible. (33)

“The European Union strategy for waste management was adopted in 1989, and then reviewed in 1996.” (34) This strategy gives the directives for how to prevent, re-use, recover and optimize the final disposal of waste. It also indicates that it is necessary to prevent the waste generation. When the prevention is not possible, the EU strategy tells the

members how to recycle or incinerate it. The landfilling is undoubtedly considered as the worst option of the waste management.

The cornerstones of the EU strategy of coping with waste are to:

- prevent waste in the first place;
- recycle waste;
- turn waste into a greenhouse neutral energy source;
- optimize the final disposal of waste, including its transport. (35)

The 6th Environment Action Programme (EAP) was adopted in 2002. In general, this environment action programme sets the priorities and targets in the field of the European environment policy. The 6th EAP features the management of waste and waste reduction as just one its four priority points. It targets a 20% reduction in waste quantity going to the final disposal by 2010, and a 50% reduction by 2050. (34)

The European Union waste policy is based on waste hierarchy. This policy divides the waste according to the way of its managing from the best to the worst one.

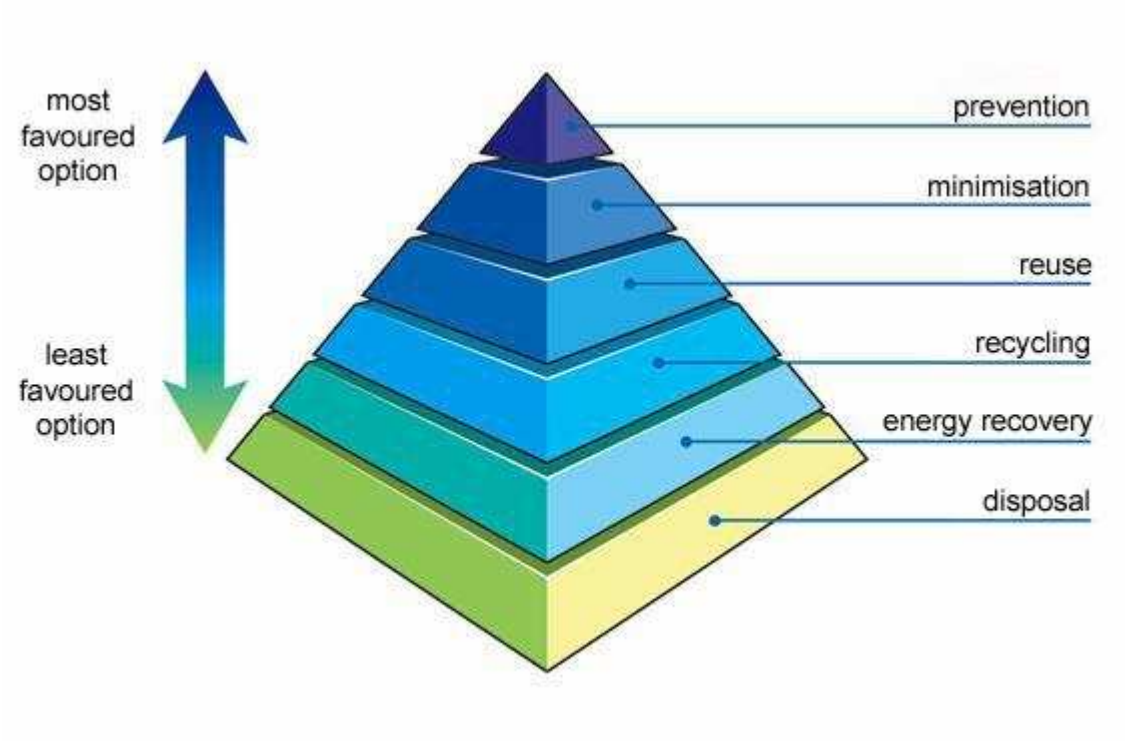


Figure 7: Waste hierarchy (Ref. 36)

According to this waste hierarchy, the best option is to prevent the creation of waste. Prevention of the waste is the strategic element of waste policy. Due to the increasing consumption and generation of the waste, it is necessary to analyze the reasons behind the waste generation. There are many new initiatives which address different sectors, from industry to schools. (37) On the other hand, the worst option is the waste disposal. Recycling belongs to the lower half of the pyramid. It would be advisable to follow the pyramid from its top.

