Czech University of Life Sciences Prague

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Diploma Thesis

Analysis of waste management in Herálec municipality

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Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Bc. Marie Krpálková

European Agrarian Diplomacy

Thesis title

Analysis of waste management in Herálec municipality

Objectives of thesis

The objective of this diploma thesis is to analyze the waste management in Herálec municipality. The main objective is to calculate cost and profitability of a new collection yard and waste management in general for the municipality and to assess benefits and efficiency for citizens.

Methodology

The practical part deals with the collection of information and comparison of the former and current state of waste management in the municipality. Obtained data retrieved from mayor of the municipality, collection yard office and from the Services of the city of Jihlava are used to determine the costing, effectiveness of the investment using Net Present Value, Internal Rate of Return and Payback Period, as well as the question whether the construction of collection yard has resulted in cost savings both for municipality and for the citizens.

The proposed extent of the thesis

60 – 80 pages

Keywords

management, municipal waste, collection yard, net present value, Internal rate of return, the payback period

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Recommended information sources

Act No. 185/2001 Coll., On Wastes and on Amendments to Certain Other Acts
BESLEY, S., BRIGHAM, E. F. Principles of Finance. Cengage Learning, 2014. ISBN 978-1-285-42964-9
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SMJ s.r.o. Waste Production Report, 2016, 2017, 2018
Waste audit of Herálec, Energy Agency Vysočina, 2016

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Declaration

I declare that I have worked on my diploma thesis titled "Analysis of waste management in Herálec municipality" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 28th March 2017 _____

Bc. Marie Krpálková

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Analysis of waste management in Herálec municipality

Abstract

The aim of this thesis is to analyse and evaluate whether the new constructed civic amenity site has a significant impact on Herálec municipality and its citizens.

The diploma thesis focuses on a description of municipality of Herálec, its waste management since 2015 till 2018 and its possible development in the future. Equally, the costs and income of the municipality for the operation of the civic amenity site and the overall waste management are considered.

If the municipality does not raise municipal waste charges for citizens to increase revenues from waste management, the construction of civic amenity site (the municipality contributed 1,911,757 CZK to the project) is never evaluated as an effective investment (the NPV calculation), while it is not possible to calculate the IRR and the payback period. If the municipality increases the above-mentioned charges by 200 CZK, the NPV of the investment will be 2,041,417 CZK in 2050. At the same time, the IRR is 0.68% and the payback period of such a project at a discounted CF is in the 32nd year.

If the municipality insisted on a more thorough separation of the waste by the citizens, it would save up to 432,387 CZK on the disposal and liquidation of MMW. Together with the total CF in 2024, this would save up to 988,651 CZK in 2024 under unchanged conditions.

Keywords: Waste management, municipal waste, collection yard, net present value, internal rate of return, the payback period

Analýza odpadového hospodářství v obci Herálec

Abstrakt

Cílem této diplomové práce je analýza a zhodnocení toho, jestli nově postavený sběrný dvůr má významný dopad na obec Herálec a její obyvatele.

Diplomová práce se zaměřuje na popis obce Herálce, jejího odpadového hospodářství od roku 2015 do roku 2018 a další možný vývoj do budoucnosti. Zároveň se práce zaměřuje na náklady a příjmy obce v rámci provozu sběrného dvoru a všeobecně odpadové ekonomiky v obci.

Pokud obec nezvýší poplatky za komunální odpad občanům, aby zvýšila příjmy v rámci odpadového hospodářství, nebude výstavba sběrného dvoru (obec se na projektu podílela částkou 1.911.757,- Kč) nikdy hodnocena jako efektivní investice (kalkulace ČSH), zároveň není možné spočítat vnitřní výnosové procento a dobu návratnosti. V případě, že obec zvýší o 200,- Kč výše zmíněné poplatky, ČSH investice by v roce 2050 byla 2.041.417,- Kč. Současně s tím je vnitřní výnosové procento bylo 0,68 % a doba návratnosti při diskontovaném CF je v 32.roce jeho životnosti.

Pokud by obec trvala na tom, aby občané důkladněji separovali odpad, ušetřila by na svozu a likvidaci komunálního odpadu až 432.387,- Kč. Společně s celkovým CF v roce 2024 by to znamenalo úsporu až 988.651,- Kč při nezměněných podmínkách.

Klíčová slova: Odpadové hospodářství, komunální odpad, sběrný dvůr, čistá současná hodnota, vnitřní výnosové procento, doba návratnosti

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List of Abbreviations

OPE	Operational Programme Environment
ERDF	European Regional Development Fund
NPV	Net Present Value
CF	Cash Flow
IRR	Internal Rate of Return
WMP CR	the Waste Management Plan of the Czech Republic
MMW	mixed municipal waste
BDMW	biodegradable municipal waste
SEF	State Environmental Fund
ZWIA	Zero Waste International Alliance

1. Introduction

With the increasing development of human society, the amount of waste produced also increases. Whereas, in earlier times, human waste was not a threat to human nature, the development of technology and industry began to produce different types of waste that could have a direct impact on the environment. The more sophisticated the company is, the more waste it produces. Wastes arise in both consumer and manufacturing spheres. The accumulation of waste can pose a great risk. The quality of water, air and soil is endangered. Nature conservation is becoming more and more important and touching each one of us. According to the Constitution of the Czech Republic, every person has the right to a favourable environment and therefore needs to be cared for and protected by him. It is precisely the field of waste management that takes over this role and strives for the rational protection of the environment and the protection of natural resources. Waste management should use a gentle approach to the use of primary and secondary resources and energy.

Wastes often contain a great deal of reusable raw materials. Due to the exhaustiveness of primary raw materials, special consideration should be given to the use of waste as a source of secondary raw materials. The importance of recycling should be constantly emphasized. Obtaining suitable materials for recycling can be done through separate collection, but this requires a high level of population involvement. Communal waste also carries the energy potential, and energy efficiency will produce energy. Both recycling and energy use can contribute to the primary raw material conservation.

The targets for waste management of the Czech Republic are elaborated in Waste Management Plans of the Czech Republic and subsequently implemented in Waste Management Plans of regions and originators. These plans are implemented by the EU Directive. For example, Council Directive 1999/31/EC on landfill requires Member States to develop a national strategy to ensure that the amount of biodegradable municipal waste deposited in landfills is reduced. For the Czech Republic, the share of this component in 2010 is 75%, in 2013 at most 50% and in 2020 at most 35% of the total amount of biodegradable waste generated in 1995. Directive 98/2008/EC requires recycling up to 50% of the weight of household waste by the end of 2020, mainly paper, metal, glass, plastics.

The municipalities deal the problems with the increasing amount of wastes and their disposal and liquidation. Nowadays, in every small community and municipality is obvious to find collection points where the containers for separate waste are located. People are separating plastics, glass and paper there. However, the amount of municipal waste has to be resolved by a more thorough separation. One of the many reasons is the ban on landfill of municipal waste from 2024. How to deal with it? The Czech Republic and the EU support municipalities to build civic amenity sites and their extension and equipment. Unfortunately, not every village can afford such a high investment as to participate in its construction. The question then remains whether such construction is necessary and if it serves the benefit of the matter.

For the proper functioning of the entire waste management system, it is necessary to involve all inhabitants. This can be achieved by providing sufficient information about the environment or the possibilities of sorting waste. The education of the population should begin from their very early age, ranging from family education, through maternity, elementary and secondary schools and education of the population in radio, magazines, the Internet, local periodicals and a by personal example.

2. Objectives and Methodology

2.1. Objectives

The objective of this diploma thesis is to analyse the waste management in municipality of Herálec. The main objective is to calculate costs and profitability of a new built civic amenity site for the municipality, whether its activity will ever generate the profit and if there is any benefit for citizens.

2.2. Methodology

In the section of the methodology of the diploma thesis elaboration is explained. The literature review is structured in three chapters. The first chapter is focused on basic concepts and legislation of waste management in the Czech Republic. The second chapter concentrates on municipal waste, obligations and payment systems for the municipality. The third part focuses on waste collection in general, what the waste collection methods are, remuneration by EKO-KOM and evolution of waste in the Czech Republic.

The practical part of the thesis describes the municipality of Herálec and its waste management from 2015. For the purposes of the diploma thesis, the Waste Production Report from SMJ, s.r.o. and the municipal documents of waste management for each year separately, were provided. Based on this, it was determined how many tonnes of waste the municipality produces per year and what its costs of waste disposal are. At the same time, the municipality´s total revenues in waste management were determined from the provided materials and based on a personal interview with the municipality mayor. The aim of the diploma thesis is to find out whether the construction of the civic amenity site was an investment that would return in the future and when.

The civic amenity site was built and financed from two sources: 85% was covered by the Operational Programme Environment and the European Regional Development Fund, and the remaining 15% was paid by the municipality from the municipal budget. The calculation of the economic effectiveness of the investment is calculated with 15% of investments, i.e. 1,911,757 CZK.

The following methods are used to evaluate the investment project:

NET PRESENT VALUE

The calculation of the net present value (NPV) consists in the deduction of capital expenditures from the present value of the cash flows that are expected in the future. The present value of future cash flows is determined by discounting of these cash flows by the discount rate that corresponds to the required rate of appreciation of the capital tied to the investment.

$$NPV = -Co + \sum_{0}^{t} \frac{CF_t}{(1+r)^t}$$

$$NPV = \frac{CF_0}{(1+r)^0} + \frac{CF_1}{(1+r)^1} + \cdots + \frac{CF_t}{(1+r)^t}$$

Co initial capital investments;

t each period;

CF_t generated cash flow in each period;

r discounted rate.

The main decision rule for a project to be accepted is:

NPV > 0 – we can accept the investment (guarantees the required rate of return and increases the market value of the firm)

NPV = 0 – the investment is indifferent to the firm (cash income is equal to the costs incurred, the market value of the firm remains unchanged)

NPV < 0 – we reject the investment (negative value says that there will never be a return of the required capital)

When deciding between multiple variants, we choose the optimal one that will display a higher net present value.

The NPV method depends very much on the required rate of return. The higher the desired yield, the lower the current value. It also depends on the distribution of revenue and expenditure over time.

The NPV method is the most appropriate way of economically evaluating investment projects. It respects the factor of time, it considers the effect of an investment to be the net income based on expected earnings after tax, depreciation, or other income. It shows the immediate benefit of the project to the company´s main financial target – the market value of the business. (Besley, S., Brigham, E. F., 2014)

INTERNAL RATE OF RETURN

The internal rate of return (IRR) is almost as good as the NPV. The IRR can be defined as the interest rate at which the present value of the cash proceeds of the investment is equal to the initial capital expenditure. It is an interest rate at which the NPV is equal to zero. It also expresses the minimum return the investment much achieve in order not to be loss-making compared to other investments.

$$0 = NPV = \sum_{0}^{T} \frac{CF_t}{(1 + IRR)^t}$$

$$0 = CF_0 + \frac{CF_1}{(1 + IRR)} + \frac{CF_2}{(1 + IRR)^2} + \frac{CF_3}{(1 + IRR)^3} + \cdots + \frac{CF_t}{(1 + IRR)^t}$$

CF_0	initial investment;
CF_1, CF_2, …, CF_t	generated cash flow in each period;
t	each period;
T	holding period;
NPV	net present value;
IRR	internal rate of return.