8 RECYCLING IN PRACTICE IN THE CZECH REPUBLIC

The Czech Republic with its waste management has quite succeeded both before and after its admission into the European Union. According to the internet portal Ekolist.cz, the Czech Republic belonged, along with Germany, to the most successful countries coping with the plastic waste in 2004. In comparison to the previous year 2003 when the gross amount of recycling of plastic waste was 38%, in 2004 it was already 44% of the entire plastic waste.

94/62/ES requirement	Czech Republic 2003	Czech Republic 2004	EU 15 in 2001	2004/12/ES requirement
Minimum 15%	38%	44%	23%	Minimum 22.5%

Table 5: Requirements and reached recycling in the Czech Republic and in the EU (Ref. 38)

Table 5 shows the requirements or targets of European Union in comparison with figures reached in the Czech Republic in the given years. Recycling of plastic waste in the Czech Republic exceeds the EU requirements and the average of EU 15 as well. A positive surprise is the figure from 2004 when the percentage of recycled plastic waste in the Czech Republic was almost double of the EU requirement.

There are many firms that deal with recycling of plastics in the Czech Republic. I would like to focus on some important companies in the region of Zlín.

Jelínek – Trading spol s r. o.

This company was founded in Zlín in 1991 and it is one of the largest recycling companies in the Czech Republic. It is specialized in processing of plastic waste, it manufactures plastic parts and it deals with other activities connected to the use and recycling of plastic materials. It focuses especially on re-granulation of PP and LDPE. At the same time, it also processes e. g. PVC, PA or PS.

Company's activities according to their website include - processing of plastic waste by re-granulation, agglomeration, granulation, injection moulding (composters, furniture parts, mud guards, etc.) and manufacturing of garbage bags by blowing. Jelínek-Trading is engaged in trading of plastic materials as well.

Jelínek-Trading is also specialized in trading of polymers, re-granulates and crushed plastic abroad. Its partners are firms in Germany, Austria, Slovakia, UK, France or Hungary. (39)

Obalpro s. r. o.

Obalpro company has a seat in Hodonín. It focuses on producing of plastic containers. The second activity of this company is recycling of plastic materials. They recycle old or damaged plastic containers made of PE or PP. Crushed material resulting from the PE or PP recycling is then sold to buyers, or it is used for manufacturing of new products.
Obalpro also offers buyout of material intended for recycling.
In 2006 this company bought (with the help of EU funds) a new recycling line with 30 tons capacity per day. (40)

Maloun s. r. o.

Maloun s. r. o. was established in 1994 in Tečovice. It is one of the first recycling companies in the Czech Republic. This company is a big supplier of plastic granulates and recycled granulates. They also purchase materials suitable for recycling. (41)

Gummitec s. r. o.

This company was founded in Otrokovice in 1991; nowadays it operates with its 12 employees in Kvasice. It is specialized in mechanical and thermal processing of various plastic materials such as PP, PVC, LDPE or HDPE. They use grinders and extruders for recycling of plastics. They employ octabins and BigBags for packaging of recycled material. Octabins and BigBags are large bags made from paper (octabins) and form plastic (BigBags). BigBags are suitable for outdoor areas. (42)

9 RECYCLING IN PRACTICE IN THE GREAT BRITAIN

United Kingdom produces annually about 330 million tonnes of municipal waste. Plastic waste participates in this huge number with 3 million tonnes.

Another interesting statistic is that 11% of the household waste is created by plastics, from which 40% are PET bottles. (43)

"Most UK legislation impacting on waste management is now implemented as a result of European Directives." (44)

All handling of the British plastic waste is governed by Packaging and Packaging Waste Directive of the European Union (94/62/EC) and by legislation of the Department of Environment.

Packaging Waste Directive target by 31 December 2008 is 55% recycling of all packaging waste.

Plastic packaging should be recycled from 22.5%. This number consists of the total UK target and the target of all other countries of the European Union. To meet this EU target UK must reach so called "business" targets which were set, for plastic packaging in this country, as follows:

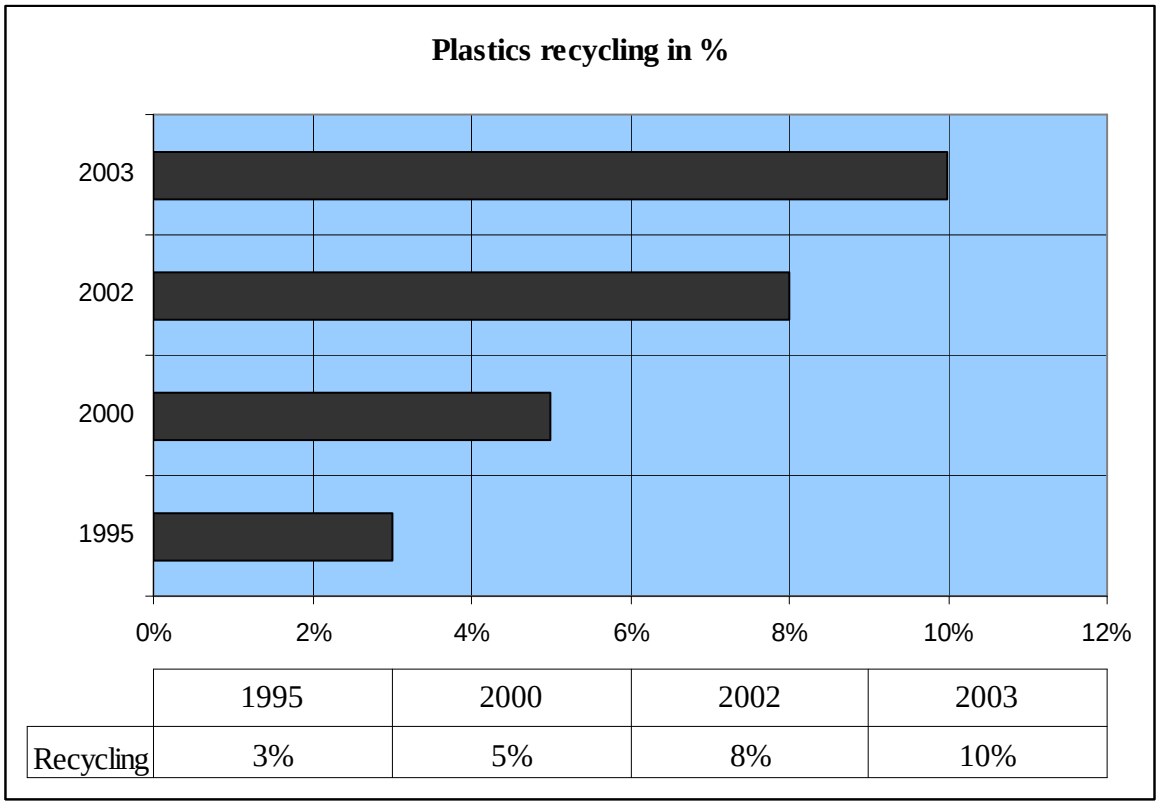
2006	2007	2008	2009	2010
23%	24%	24.5%	25%	25.5%

Table 6: Development of UK plastic recycling and its targets (Ref. 45)

According to the Department of Environment, the problem of plastics recycling is a complex one, mainly because of the high costs of equipment and energy needed for the recycling, along with a different chemical composition, hence diverse material properties of various plastics. Another reason is that plastic recycling is not considered to be as important as recycling of e.g. biodegradable waste which produces greenhouse gasses when disposed in landfills.

There exists a Waste and Resources Action Programme (WRAP) in the UK. This was elaborated to reduce and minimize the packaging waste in this country. This programme is supported by 13 famous retailers as Asda, Tesco, Sainsbury's, Morrison's or Marks&Spencer.

Each retailer has its own programme for packaging reduction. (46) Another important company in the field of plastic materials in the UK is British Plastics Federation.



	1995	2000	2002	2003
Recycling	3%	5%	8%	10%

Figure 8: Plastics recycling in the UK (Ref. 47)

The amount of recycled plastic materials increased almost three times in eight years. The current figure of plastics recycling was not published.

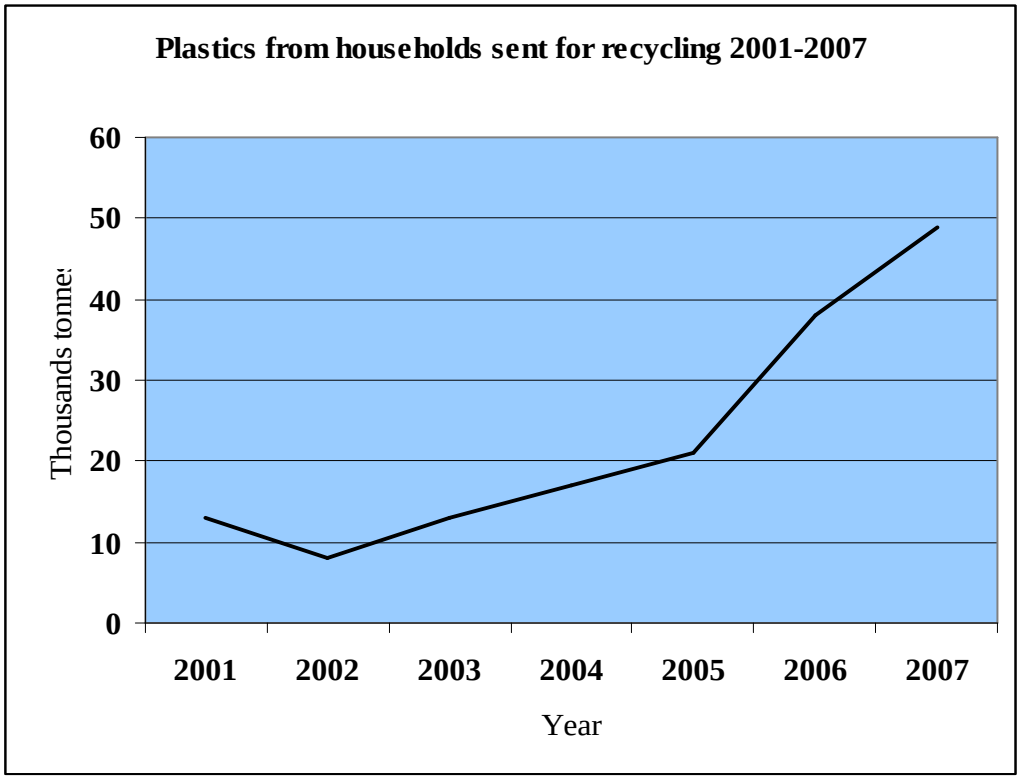


Figure 9: Plastics from households sent for recycling 2001-2007(Ref. 48)

Fig. 10 gives the number of plastics from households sorted and given for recycling. Here, an increasing trend in plastics recycling is also evident.

Year	Tonnes	% of total packaging waste
1999	198,461	12%
2000	204,430	13%
2001	269,962	16%
2002	360,418	21%
2003	321,205	18%
2004	344,317	19%
2005	414,225	22%

Table 7: Amount of recycled and recovered plastic packaging in the UK (Ref. 49)

The last chart elaborated for the UK shows the amount of plastic packaging recovered and recycled in the period of 1999 – 2005.

In 2003 there was a decrease in plastic packaging and recovery and the same trend occurred between 2002 and 2003 at household plastic waste sent for recycling – a decrease was noticed here as well. Unfortunately, the circumstances of the decrease occurred in 2003 are not known.

10 RECYCLING IN PRACTICE IN CANADA

Canada is famous for its infinitely various environment and beautiful nature. People take care off their environment which is evident especially in the urban areas.

In Canada, there exists an Environment and Plastic Industry Council which deals with the problem of plastics, recycling of plastic materials and the impact of plastics on the environment.

This Council deals with two important aspects in this area – methodology and technology. General public is motivated to take an active part in plastics recycling.

Across the country of Canada, some types of the plastic packaging are being successfully recycled. These include soft drink bottles and milk, water and juice jugs made of HDPE. Recycling of these kinds of bottles is increasing.

The number of factories which recycle plastic materials has grown from roughly 10 in 1988 to more than 80 today.

Composition of plastic waste in Canada is as follows:

Out of the total plastic waste plastic packaging is participated from 84%. These are divided to:

- PET (54%)
- HDPE (37%)
- PP (6%)
- PVC (3%) (50)

Bottles	196.8 kt	35%
Unrecyclable film	176.0 kt	31%
Recyclable film	106.0 kt	19%
Polystyrene	58.1 kt	10%
Tubs	20.9 kt	4%
PET food trays	3.4 kt	Less than 1%
Crates and pails	2.8 kt	Less than 1%
Total	564.0 kt	100%

Table 8: Distribution of the Produced – Disposed of plastic material in Winnipeg in 2002 (Ref. 50)

Table 8 provides data about the detailed composition of plastic waste in Canada, especially in state Winnipeg. According to EPIC, the composition of plastic waste is very similar in all Canadian states.