For investments with a lifetime longer than two years, it is calculated using iterative methods or trial and error methodologies (spreadsheets such as MS Excel). An investment is acceptable under this criterion if the IRR is greater than the discount rate. The higher the IRR, the higher the return on investment.

The great advantage of the above-mentioned method is the fact that the decision to accept or reject an investment project does not need to know the exact amount of the interest

rate and also that the calculated value is perhaps interpretable. On the other hand, the disadvantage lies in the fact that the calculation of the IRR method is more complex. Problems can also arise with multiple changes in positive cash flows to negative, and vice versa. (Besley, S., Brigham, E. F., 2014)

PAYBACK PERIOD

Payback period is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment. It is a simple way to evaluate the risk associated with a proposed project. An investment with a shorter payback period is better since the investor´s initial outlay is at risk for a shorter period.

The payback method should not be used as the sole criterion for approval of a capital investment. The method is used rather as ancillary, its disadvantage is not considering the financial flows resulting from the investment that follow the return period. (Besley, S., Brigham, E. F., 2014)

$$Payback\ Period = \frac{Initial\ Investment}{Annual\ Net\ Cash\ Profit}$$

3. Literature Review

3.1. Basic concepts and legislation of waste management in the Czech Republic

3.1.1. Waste Management

Waste management is a dynamically developing national area economy. The following activities such as waste prevention, disposal with waste, aftercare of the place where waste is stored, and control are included. The industrialized and economically advanced countries have begun their waste intensively engaged in the 80s of the last century. The Waste Act was first established in the Czech Republic in 1991. The current Waste Act establishes the rights and duties on waste management, emphasizes prevention waste generation, then sets the hierarchy of waste management and promotes the basic principles of environmental protection and human health when dealing with waste. (Ministry of the Environment, 2014)

3.1.2. Legislation of waste management

Current progress in the management of biodegradable waste are affected by many factors, of which the conditions given by the legislation can be considered as determining. Compliance and knowledge of the law of various obligations play a key role in a uniform way of assessing and managing biodegradable waste.

The following legislation is currently in the Czech Republic in waste management:

- ***Act No. 185/2001 Coll., on Waste and the Amendment of Some Other Act* – basic legislation that contains waste management obligations including biodegradable waste**

"In accordance with the law of the European Community, this Act regulates

a) The rules on the prevention of waste production and on waste management while respecting the areas of environmental protection, the protection of human health and sustainable development

b) The rights and obligations of persons in the waste management sector, and
c) The competence of the public administration authorities. (Act No. 185/2001 Coll., on Waste and the Amendment of Some Other Acts, 2001)

Amendment No. 229/2014 Coll., of the Waste Act No. 185/2001 Coll brought municipalities a duty to afford space for storing sorted hazardous waste, paper, plastics, glass and at the same time for the storage of metals and biodegradable waste. This Directive requires that the weight of biowastes in the municipal waste should be reduced to 75% of the weight of such waste type produced in 1995. By 2020 the weights should drop to 50% and 35%, respectively. (BiPRO and the CRI, 2015)

- ***Act No. 477/2001 Coll., on Packaging and Amendments to Certain Other Acts***

a) „The purpose of this Act is to protect the environment by preventing the generation of packaging waste by reducing the weight, volume, and harmfulness for the environment of packaging and chemical substances. This Act stipulates the rights and obligations of legal entities and natural persons carrying on business activities (hereinafter referred to as a "person") and the competence of administrative authorities concerning packaging management, the placing of packaging and packaged products on the market or into circulation, and the take-back and recovery system; it also stipulates fees and protective measures remedial measures, and penalties.
b) This Act applies to the management of all packaging which is placed on the market or into circulation in the Czech Republic, except for containers used in road, railway, or air transport or in sea or inland waterway transportation pursuant to international conventions which are binding upon the Czech Republic and which are published in the Collection of International Treaties or in the Collection of Laws.
c) Unless stipulated otherwise by this Act, packaging waste management shall be governed by the legislative regulations in force for waste management.
d) Other requirements concerning packaging stipulated by separate legislative regulations shall not be affected by this Act." (Act No. 477/2001 Coll, on Packaging, 2001)

Act No. 341/2008 Coll., Decree of the Ministry of the Environment on the details of the treatment of biodegradable waste

Act No. 374/2008 Coll., Decree of the Ministry of the Environment on the shipment of waste and amending Decree No. 381/2001 Coll.

Act No. 352/2014 Coll., Government Regulation on the Waste Management Plan of the Czech Republic for the period 2015-2024 (Fiedor, J.,2012)

- ***Decree No. 383/2001 Coll, on the details of waste management*** *known as "****Landfill Directive 1999/31/EC***

Landfill Directive was introduced in April 1999 and should has been implemented by its member states by the year 2001.

The objective of this Directive is to reduce biodegradable waste going to landfills by means of organic recycling, material recycling and/or energy recovery. The main motivation for these targets and measures is to reduce the production of methane gas from landfills and reduce global warming. (Poltronieri, P., D´Urso, O. F., 2016)

On the contrary of the Landfill Directive, the study from 13th International Conference on Environmental Science and Technology (Hutton, B., 2013) says that composting does not always mean that there is lower total greenhouse than through landfill. The main issue is diverting organic waste from landfill to compost and it results in an increase of carbon dioxide.

- ***Amendment to the Waste Act***

The Amendment follows primarily from the requirements of the European Union which imposes to the Member States to introduce a ban on the landfill of a so-called usable land of municipal waste by 2030 at the latest. The Czech Republic has been banned 6 years earlier mainly due to the fact, that landfilling in our country is in comparison with other countries to a significant way of dealing with waste. In 2015, 47% of municipal waste was landfilled. The aim is, therefore, to use the waste in a different way. (Poltronieri, P., D´Urso, O. F., 2016)

3.1.3. The Waste Management Plan (WMP)

The Waste Management Plan creates in harmony with the principles of sustainable development the objectives, policies, and measures of waste management in the Czech Republic. WMP CR refers to the management of all waste, except for waste listed in §2., paragraph 1, letters a) to i) of the Act No. 185/2001 Coll., on waste, amending certain other laws, as amended. WMP CR is the reference document for the development of regional WMP. The binding part of WMP CR constitutes the mandatory basis for decision-making and other activities of the appropriate administrative authorities, regions, and municipalities in the area of waste management.

WMP CR has been drawn up for the period of 10 years (the period 2015 – 2024) and will be reformed instantly following any essential change in the conditions under which it has been drawn up (e.g. new legislation on waste management, which will fundamentally affect the waste management strategy, including establishment of new objectives or redefinition of existing objectives, policies, and measures).

There are total of three waste management plans:

- Waste Management Plan of the Czech Republic,
- Waste Management Plan of Regions,
- Municipal Waste Management Plan.

WMP of the Czech Republic and regions are public. (Ministry of the Environment of the Czech Republic, 2014)

Waste Management Plan of the Czech Republic

The WMP of the Czech Republic is being processed by the Ministry, which cooperates with the relevant public authorities and the public. This plan includes waste prevention programs, status evaluation waste management, a binding part and a guiding part. The binding part of the plan is proclaimed by the Government by its regulation and sets out objectives and measures to achieve them for.

- Prevention of waste generation and reduction of specific waste production,

- Minimizing the adverse effects of waste generation and its management on human health and the environment,
- Sustainable development of the company and approach to a European “recycling society”,
- Maximum use of waste as a substitute for primary resources and transition to a circulating economy.

The WMP of the CR is processed for a period of at least 10 years. The current one is valid from 2014 – 2024. (Ministry of the Environment of the Czech Republic, 2014)

The Waste Management Plan of Vysočina Region

The representative of the Vysočina Region approved a strategic document Waste Management Plan of the Vysočina Region (WMP VR) in accordance with the binding part of the Waste Management Plan of the Czech Republic. The binding part was declared as a generally binding Decree of the region and is the basic root for the issue of Waste Management Plans of municipalities and towns of our region with the production of other wastes above 1000 t/year or over 10 t/year of hazardous waste.

Regions in their own area are working on a waste management plan for its territory, this plan must be in line with the binding part of the WMP of the CR. WMP of the region includes a binding part and guiding part and has individual objectives (loading with municipal waste, prevention of waste, limiting its quantity, etc.). WMP of the Region is processed for a period of at least 10 years. This plan we can find it on the public administration portal. (EEA, 2013)

Waste management plan of the municipality

An obligation to process a waste management plan for the municipality for its management a municipality has more than 10 tonnes of hazardous waste or more than 1000 tonnes of other waste per year. This plan must be in line with the binding part of the WMP of the region. The WMP of the municipality is processed at for at least 5 years and is a binding basis for its activities. The content of this plan stipulates legislation from the Ministry. (ISNOV, 2017)

3.1.4. Basic concepts of waste management

Waste management includes many concepts. The basic are as follow:

Waste

"Waste shall be any movable thing that a person discards or intends to discard or is obliged to discard and that is specified in some of the waste categories." (Act No. 185/2001 Coll., on Wastes)

Municipal waste

Municipal waste is all waste produced on the territory of the municipality under the activities of its citizens. At the same time, it is listed as municipal waste in an implementing legal regulation except for waste generated by legal entities or natural persons authorized to do business. (Christensen, T. H., 2010)

Commercial waste

Garbage like communal waste is considered as the waste from legal activities and natural persons entitled to business classified under the Waste Catalog as a waste like communal in Group 20. This is the waste that arises in the process of consumption in shops, offices, and institutions and which is similar to nature and composition as municipal waste. (Wikipedia, 2017)

Mixed municipal waste

Mixed municipal waste is such a kind of waste that remains after the separation of materially recoverable components (separately collected paper, glass, plastics, ferrous and non-ferrous metals and their alloys, textiles, bio waste) and dangerous components (one of the criteria for the hazardous properties of the waste during its removal is exceeded: explosivity, oxidation, flammability, irritation, health damage, etc) from municipal waste. It is used to be called "residual" waste. (Univerzita Karlova v Praze, 2017)

Bulky waste

Bulky waste is a special form of house waste. This is primarily a rejected household utilisation, material from minor repairs and modifications in households. It is collected in containers that are manufactured in building in pre-agreed terms. (Christensen, T. H., 2010)

Hazardous waste

Hazardous waste stems from industry, manufacturing, maintenance, and services. The common types of hazardous waste are waste oil, liquid waste containing sulfur and chlorine, high calorific waste, acid, bases, etc. (Christensen, T. H., 2010)

Construction and demolition waste

This waste is one of the heaviest and most voluminous waste streams generated in the EU. It includes bricks, gypsum, wood, glass metals, plastics, asbestos, etc. (European Commission, 2016)

Biodegradable waste

Biowaste most often occurs in households such as kitchen debris, maintenance of gardens (cut grass, leaves, branches, dead plants, etc.), but also by municipalities in the maintenance of orchards, green areas and forest parks, residential and street greenery as well as grass fields and waste from cemeteries owned or managed by cities. It is waste that is capable of anaerobic or aerobic decomposition. (Evans, G., 2016)

Mr. Hřebíček and Mr. Horsák (2014) add that biodegradable waste is any waste that is capable of aerobic, anaerobic digestion or another processing technology, or even to gain biofuels such as biogas or bioethanol. Can be used to obtain numerous bio products by composting. The terms “biodegradable waste” or “biowaste” are also used.