Bottles, as anywhere else in the world, rank the first in produced plastic waste. The second largest group of plastic waste are unrecyclable films with 176.0 kt. Then there is a big gap between unrecyclable and recyclable films – almost 12%.

Bottle recycling in Canada

Programs for recovery of PET and HDPE bottles were introduced in Canada in 1998. From that time, recycling of these materials has been increasing gradually.

The biggest part of the bottle recycling is created by PET and HDPE bottles. These two materials prevail with almost 90% in this group. Markets for PET and HDPE exist across the entire territory of Canada.

Another part of this group consists of bottles made from PP, polyvinyl chloride or other composite materials. These bottles are either collected and saved, or they wait for possible market. They can also be recovered. (50)

Plastic film recycling

Table 8 shows that there are two groups of plastic films – the recyclable and the unrecyclable ones. Only 40% of plastic films can be recycled. Material which is suitable for recycling and fits into this group is clean polyethylene.

On the other hand, the group of unrecyclable films consists of more materials: mixtures of PE, PVC or PP. (50)

11 COMPARISON WITH EUROPEAN UNION STANDARDS

As said in the previous chapters, European Union waste management is governed by Packaging Waste Directive No. 94/62/EC.

A current target of the European Union and all member states is to recycle 22.5% of plastic waste. This amount must be reached by all members till December 31, 2008.

Table 9 gives detailed comparisons of recycling in the European Union, Czech Republic and United Kingdom.

It is worth to mention that Czech Republic has recycling highly above the average of the European Union. 22,5% target was double exceeded already in 2004.

Surprising fact is that western and advanced country as the United Kingdom has its recycling rate much lower than Czech Republic.

Following chart contains data from the period 2003 – 2005 only because up-to-date figures have not been yet published.

		EU	**Czech Republic**	**United Kingdom**
Packaging waste generated (tones)	Year 2003	11,536,055	172,698	1,792,200
	Year 2004	13,208,115	177,138	1,846,966
	Year 2005	14,017,008	206,781	1,901,345
Mechanical recycling (tones)	Year 2003	2,601,183	64,936	321,205
	Year 2004	3,001,331	77,568	344,317
	Year 2005	3,366,635	72,427	414,225
Other forms of recycling (tones)	Year 2003	304,700	0	0
	Year 2004	249,013	0	0
	Year 2005	104,005	5	0
Total recycling (tones)	Year 2003	2,905,883	64,936	321,205
	Year 2004	3,250,344	77,568	344,317
	Year 2005	3,470,640	72,432	414,225
Recycling rate (%)	Year 2003	25.2	37,6	17,9
	Year 2004	24.6	43,8	18,7
	Year 2005	24.8	35,0	21,8

Table 9: Comparison of EU, Czech Republic and United Kingdom in generated plastic waste and its ways of recycling (Ref. 51)

CONCLUSION

Recycling of plastic and other materials is very important in these days. In my thesis I tried to describe the current situation in the field of plastic recycling in chosen countries. Development of new techniques and ways of plastic recycling leads to more effective with plastics. Researchers are inventing new biodegradable plastics which will be less dangerous for environment. In general, people are trying to reduce the amount of plastic waste which is landfilled.

There is a growing trend in trading in final products of recycling. There are also many firms who recycle the plastic materials and produce new products as well. In my thesis I mentioned only companies in Zlínský region because of their regional importance. There are many firms that produce big amounts of recyclable waste in Zlínský region and that is why there is need of recycling companies. The four mentioned belong to the biggest recyclers of plastics in our region and they recycle not only their own plastic waste but also waste bought from other companies.

When describing the current situation in the United Kingdom and in Canada I focused on the trends in plastic waste generation and in plastic materials recycling. In comparison with these countries, the Czech Republic is No. 1 in plastic waste recycling. In the area of the European Union, the Czech Republic is second in plastic waste recycling (after Germany).

Czech citizens have a reason to be proud of our country waste management system and its position within Europe. Not only our country, but also Europe and the whole world can become a better place to live in when the ecologically oriented legislative acts of governments set on waste management will be put into practise at all levels: by every individual citizen, firm, company or any other responsible institution.

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LIST OF ABBREVIATIONS

EU	European Union
PVC	Polyvinyl choride
PET	Polyethylene terephthalate
PP	Polypropylene
HDPE	High-density polyethylene
LDPE	Low-density polyethylene
PE	Polyethylene
PS	Polystyrene

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