Biodegradable municipal waste

Biodegradable municipal waste (BDMW) forms a quantitatively significant group of waste among community waste, and the way it is handled can positively or negatively affect the basic components of the environment in both the municipality and the region.

In addition to biowaste, BDMW includes also paper and board, textile waste, wood waste and market and bulk waste.

Waste collection

An activity of the concentration of waste by a legal or natural person authorized to do business by another person. The collection includes pre-sorting and pre-storage for transporting waste to waste treatment facilities.

Landfill

It means a technical facility designed for waste disposal by means of its permanent and controlled deposit onto or into land. (Act No. 185/2001 Coll., on Wastes, 2001)

Waste sorting

It is the separation of individual types of waste according to the same composition, properties and categories according to the waste catalogue.

Reuse

There are the procedures whereby products of parts are reused for the same purpose for which they were originally intended.

Waste processing

The waste is used or removed during processing. Processing also includes preparation prior to the recovery or disposal of waste. (Act No. 185/2001, on Waste, 2001)

3.1.5. Hierarchy of Waste Management

Within the framework of waste management, this hierarchy of methods should be respected waste management:

- Prevention of waste generation,
- Preparation for re-use,
- Recycling of waste,

- Other uses of waste, such as energy recovery,
- Removal of waste.

The hierarchy of waste management says that everyone has their business or within the scope of its ability, to prevent the generation of waste. Restrict it their quantity and hazardous properties. Waste that cannot be avoided must be used or possibly removed in a way that does not endanger human health and the environment and is lawful. (Christensen, T. H., 2010)

3.1.6. Ways of reducing waste

There are several ways that can minimize or reduce the amount of waste. These are the following:

- **Product design**
  - Construction of a product with less waste, an extension of product life
- **Changing the packaging**
  - Product in bulk form, reusable of recyclable packaging
- **Material changes**
  - Replacement with less toxic materials, use of reusable or recyclable materials
- **Technological changes**
  - Increasing the effectiveness of tools, cleaner technologies
- **Economic/management procedures**
  - Appropriate working procedures and regular maintenance
  - Supply management, training and clear instructions, separation of the waste facility (Harrison, R.M., 1996)

3.1.7. Use and disposal of waste

Recycling, utilization and landfilling (RUL) is the last step in the waste management system. The objective of RUL is to recuperate and use materials in the waste for a purpose or to place it safely into a landfill, where it is planned to persist for centuries. The terms are:

- **Recycling:** Recycling is understood as any kind of waste recovery where waste is reprocessed on products, material or substances for original or other use. This use

includes the reworking of organic materials. (Act No. 185/2001 Coll., On Wastes, 2001)

- **Utilization:** Utilization is often determined by secondary characteristics of the waste material. It may be used as a compost on land as a fertilizer, use of compost substituting for peat in manufacturing of soils for landscaping, the use of bottom ash from waste incineration as base material in infrastructures and the use of plastic waste as low quality material for manufacture of products that usually are not produced with plastic. (Christensen, T.H, 2010)
- **Landfill:** The landfill is still the most widely used method of liquidation in the EU, however, it is according to the waste hierarchy the worst option. To avoid damage the environment due to the formation of methane and wastewater, landfills are needed build and operate in accordance with the EU Landfill Directive 1999/31/ES. Biodegradable waste being landfilled produces gas and leakage water. According to the Intergovernmental Panel on Climate Change, if the landfill is not captured, it contributes significantly to the greenhouse effect because it consists mainly of methane that is 23 times stronger than carbon dioxide. (Bogner, J., M. Abdelrafie Ahmed and col**.,** 2007)

Other ways of processing waste are as follows:

- **Composting:** Composting is the natural process of decomposing of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, improve their suitability for application to the soil as a fertilizing resource. Compost plays an important role in sustaining soil fertility for its rich source of organic matter. It also improves the physic-chemical and biological properties of soil.

Because of these improvements, the soil becomes.

- More resistant to stresses such as drought, diseases, and toxicity,
- Helps the crop in improved uptake of plant nutrients,
- Possesses an active nutrient cycling capacity because of forceful microbial activity. (Misra, R.V. and col., 2003)

- **Incineration:** Waste incineration is the procedure for removal undesirable physical properties of waste (reduction in volume, weight, a waste treatment that cannot be disposed of in another way) and complete or partial elimination of hazardous properties of thermal and oxidic waste destruction at both molecular and cellular levels. (Groda, 1997)

Main reasons for the recovery of secondary raw materials

There are plenty of reasons for a higher value of secondary raw materials. The main ones are:

- Time border and real availability of natural resources,
- Growth in industrial production that leads to an increased need for raw materials,
- Higher economic efficiency of the use of secondary raw materials savings on materials and energy in manufacturing,
- The need to reduce import dependency on raw materials,
- The technological necessity of using secondary sources in certain manufacturing processes,
- The need to protect the environment that is affecting everyone sectoral and spatial interests in the national spheres economy. (EESC, 2011)

3.2. Municipal waste

3.2.1. Obligations and entitlements of the municipality

The municipality must obey with the obligations of waste producers when handling municipal waste. At the same time, it is in its own competence to lay down a generally binding regulation of the municipality on the system of collecting, transporting, sorting, utilizing and removing municipal waste arising in its cadastral territory. In addition, a general binding decree may provide a system for the disposal of construction waste produced by in its cadastral territory by non-natural persons.

It is the duty of a municipality to identify the sites that will serve to dispose of all municipal waste produced by physical non-entrepreneurs in its cadastral territory. Another obligation is to determine the location for separate collection of municipal waste

components. This is at least hazardous waste, paper, plastic, glass, metals and biodegradable waste.

The municipality may charge for the collection, transport, sorting, use, and disposal of municipal waste based on a contract from natural persons. The contract must be in writing and its content must primarily be the amount of the reimbursement. If the municipality uses this option, it cannot set a municipal waste tax or local fee for the operation of municipal waste. (Act No. 185/2001 Coll., on Wastes)

3.2.2. Payments for municipal waste

Payments for municipal waste are included in one of the categories of environmental payments. The categorization of environmental payments is as follows:

- Taxes,
- Special fees,
- Administrative and user fees,
- Reimbursements (contributions, deductions)

Some of the most basic ways to charge waste production include:

- *Local taxes*. Many local services are financed by local taxes, the waste management is one of them
- *Non-performance payments*. The amount of these payments is not dependent on household services consumed
- *Performance – dependent payments.* Payments that depend on the number of services consumed. (EEA, 2013)

3.2.3. Calculation of basic payment for municipal waste

There are a lot of measures for calculating the basic payment, but the mainly used are:

- *According to the number of household members.* Since it has the nature of a fixed payment, the taxpayer is not motivated to prevent the generation of waste from being sorted.

- *According to the number of households.* This option does not determine the number of household's members, but the number of households. Even in this case, the taxpayer is not motivated to prevent or sort waste.
- *Depending on the number of collectors.* The decisive fact is how many collectors have the taxpayer available.
- *By land size.* The requirement is to define the size of the plot. The problem is, that municipalities are confronted with the questions, whether to take the land as a whole or only a built-up area. (Slavík, J. and col, 2009)

3.2.4. Payment systems for municipal waste in practice

Nowadays, many municipal payment systems are in place. According to the German payment method, we mainly refer to the following system:

- Mixed systems,
- Stamp systems,
- Systems based on waste identification,
- Systems based on the weighed waste collection.

Mixed systems

Mixed systems combine different scales to calculate the amount of the payment. In practice, it is a combination of the calculation based on the number of household members, the number of households or the size of the plot with the calculations according to the volume and number of collecting vessels and the frequency of their collection. These systems are most suitable for municipalities with up to 20,000 inhabitants and then for municipalities with more than 50,000 inhabitants. The main reasons are small administrative, personnel and administrative costs. Clearly, the greatest benefit of mixed systems is that they motivate waste prevention. Another advantage can be the applicability of the system in areas with high population density. (Slavík, J. and col., 2009)

Stamp systems

The payment amount for these systems is a fixed at a lumped system. The citizen collects a so-called stamp on the collection container and thereby determines the frequency

of the collection. Citizens buy the stamp mainly at municipal offices. A big problem with these systems is the frequent occurrence of black dumps. However, it is possible to determine the minimum number of stamps purchased and partly to combat it. The motivation is the choice of container volume. (Mrázek, P., Kotoulová, Z., Černík, B., 1998)

Systems based on waste identification

These are the more modern municipal waste payment systems that have begun to replace stamp systems. Compared to the stamping systems, the collection bottles are identified by means of barcode or chip that is part of a collection container. The main advantages of these systems are the low operating costs and the responsibility of households, for the waste produced. Negative may be the creation of black dumps, which can be reduced by a rigorous control in municipalities. (Slavík, J. and col., 2009)

Systems based on weighed waste collection

The payment is determined by the amount of waste actually present in the collection container. The volume of waste is measured when the container is emptied. The main incentive element for this system is that it is possible to reduce the amount of waste. This can be achieved primarily by the use of the sorted collection. The payment consists of a lump sum (usually 50% of the price) and a variable amount, which is determined by the amount of waste in the container. (Mrázek, P., Kotoulová, Z., Černík, B., 1998)

3.2.5. The municipal waste taxes

The municipal waste taxes, which arise on the territory of the municipality, can be determined and collected by a general binding decree. This fee cannot be fixed by the municipality at the same time as the local fee for the operation of the collection, transport, sorting, utilization, and disposal of municipal waste.

A taxpayer is any natural person whose community waste is generated. The payer is the owner of the property in which the waste is generated. In the case of a building in which a unit of ownership has been established, the payer is the community. The administrator of the charge is then the municipality that has introduced it in its own district.

The maximum amount of the fee is set based on the estimated eligible costs of the municipality resulting from the municipal waste management scheme. These costs are allocated to individual taxpayers according to the number and volume of containers that are intended for the disposal of waste pertaining to individual properties. An alternative may be the number of an occupant by the level of sorting of this waste. The costs associated with leasing the containers in which the waste is collected may reflect up to the amount of the charge. (Act No. 185/2001 Coll, on Wastes, 2001)

3.2.6. Waste classification

"Correct classification is the foundation for ensuring that the collection, transportation, storage and treatment of waste is carried out in a manner that provides protection for the environment and human health and in compliance with legal requirements. "(EPA, 2015)

This waste classification system is applied across the EU and based on this, states are subject to certain obligations. The different types of waste that are on the list are defined by a 6-digit number. (EPA, 2015)

3.3. Waste collection

Municipalities mean to guarantee and implement a separate collection of usable components of municipal wastes on a required base. They must set up the collection system depending on available waste processing technology.

In the Czech Republic, a collective system of a collection has been established since 2013. Most of the inhabitants of the Czech Republic have the option of sorting their municipal waste and almost 75% of the inhabitants regularly used the system of sorted waste. Most inhabitants have access to collection bins or other collection methods for separate collection. (BiPRO and the CRI, 2015)

3.3.1. Waste collection and collection methods

Collection of waste can be done by several methods. These methods can be broken down into several ways:

According to the technical equipment

- *Container collection*

The basic principle of container segregated collection is the multiple uses of collection vessels (Picture 1). Most often it is a container collection with emptying of containers. This method is most widespread in the Czech Republic. But it can also be a container collection with a container replacement. For the emptying variant, colour-coded containers with a capacity of 40-3200 litres are used with special modifications. The usual colour resolutions are blue - paper and cardboard, white – clean glass, green – coloured glass, yellow – plastic, brown – biowaste, orange – drink cartons.

Advantages: accepted way by citizens, the choice of container sizes for different types of closures.

Disadvantages: high investment costs, the necessity of carefully selecting the station position.

Picture 1: Containers for separate collection of secondary raw materials

Source: Own picture, 2018

In the second variant, containers are exchanged between 5 and 11 m^3 internally divided for individual components of the municipal waste and outwardly colour-coded. They are used primarily for paper, clear and coloured glass.

Advantages: deploy ability.

Disadvantages: the possibility of contamination of the environment during the impact of the container.

- *Bag collection*

This method is based on individual components of household waste are collected in households in colour-coded bags of 40 – 120 l, which are taken by citizens on the day of collection either in front of their house or at a designated place in the village (civic amenity site). Bagging is most often used for paper and plastics. An example of bag collection is visible in Picture 2.

Advantages: lower investment costs, deployability.

Disadvantages: difficult placement of bags in households, a possibility of pollution of roads, difficult to use for multi-story buildings.

Picture 2: Bag collection in Brussels

Source: Bruxelles – Propreté, 2018

- *Without container collection*

The individual components of municipal waste, especially collecting paper, are collected in households and are preserved at a predetermined location at a designated location. On the same day, these collected municipal waste components are taken to further processing. Sometimes this method is called a “timed” collection or “house-to-house” collection. Prepared waste is then dispatched by local associations or other social organizations.

Advantages: low investment costs, yield comparable to container collection.

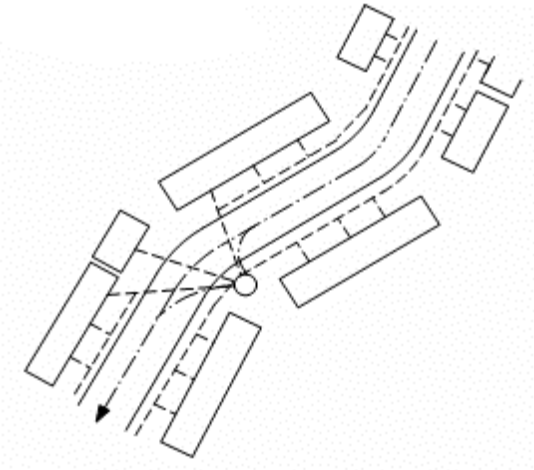
Disadvantages: the need for permanent awareness of the population, the possibility of polluting the environment.

Depending on the availability of the collection point

- *Bring system*

Bring systems (Picture 3) are those where householders are required to take a recyclable material to communal collection points (e.g. into freely accessible containers in the system of simultaneous separate collection of other commodities or closed civic amenity sites).

Picture 3: Bring system



Source: Filip, J. and col., 2003

When collecting, the citizens take the sorted waste components to the designated location, which is equipped with colour-coded containers of 660 – 3200 litres. The possible way of delivery is a system where all containers are collected in one container, irrespective of the what kind of material is. However, the condition of this system is the cleanliness of the dispatched packaging from households. These containers are located near shops and shopping centres, public transport stops, etc. The walking distance from the hatches should not exceed 150 m. The interval of the individual commodities is chosen according to the volumes of the containers. Donation collection uses a system of free-standing containers at

a public site. However, it may also be closed areas called “civic amenity sites” or “recycling yards”.

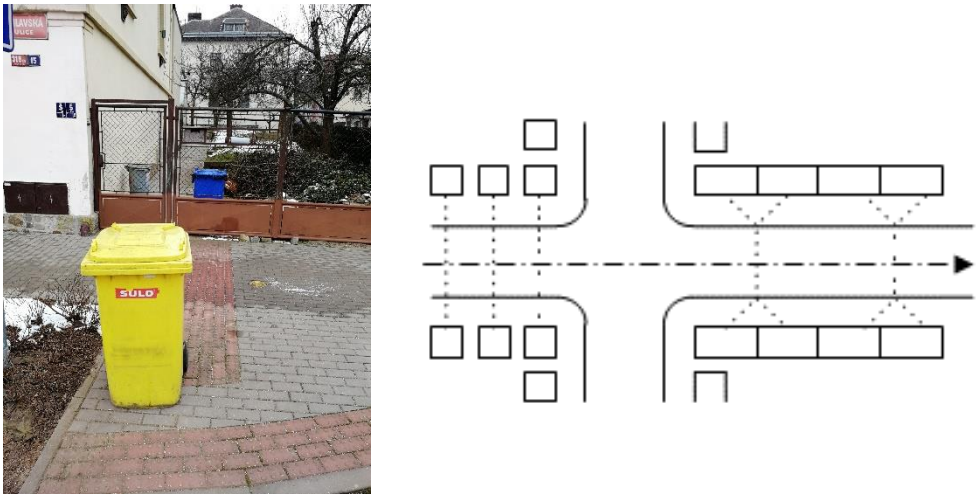
Advantages: lower investment costs compared to the transport mode, acceptability for citizens, low cost of container acquisition.

Disadvantages: Poor availability for citizens compared to the transport mode, lower yield, and quality of municipal waste components, need to cut hollow packs.

- *Curbside collection*

Curbside collection (picture 4) is characterized by the short distance of colour-coded collection vessels from the place of residence of citizens. The distance should be a maximum of 50 m from the house. This method of collection is used in the Czech Republic for mixed municipal waste. The containers are placed in front of the entrance to the apartment building. Owners of houses have their own container for each house, located mostly behind the fence, and place it on public transport on the day of departure. The curbside collection is suitable for older residential buildings or for the construction of family houses or housing estates.

Picture 4: Curbside system



Source: Own picture, 2018; Filip, J. and col., 2003

Advantages: Citizens´ greatest acceptability, yield, and quality of municipal waste components compared to a delivery collection.

Disadvantages: High investment costs associated with the number of containers delivered. (Harrison, R.M. and Hester, R.E, 2007)

According to the collection organization

- *Stationary collection*

Stationary collection means all methods of separate collection, where the citizen must have a permanent place for the disposal of separated municipal waste components, which is equipped with containers. It follows that stationary collection includes the bring and curbside collection as it was mentioned. The exception, however, is the collection of bags and collection of a "house from a house". The stationary collection also includes the collection of medicines in pharmacies or the collection of batteries in stores with electrotechnics.

- *Mobile collection*

The mobile collection represents the provision of a means of transport designed to collect and transport separate municipal waste components near citizens. It includes bagging and collecting a "house from a house". In addition, any on-demand removal is possible (e.g. delivery and removal of a container for building debris). The mobile collection can also include the collection of hazardous components of municipal waste into specially modified collection facilities at pre-announced deadlines. The means of transport are delivered at regular intervals for 20 to 60 minutes at a pre-announced spot in the village. (Voštová, V., 2009)

3.3.2. EKO-KOM

"EKO-KOM a.s. is authorized packaging company, which provides associated compliance of take-back and recovery of packaging waste" (EKO-KOM, 2011)

The municipality that operates sorted municipal waste collection can join the EKO-KOM system based on a contract on the recovery of packaging waste. Under this agreement, the municipality is entitled to a fee for securing the take-back and subsequent recovery of waste from packaging. The remuneration is calculated based on a regular quarterly report on the number of species and ways of dealing with usable components of municipal waste. The

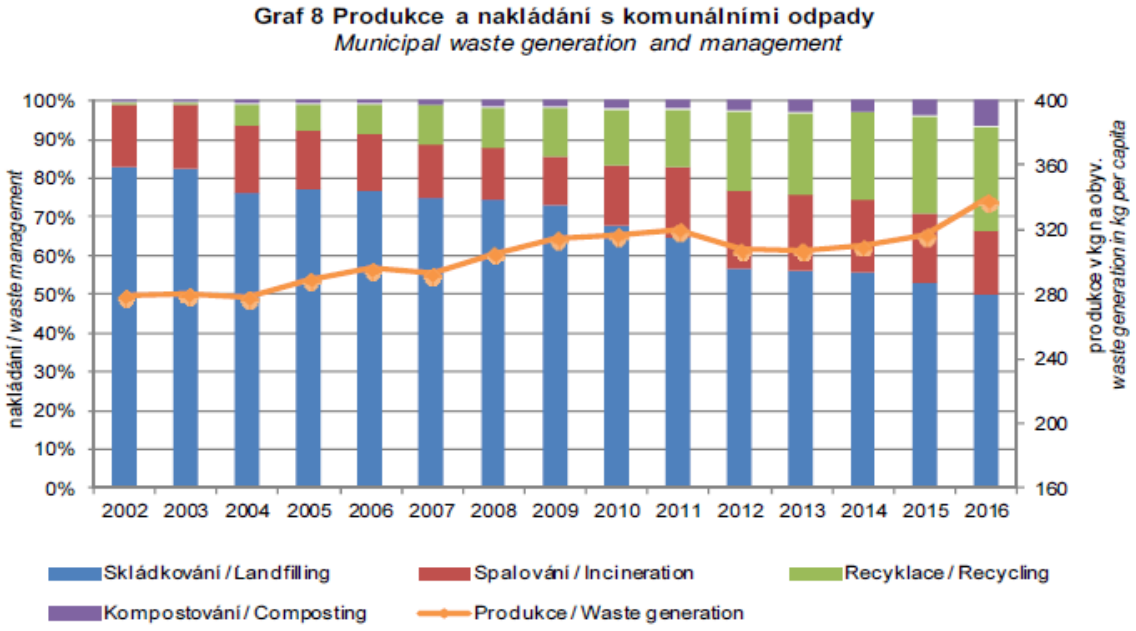
amount of the reward depends mainly on the amount of sorted waste, its amount increases along with the efficiency of the collection system. Remuneration helps reduce the costs associated with running a collection system for using municipal waste components.

By joining the EKO-KOM system, the municipality acquires the right to participate in the development projects of the company. It also can obtain information materials and other products in the area of consulting or public relations. (EKO-KOM, 2011)

3.4. Communal waste in the Czech Republic

The following Figure 1 show the production and management of municipal waste in the Czech Republic from 2002 until 2016.

Figure 1: Municipal waste generation and management



Source: Czech Statistical Office, 2017

It is very well illustrated in this figure how the amount of waste ending in landfills is decreasing. In comparison to 2002, when more than 80% of all municipal waste was deposited in the landfill, it was only 50% of the waste in 2016.

This is related to an increase in waste separation where the proportion of waste that has been disposed of by composting and recycling is gradually increasing. Even though the production of waste increases every year, its proper separation does not lead to a high level of contamination of soil and air.

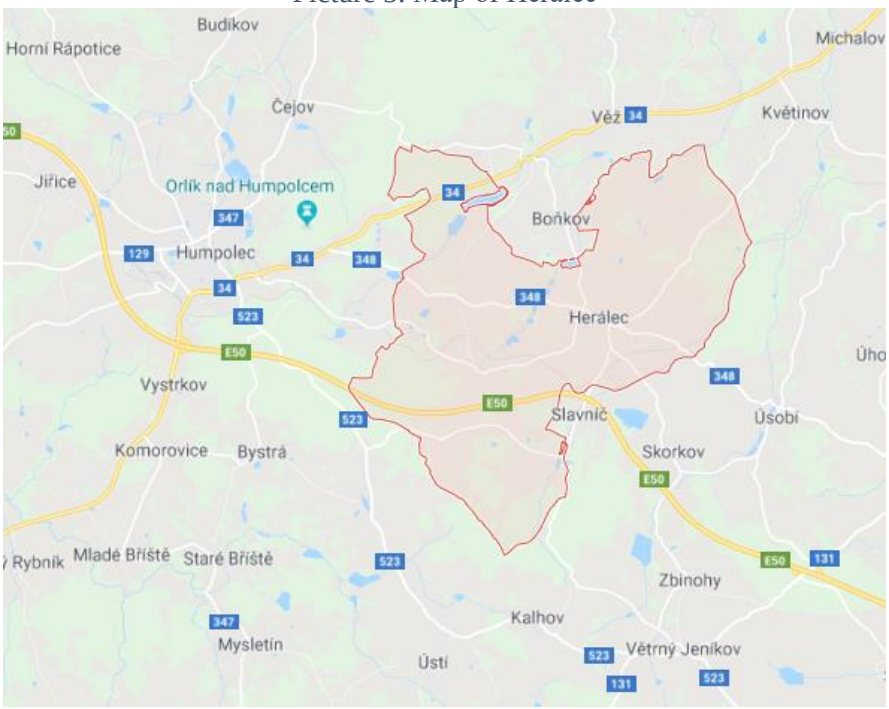
A positive trend can be seen in increasing the proportion of compost waste. This may be due to public awareness and, at the same time, subsidy titles for the preparation and construction of composting plants using biodegradable household waste and maintenance of urban greenery.

4. Practical Part

4.1. Characteristics of Herálec

Herálec is located in the south-western part of the Havlíčkův Brod district in Vysočina region. The population in 2017 was 1130 inhabitants. Herálec is divided into seven cadastral territories: Herálec, Dubí, Kamenice, Koječín, Mikulášov, Pavlov and Zdislavice. The surrounding area is hilly, with extensive forests, numerous ponds, and streams with an average altitude of 600 m. (Obec Herálec, 2006)

Picture 5: Map of Herálec



Source: Google Maps, 2018

4.2. Waste management in Herálec

Municipality of Herálec has a contract with a company SMJ, s.r.o. from the city of Jihlava and with a company HBH odpady, s.r.o. from the city of Havlíčkův Brod based on which a municipal waste collection system is secured. The collection of municipal waste is carried out at regular intervals by means of linear compression vehicles. A frequency of municipal waste collection from Herálec is twice per month. Communal waste produced in adjacent municipalities is also exported twice per month. For the disposal of municipal

waste, containers with a capacity of 1,100 litres are designed. It is calculated as average production 200 litres of municipal waste per person per week.

The separate waste collection is provided by a company EKO-KOM, a.s., which has been cooperating with Herálec for several years. The sorted waste is intended especially for special containers placed in public areas in the city. Herálec has an indefinite signed contract with the collection company of Mr Jan Krpálek, which specializes in biodegradable waste, and with the nearby composting plant of Ms Marie Krpálková, where the biodegradable waste can be stored free of charge. Citizens can also use the services of the newly-built civic amenity site, which started its operations in March 2016.

4.2.1. Civic amenity site

Thanks to subsidies from the State Environmental Fund of the Czech Republic in 2016, the village built up a highly modern civic amenity site. The collecting yard serves for the disposal of sorted waste for the inhabitants of the municipality, or for the citizens of other municipalities, which signed the agreement with the yard. The purpose of the facility is to ensure the collection of sorted waste into the civic amenity site, the handing over of collected waste to persons authorized to take over, to take back products, to ensure waste management in accordance with applicable legal regulations. Citizens, who prove their identity and permanent residence, can store biodegradable waste, bulky and hazardous waste, rubble, wood but also products subject to take-back. Within the civic amenity site, the take-back system of used electrical equipment also operates.

Picture 6: Civic amenity site

Source: Own pictures, 2018

In the civic amenity site can be given old tires, polystyrene, but also mainly metals, building rubble, wood, biodegradable waste, paper, plastic and bulk waste such as furniture, polystyrene, textiles, edible fats and extracted motor oils and books. (Appendix 1)[1]

4.2.1.1. Take-back of the electrical material

Many citizens in the municipality export used functional and non-functional electronic equipment to a civic amenity site. Recycling waste is a good way to handle the electronic device. Since 2005, the manufacturer has been obliged to take back the electronic equipment. Take-back situated in civic amenity site can be used by citizens giving back from old lamps and batteries to refrigerators, television, and computers. Take-back can be used not only by citizens from Herálec and adjacent neighbourhoods, but by anyone.

There are several companies involved in the sorting of electrical waste:

- *Asekol s.r.o.* provides one red electrical waste container, which is placed on a stand for sorting waste next to the municipal shop and equally provides a spacious spot in the civic amenity site, where larger appliances can be imported. The company provides disposal of information technology equipment and telecommunication equipment and consumer devices (including televisions and monitors), toys, leisure equipment, and sport; medical devices.
- *Elektrowin, a.s.* disassembles large household appliances (including refrigerators and freezers), washing machines and small household appliances (mixers, drills) and electrical and electronic tools.
- *Ekolamp* provides the disposal of energy-saving light bulbs, fluorescent lamps, lamps etc. Batteries can also be handed over to disposal.

[1] Appendix 1 – pictures from collection yard of various types of waste

Picture 7: Take-back

Source: Own picture, 2018

4.2.2. Biodegradable waste

With the produced biodegradable waste, the citizens can handle as follows:

- **Collecting in a bulk container in a civic amenity site**. Considering the location of the civic amenity site at a greater distance from the centre of the village, this container servers primarily for residents of the municipal part Nádraží and for adjacent municipalities.
- **Delivery to large-volume containers in public areas in municipalities.** These large-volume containers owned by the municipality are emptied and transported by a company of Jan Krpálek to a nearby composting plant, which offered cooperation to the village. Containers are available during production period from spring to autumn at 16 different locations and emptied if necessary.
- **Domestic composting**, which is an important part of the biodegradable waste disposal system. The municipality was considering purchasing the domestic composting containers, but after buying large-volume bio-waste containers, it has rejected it. For this reason, the network of containers is very dense to meet the need of the population.

4.2.3. Unauthorized landfills

Because of the creation of unauthorized landfills, it is necessary to take care of this issue. In addition, steps are being taken to subsequently remove them. Cleaning of non-authorized waste on the municipal property is removed by the municipality. Illegal landfilled waste at places such as old quarry, forest paths is enhanced, but that waste is old burdens. In other cases, however, each owner should be responsible for the condition of his land.

Picture 8: Illegal landfill

Source: Own picture, 2018

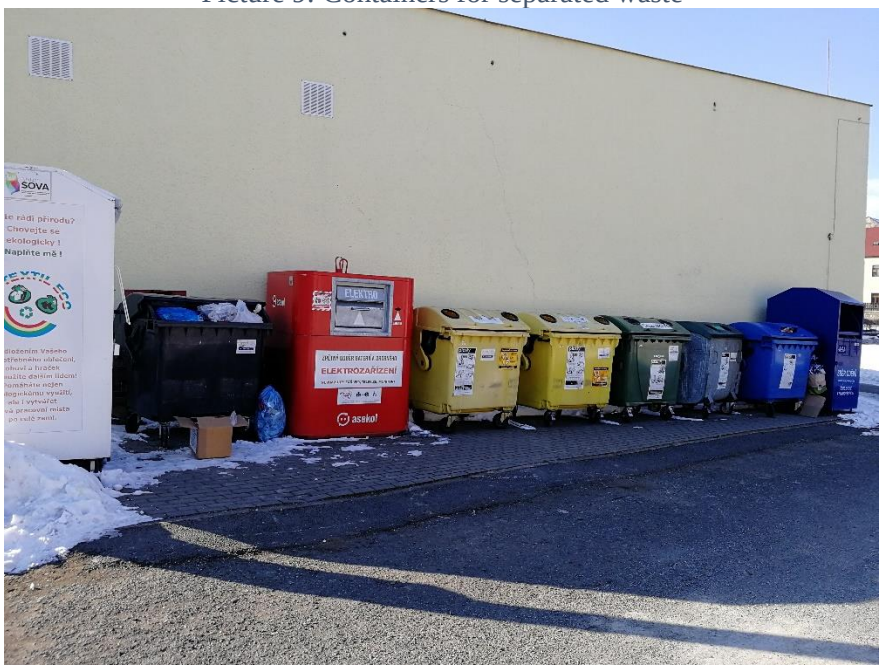
4.3. Waste production in Herálec

In this section can be seen how many and what waste the municipality produces annually. The tables below show the production of an individual type of waste for three years in tonnes. The quantity of individual types of waste is taken from the documents provided by the municipality and SMJ, s.r.o, who must complete the Waste Production Report every year.

4.3.1. Waste sorting

Prior to the commencement of operation of the civic amenity site, only 8 municipal containers are available and located in the village, concretely for collecting paper, plastic and mixed municipal waste. In 2016, municipality bought 19 large-volume containers for biodegradable waste. Another 73 containers are rented from the collection companies. and 12 vessels are rented by EKO-KOM a.s.

Picture 9: Containers for separated waste



Source: Own picture, 2018

Several public places also include clothing containers and red container for take-back of small electrical appliances. Return of batteries is also possible in the local store.

Table 1: Number of specific vessels located in Herálec

Containers	Proprietary and number of vessels			Total
	Municipality	Collection company	EKO-KOM	
Paper	3	15		18
Plastic bottle	2	22		24
Clear glass		3	12	15
Mixed glass		16		16
Large volume - Bio waste	19			19
Textile		3		3
MMW	3	14		17

Source: Municipal Documents, 2017

Separated collected municipal waste

In the following Table 2, we can see the evolution of the amount of waste that has been separated. Commodity “plastic packaging” is only recorded since 2017 because it was not previously collected separately.

Table 2: Evolution of separated waste in kg/year

Commodity	2015	2016	2017
15 01 02 Plastic packaging	-	-	910.00
Average per citizen	-	-	0.805
20 01 01 Paper and cardboard	20,570.00	13,072.00	13,280.00
Average per citizen	18.20	11.56	11.75
20 01 02 Glass	22,530.00	21,930.00	23,445.00
Average per citizen	19.94	19.40	20.74
20 01 39 Plastics	19,340.00	19,398.00	20,033.00
Average per citizen	17.12	17.16	17.73
20 01 40 Metals	20,00.00	8,180.00	9,440.00
Average per citizen	0.017	7.23	8.35
In total	62,460.00	62,580.00	67,108.00
Average per citizen (kg/year) in total	**55.277**	**55.35**	**59.375**

Source: Waste Production Report, 2016, 2017, 2018, own calculation, 2018

Here is the percentage of sorted municipal waste in relation to mixed municipal waste.

Table 3: Share of separation in tonnes

	2015	2016	2017
Mixed municipal waste	230.3	222.7	224.8
Separated waste	62.46	62.58	67.11
% separated waste from MMW	27.12	28.10	29.85

Source: Own calculation, 2018

It is clear from the Tables 2 and 3 that in the year 2017, the quantity of separated waste increased by 4.65 tonnes compared to the year 2015. Together with higher population

and decreasing of mixed municipal waste by 5.5 tonnes of municipal waste, this is a positive trend in waste separation in Herálec.

Hazardous waste

Table 4: Waste production – Hazardous waste in kg/year

Commodity	2015	2016	2017
15 01 10 Packaging [2]	-	-	421.00
15 01 11 Metallic packaging[3]	-	-	21.00

Source: Waste Production Report, 2016, 2017, 2018

By establishing the civic amenity site, citizens learned to separate even less frequent wastes such as packaging containing residual hazardous waste and metal waste containing dangerous fillings, including empty pressure vessels or a can of hardened paint.

Oils, tires, building waste

Originally, an oil container was also in the centre of the village, but after it was filled with waste that did not belong to this category, it was taken away and the citizens can hand it over to the civic amenity site.

Table 5: Waste production – Oil, tyres, building waste in kg/year

Commodity	2015	2016	2017
16 01 03 End-of-life tyres	-	1,820.00	2,410.00
16 01 07 Oil filters	-	95.00	102.00
20 01 13 Solvents	-	-	435.00

Source: Waste Production Report, 2016, 2017, 2018

Waste tires are sorted into the take-back system. However, the take-back of this commodity does not work as well as in the case of electro-equipment. Because of this fact, the municipality allows citizens to hand over tires in civic amenity site. Sellers usually only take back as many tires as the customer buys. The approach of the village is probably the

[2] Packaging containing residues of or contaminated by hazardous substances

[3] Metallic packaging containing a hazardous solid porous matrix, including empty pressure containers

only possible solution to prevent tires from being thrown into nature. The desired goal is to reduce the number of tires in the civic amenity site and to develop the take-back system by obligated persons. Nevertheless, it is important that this waste ends up in the civic amenity sites and not in the municipal landfill.

Table 6: Waste production in kg/year - classification 17

Commodity	2015	2016	2017
17 01 07 Mixtures of concrete, bricks	-	86,400.00	142,160.00
17 06 04 Insulation materials	-	-	4,774.00
17 06 05 Construction materials containing asbestos	-	6,680.00	7,046.00

Source: Waste Production Report, 2016, 2017, 2018

It can be seen from the Table 6 that the volume of building materials and insulation materials increases year after year. This positive trend could mean the loss of forbidden landfills arising from the accidentally deduced building debris.

Biodegradable waste, Other non-biodegradable waste, wood

Table 7: Waste production in kg/year – Biodegradable waste

Commodity	2015	2016	2017
20 01 38 Wood	50,000.00	38,000.00	41,280.00
20 02 01 Biodegradable waste	110,000.00	65,233.00	93,479.00
20 02 03 Other non-biodegradable waste	-	4,080.00	3,130.00

Source: Waste Production Report, 2016, 2017, 2018

The amount of biodegradable waste is fluctuating, with only 65 tonnes in 2016 attributable to the weather. Code 20 02 03 contains residues of various green masses, plastic packaging, wax remnants and metal caps of cemetery candles, etc.

In 2015, the inhabitants sorted only basic waste, namely paper, glass, plastic, metals, biowaste, communal waste and bulky waste. This was due to the low number of disposable containers for individual components of waste in the municipality.

In 2016, when a civic amenity site was built and a general mobilization of the waste subconscious and the necessity of sorting it, citizens became more consistent in the recycling and sorting of hazardous waste or building waste and tires. Although the total produced quantity decreased by 43 tons, there is a clear shift in the recycling of plastics and metals. The cause of the loss of bulky waste may be an interest in so-called "up-cycling", which is a "process of transforming by-products, waste materials, useless, or unwanted products into new materials or products of better quality or for better environmental value." (Wikipedia, 2018)

In 2017 total waste production again increased by about 134 tons. This can be explained by the widespread interest of citizens in the proper sorting of waste and, for example, the clearance of old areas, the modernization of houses (see the increase in the share of building waste in total production). Newly sorted hazardous waste includes oil filters, insulating materials, asbestos, solvents, paints and inks and oils and edible fats.

From the resulting values, it can be stated that the level of sorting of individual municipal waste commodities is at a very good level in the village.

4.3.2. Municipal expenditures in waste management

All data listed in the Table 8 refer to the year 2015, 2016 and 2017. Financial amounts spent on collection, recovery of waste and other items related to waste management are sums of individual service sums made by the shipping company over a given period. Other general costs such as the operating costs of the civic amenity site are also included. The waste collection company are SMJ, s.r.o. (Služby města Jihlavy, s.r.o.), HBH odpady, s.r.o. and Kompostárna Pavlov. Total price includes manipulation and removal of waste by the company designated for that purpose.

Table 8: Total expenditures in CZK including VAT

Waste classification	2015	2016	2017
Hazardous waste	-	26,865.00	55,680.00
17 01 07 Mixtures of concrete, bricks	-	143,154.00	116,930.00
20 01 01 Paper and cardboard	82,668.33	85,814.00	100,530.00
20 01 02 Glass	63,008.27	51,344.00	61,871.00
20 01 13 Solvents	27,745.10	-	-
20 01 38 Wood	20,000.00	25,364.10	27,000.00
20 01 39 Plastics	217,554.01	220,766.00	268,858.00
20 02 01 Biodegradable waste	28,477.01	32,936.90	36,025.00
20 03 01 Mixed municipal waste	500,254.23	500,227.00	484,232.00
20 03 07 Bulky waste	117,055.70	88,892.00	155,128.00
Take-back, extraordinary carriage	19,089.20	-	-
Promo	1,000	1,000	1,000
Costs of operating of civic amenity site	-	341,199.00	410,622.00
Waste generated by the maintenance of community	-	-	20,000.00
Administration of waste management	-	-	3,000.00
Total	**1,076,851.85**	**1,517,562.00**	**1,740,876.00**

Source: Processed from municipal documents, 2018

The costs of waste collection and its disposal are high for the municipal budget. As the highest cost, we can assume the collection and disposal of mixed municipal waste, which the municipality produced the most in 2015, 230 tonnes. Removing the MMW costs the municipality up to half a million CZK a year. For this reason, the municipality should encourage citizens to properly separate waste.

When calculating the municipal waste costs per inhabitant, we find out that costs are enormously high for such a small community – 1,540 CZK/year. Compared to the maximum amount of waste fee imposed by law (i.e. 1,000 CZK), the values per citizen are higher by half. The municipality pays for every person extra 1,000 CZK.

A ban on landfilling of recoverable waste will begin in 2024, which in practice means that for every tonne of unseparated waste the municipality will pay 1,850 CZK per tonne instead of current 500 CZK. (Česká pozice, 2016)

4.3.3. Municipal revenues in waste management

Municipal revenues over the past three years were significantly lower than in case of costs. We can see this in a Table 9 showing each revenue item.

The financial amounts that make up the municipal revenues are supplemented by the following sources:

- A fee from citizens, holidaymakers and other waste producers (fee per citizen is 500 CZK/year, fee per vacationer 600 CZK/year)
- Revenues from EKO-KOM a.s. company
- Take-back of electrical equipment
- Sale of usable components

Table 9: Total revenue in CZK

Revenue	2015	2016	2017
Sale of usable components	0	0	36,211.00
EKO-KOM a.s.	162,817.00	156,396.50	163,218.00
Remuneration (take-back of equipment)	0	2,563.00	14,505.00
Citizens fee	464,026.00	464,839.00	456,359.00
Vacationers fee	137,400.00	141,600.00	149,400
Total	**764,243.00**	**765,398.50**	**819,693.00**

Source: Processed from municipal documents, 2018

The main income is the local fee, which was set at 500 CZK. Another more significant income is the reward from EKO-KOM, a.s., which the municipality receives, and its amount always depends on the amount of sorted waste. No revenue generates a fee for business entities and sales of usable components.

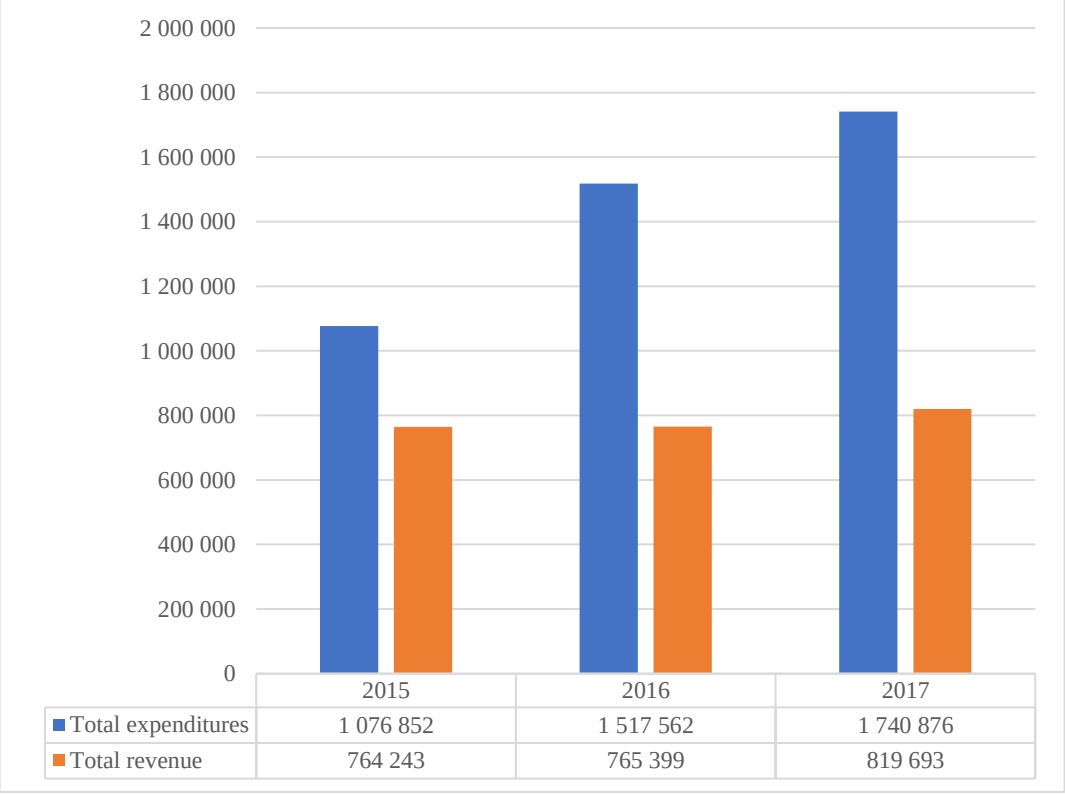
Total revenues:

- For the year 2015: 764,243.00 CZK, which is 71% of the cost.
- For the year 2016: 765,398.50 CZK, which is 50,4% of the cost
- For the year 2017: 819,693.00 CZK, which is 47% of the cost

4.3.4. Expenditures and revenues comparisons

In the Figure 2 below is showed the difference in costs compared to revenue, which increases each year by hundred thousand, while revenue increased by only a few tens of thousands.

Figure 2: Comparison of expenditures and revenues in CZK



	2015	2016	2017
Total expenditures	1 076 852	1 517 562	1 740 876
Total revenue	764 243	765 399	819 693

Source: Own calculation, 2018

4.4. Indicators of the effectiveness of the investment into the civic amenity site

This part of the work will focus on the evaluation of the investment made by the municipality, namely financial participation in the construction of the civic amenity site. It is a question of whether its construction has made it easier for the municipality to handle

waste and whether the operation costs of the civic amenity site is not a major burden for the municipal budget.

Thesis works with two versions.

1) **The real version with real data.** We include the initial investment in its implementation as well as court running costs such as wages, electricity and water charges and other overhead costs (necessary repair at the civic amenity site). From the first year of opening, the civic amenity site generates a small income, mainly in the take-back of equipment and the sale of commodities (for example, iron). Due to the high cost of waste management in the municipality, which also the costs of the civic amenity site have been added, it is necessary to cover costs by other than generated revenues. I included 30% of the waste fee from citizens and vacationers. We assume that number of citizens will be more less stable and the number of commodities for sale and take-back of electrical equipment will increase approximately by 1,000 CZK per year. If we do not consider the potential increase in the cost of running the civic amenity site (an increase of electricity charges, wage growth), we expect a constant amount up to 2035.
2) **The optimistic version.** In this version, we calculate the same expense as in the previous version, ie. initial investment and the cost of running the civic amenity site. Due to the high costs and lower revenues generated, which results in a large subsidy for running the court from the municipal budget, it is necessary to consider the potential increase of municipal fees for citizens and holidaymakers by 200 CZK for each. At the same time, the municipality would cover the cost of the collection court by 50% of the collected fees.

4.4.1. Effectiveness based on the real data

In the table below can be seen the default information for the calculations.

Table 10: Default data for calculation

Citizen fee					
CZK per person	Number of paying people	Year	Income in CZK	Share of costs in %	Considered amount per year in CZK
500	928	2015	464,026	0.3	138,750
	929	2016	464,839		
	912	2017	456,359		
	925	2018–2035	462,500		
Vacationer fee					
600	229	2015	137,400	0.3	45,000
	236	2016	141,600		
	249	2017	149,400		
	250	2018–2035	150,000		

Source: Own calculations, 2018

Investment indicators include net present value, internal rate of return and payback period.

Net present value

Net present value is the sum of the future cash flows of the investment and the cash flow in the zero periods. The discount rate is set at 2.65% according to the Czech National Bank[4]. sustainability (time index) of the project is 20 years.

From the cash flow in Table 10, the current NPV has calculated values according to the formula given in Chapter 2.2 Methodology.

[4] **Czech National Bank, 2018**. *Systém časových řad.* Available on: <http://www.cnb.cz/cnb/STAT.ARADY_PKG.VYSTUP?p_period=1&p_sort=2&p_des=50&p_sestuid=16828&p_uka=20&p_strid=AAABBA&p_od=201701&p_do=201712&p_lang=CS&p_format=0&p_decsep=%2C>

Table 11: Cash Flow with real data in CZK

	Year	Revenues	Expenses	Cash flow	Discounted CF	Σ
1	**2016**	182,991	341,199	-158,208	-154,259	-2,509,710
2	**2017**	232,648	410,622	-177,974	-169,200	
3	**2018**	241,728	420,000	-178,272	-165,253	
4	**2019**	247,750	420,000	-172,250	-155,685	
5	**2020**	250,750	440,000	-189,250	-166,781	
6	**2021**	253,750	420,000	-166,250	-142,854	
7	**2022**	256,750	420,000	-163,250	-136,775	
8	**2023**	258,750	420,000	-161,250	-131,727	
9	**2024**	260,750	420,000	-159,250	-126,846	
10	**2025**	262,750	440,000	-177,250	-137,659	
11	**2026**	264,750	420,000	-155,250	-117,564	
12	**2027**	266,750	420,000	-153,250	-113,153	
13	**2028**	268,750	420,000	-151,250	-108,888	
14	**2029**	270,750	420,000	-149,250	-104,766	
15	**2030**	272,750	440,000	-167,250	-114,471	
16	**2031**	274,750	420,000	-145,250	-96,932	
17	**2032**	276,750	420,000	-143,250	-93,211	
18	**2033**	277,750	420,000	-142,250	-90,250	
19	**2034**	278,750	420,000	-141,250	-87,379	
20	**2035**	280,750	440,000	-159,250	-96,055	

Source: Own calculation, 2018

NPV: - 4,221,467 CZK

The calculated value indicates the financial loss of the developer. Under market conditions, the project would be unacceptable. In this case, the project applicant is the municipality whose goal is not to get rich, but to contribute to improving the living environment by properly separating the waste and reducing the amount of municipal waste.

Internal Rate of Return

An investment project is appropriate if the IRR is higher than the required minimum return on investment that is given by the enterprise´s discount rate. The higher the IRR percentage, the more effective the investment. The IRR method can be used if the flows of the investment are conventional (i.e. the difference between the income and the expense of

the investment shows a negative value of the “net flow”). The MS Excel function is used to calculate the IRR. The CF value is considered from the point of view of the investment.

In case of minus value of cash flows is not possible to determine the IRR.

Payback Period

In this case, it is not appropriate to calculate the payback period because the cash flow is in negative numbers throughout the life of the project.

4.4.2. Effectiveness based on the optimistic data

In the table below can be seen the default information for the calculations.

Table 12: Default data for calculation

Citizen fee					
CZK per person	Number of paying people	Year	Income in CZK	Share of costs in %	Considered amount per year in CZK
700	928	2015	464,026	0.5	323,750
	929	2016	464,839		
	912	2017	456,359		
	925	2018–2035	460,000		
Vacationer fee					
800	229	2015	183,200	0.5	100,000
	236	2016	188,800		
	249	2017	199,200		
	250	2018–2035	200,000		

Source: Own calculation, 2018

Net present value

The default values for the NPV calculation remained the same.

Table 13: Cash Flow with optimistic data in CZK

	Year	**Revenues**	**Costs**	**Cash flow**	**Discounted CF**	**Σ**
1	**2016**	422,113	341,199	80,914	78,894	1,208,612
2	**2017**	469,516	410,622	58,894	55,991	
3	**2018**	483,750	420,000	63,750	59,094	
4	**2019**	487,750	420,000	67,750	61,235	

5	**2020**	490,750	440,000	50,750	44,725	
6	**2021**	493,750	420,000	73,750	63,371	
7	**2022**	496,750	420,000	76,750	64,303	
8	**2023**	498,750	420,000	78,750	64,332	
9	**2024**	500,750	420,000	80,750	64,319	
10	**2025**	502,750	440,000	62,750	48,734	
11	**2026**	504,750	420,000	84,750	64,177	
12	**2027**	506,750	420,000	86,750	64,052	
13	**2028**	508,750	420,000	88,750	63,893	
14	**2029**	510,750	420,000	90,750	63,702	
15	**2030**	512,750	440,000	72,750	49,792	
16	**2031**	514,750	420,000	94,750	63,231	
17	**2032**	516,750	420,000	96,750	62,954	
18	**2033**	517,750	420,000	97,750	62,017	
19	**2034**	518,750	420,000	98,750	61,088	
20	**2035**	520,750	440,000	80,750	48,706	

Source: Own calculation, 2018

NPV: -703,145 CZK

Even after increasing the municipal waste fee and stable project lifespan of 20 years, the NPV is not positive at all. It would seem that this project is not an appropriate choice as an investment. Even so, it can be said that the sum of cash flows increased. If we add a further 15 years to the lifetime of the project (in Table 14), we will see that in this case, NPV will be in positive trend. A project with these conditions would, therefore, be acceptable in the long term.

Table 14: Cash flow of other 5 years in CZK

	Year	**Revenues**	**Costs**	**Cash flow**	**Discounted CF**	**Σ**
21	**2036**	522,750	420,000	102,750	60,429	
22	**2037**	524,750	420,000	104,750	60,067	
23	**2038**	526,750	420,000	106,750	59,686	
24	**2039**	528,750	420,000	108,750	59,287	
25	**2040**	530,750	440,000	90,750	48,239	2,041,417
26	**2041**	532,750	420,000	112,750	58,437	
27	**2042**	534,750	420,000	114,750	57,989	
28	**2043**	536,750	420,000	116,750	57,527	
29	**2044**	538,750	420,000	118,750	57,052	

30	**2045**	540,750	440,000	100,750	47,196	
31	**2046**	542,750	420,000	122,750	56,066	
32	**2047**	544,750	420,000	124,750	55,558	
33	**2048**	546,750	420,000	126,750	55,039	
34	**2049**	548,750	420,000	128,750	54,512	
35	**2050**	550,750	440,000	110,750	45,721	

Source: Own calculation, 2018

NPV: 129 660 CZK

These values mean that after 35 years, in 2050, the project would be effective.

Internal Rate of Return

The IRR is 0.68%, indicating the discount rate at which the NPV is equal to 0.

Payback Period

The payback period method serves to determine whether the future cash flows (no discounted) generated by the investment plan will cover initial capital expenditures. The following table shows the progress of cumulative cash flow values in each operating year.

Table 15: Payback Period in CZK

Year	Cash flow	Cumulative CF	Year	Cash flow	Cumulative CF
2015	-1,911,757		**2028**	88,750	-956,699
2016	80,914	-1,830,843	**2029**	90,750	-865,949
2017	58,894	-1,771,949	**2030**	72,750	-793,199
2018	63,750	-1,708,199	**2031**	94,750	-698,449
2019	67,750	-1,640,449	**2032**	96,750	-601,699
2020	50,750	-1,589,699	**2033**	97,750	-503,949
2021	73,750	-1,515,949	**2034**	98,750	-405,199
2022	76,750	-1,439,199	**2035**	80,750	-324,449
2023	78,750	-1,360,449	**2036**	102,750	-221,699
2024	80,750	-1,279,699	**2037**	104,750	-116,949
2025	62,750	-1,216,949	**2038**	106,750	-10,199
2026	84,750	-1,132,199	**2039**	108,750	**98,551**
2027	86,750	-1,045,449	**2040**	90,750	189,301

Source: Own calculation, 2018

The calculations show that the payback period of the zero-return investment will be between the 23rd and 24th years of the investment´s life. It is necessary to find the exact payback time in months and days.

$$23 + \frac{0 + 10199}{106750} = 23.09554 = \mathbf{23\ years, 1\ month, 4\ days}$$

Payback period is often used method that is criticized for not determining the time factor. For a more accurate expression of reality, it is necessary to discount individual cash flows. Such a calculation is simplified in the following table.

Table 16: Payback Period with discounted CF in CZK

Year	Cash flow	Cumulative CF	Year	Cash flow	Cumulative CF
2015	-1,911,757		**2033**	62,017	-812,939
2016	78,894	-1,832,863	**2034**	61,088	-751,851
2017	55,991	-1,776,872	**2035**	48,706	-703,145
2018	59,094	-1,717,778	**2036**	60,429	-642,716
2019	61,235	-1,656,543	**2037**	60,067	-582,649
2020	44,725	-1,611,819	**2038**	59,686	-522,963
2021	63,371	-1,548,447	**2039**	59,287	-463,676
2022	64,303	-1,484,144	**2040**	48,239	-415,437
2023	64,332	-1,419,812	**2041**	58,437	-357,000
2024	64,319	-1,355,493	**2042**	57,989	-299,011
2025	48,734	-1,306,759	**2043**	57,527	-241,484
2026	64,177	-1,242,581	**2044**	57,052	-184,432
2027	64,052	-1,178,529	**2045**	47,196	-137,236
2028	63,893	-1,114,636	**2046**	56,066	-81,170
2029	63,702	-1,050,934	**2047**	55,558	-25,612
2030	49,792	-1,001,141	**2048**	55,039	**29,427**
2031	63,231	-937,910	**2049**	54,512	83,940
2032	62,954	-874,956	**2050**	45,721	129,660

Source: Own calculation, 2018

Values from the table say that if we consider the discounted cash flows, the investment will be recovered in the 32nd year of the life of the project.

4.5. Financial flows of the waste management system

Because of the improvement of the waste separation, in most cases, the financial assurance in the waste management area is upgraded. Considering the increase of the fee for landfilling waste **(up to 1,850 CZK per tonne of waste)**, Herálec must adhere to the set standard – a reduction of MMW. An important fact is that the waste management system will be increased by 200 CZK per year per individuals to cover the high costs of waste management and the operation of the civic amenity site.

The higher quantity of sorted commodities will result in higher costs for the collection of individual components of the separated waste and, on the other hand, increase the income of the municipality in the item of contributions from the packaging company EKO-KOM. An important factor that will increase the amount of separated waste and at the same time reduce the amount of MMW in the containers is the thorough education of the citizens in the municipality.

Because of the high fees for landfilled waste from 2024, it is necessary to reduce the amount of MMW. If this was not the case, the municipality would pay the costs incurred from the municipal budget and it would not be possible to invest in a project supporting the living conditions in the village.

The Table 17 below shows how much the municipality would have to pay to dispose of the waste in different scenarios.

Table 17: Two scenarios of costs in 2024

	MMW	Paper	Plastic	Glass	**Costs**
Amount (tonnes)	**224.80**	13.28	21.00	23.45	**1,139,789.00**
Manipulation (CZK)	194,102	47,849	195,252	43,720	
Disposal/Containers rent (CZK)	602,014	15,228	22,334	19,289	
Total (CZK)	796,117	63,077	217,586	63,009	
Amount (tonnes)	**135.48**	26.12	24.82	23.65	**992,819.00**
Manipulation (CZK)	179,477	85,603	261,573	46,471	

Disposal/Containers rent (CZK)	362,815	15,235	22,345	19,298	
Total (CZK)	542,293	100,839	283,918	65,769	

Source: Own calculation, 2018

In the table there are two scenarios that could happen in 2024:

1st scenario: The amount of MMW has not decreased and is at the same level as in 2017.

- Amount of waste 224.80 tonnes
- Waste disposal 828 CZK per tonne
- Landfill fee according to the Waste Act 1,850 CZK per tonne
- (828*224.80) + (1,850*224.80) = **602,014 CZK**

2nd scenario: The amount of MMW decreases by 89 tonnes since 2017, that is ideal and realistic amount of MMW to handle for the municipality according to the Waste audit (ISNOV, 2016).

- Amount of waste 135.48 tonnes
- Waste disposal 828 CZK
- Landfill fee according to the Waste Act 1,850 CZK per tonne
- (828*135.48) + (1,850*135.48) = **362,815.40 CZK**

The decline of municipal waste has caused an increase of separated waste and increase of costs for their removal.

In the Table 18, there are two scenarios of potential revenues and their sources.

Table 18: Two scenarios of revenues in 2024 in CZK

Source	Revenues	Σ
EKO-KOM	163,218	**768,977.00**
Citizen fee (Table 10)	456,359	
Vacationer fee (Table 10)	149,400	
EKO-KOM	213,234	**1,060,734.00**
Citizen fee (Table 12)	647,500	
Vacationer fee (Table 12)	200,000	

Source: Own calculation, 2018

1st scenario: The revenues remain the same as in the year 2017.

2nd scenario: The remuneration by EKO-KOM increase thanks to the higher amount of separated waste according to the Waste Audit (ISNOV, 2016). The charges for citizens and vacationers increase by 200 CZK per person (see Table 12).

In 1st scenario, the charges for citizens remained at their current level, i.e. 500 CZK per year. However, this level is unprofitable in the long run and municipality does not make a significant contribution to the waste management, which is more expensive from year to year. This is the reason to think about increasing the fees by 200 CZK (as seen in Table 18). It would bring more money into the municipal budget, and waste management would not have to be subsidized so much. The current excellent level of waste collection and all services would remain unchanged.

When we compare the two variants and their cost and revenues in 2024, the potential savings in introducing higher charges and reducing municipal waste are close to half a million CZK. (see Table 19)

Table 19: Comparing of two variants in CZK

	Costs	Revenues	Profit	Surplus
1st scenario	1,139,789	775,317	**-364,472**	**432,387.00**
2nd scenario	992,819	1,060,734	**67,915**	

Source: Own calculation, 2018

4.6. Benefits of waste management in Herálec for municipality and citizens

As has been said, the municipality should never profit from the projects it invests in in the village. However, investments can bring certain benefits to the municipality and citizens.

The construction of the civic amenity site is the largest investment done in the municipality today and it means a major burden of the municipal budget and together with the established environmental policy, it is costlier to maintain waste management to such an extent that there is no significant damage to the municipality and citizens caused by a low amount of municipality money.

The above-mentioned efficiency indicators for the civic amenity site and the potential savings of the municipality in waste management were calculated separately, but they were considered. In the following calculation, the total cash flow (optimistic version) in the year 2024 is added together with the profit.

Sum of CF in 2024 (Table 12) + Surplus (Table 19) = socio-economic benefit

556,264 + 432,387 = 988,651 CZK

This result shows the amount that the municipality potentially can save by applying the new policy in waste management. Such a socio-economic benefit may be used to develop living conditions in the village (a development of a municipal infrastructure, a revitalization of local primary school equipment, an extension of sports grounds, etc.)

5. Results

Waste management in municipality of Herálec is at very good level. It cooperates with SMJ, s.r.o., HBH Odpady, s.r.o. and Kompostárna Pavlov (the composting plant), where each company is in charge of the disposal and liquidation of a particular type of waste. There are about 13 sites in the village and the adjacent municipalities, where at least the waste containers for separated waste (plastic, beverage carton, paper, glass) are located, in some locations also containers for mixed waste, used clothing or small electrical equipment are situated. In 2015, the municipality asked the State Environmental Fund of the Czech Republic for a subsidy to construct a modern civic amenity site, which greatly contributes to the separation of waste. In the civic amenity site, residents can leave used tires, building waste, bulky waste, hazardous waste, but there is also a take-back of electrical equipment. Take-back can be used by citizens and also by people who have no place of residence in Herálec village.

Thanks to the construction of a civic amenity site, people have learned to separate more waste, while reducing the number of forbidden landfills that were visible in the surrounding forests and on the less-used roads. Table 2 shows that the amount of separated waste increases year by year at the expense of reduced MMW. In 2017, the share of disposed waste from municipal waste was 29.85%. However, a common EU target of 2030 is the recycling of 65% to 70% of municipal waste. Increasing the amount of separated waste has its positive and negative effect. The negative result of higher amount of separated waste is the higher price for its removal and disposal. The municipal waste management costs increase each year, and after the construction of the civic amenity site, the costs of its operation (i.e. fixed operating overhead such as wages, electricity, etc.) are added to them. The positive effect is firstly the great impact on the environment and secondly an increasing of the reward from EKO-KOM, which can serve as a motivation for the municipality to appeal to the citizens. Greater quantities of sorted municipal waste need to be collected more efficiently in containers to reduce the size of the commodity as much as possible. If the volume of containers were not enough due to poorly pressed vessels and commodities, the municipality would have to rent more containers, which would again mean higher costs. In addition, sales of commodities such as iron and take-back of electrical equipment are also

included in revenues since 2016. A large share of the income has waste fees which are set to 500 CZK for citizens and 600 CZK for vacationers.

Although the 85% of the construction of the court was financed by the SEFCR, and the municipality had to invest only 15% (almost 2 million CZK), this is a big financial burden for the municipality and has deepened the already high costs of waste management. For the purposes of determining the return and efficiency of the project, two options were considered:

1st version:

Costs – operational costs of the civic amenity site,

Revenues - 30% of total amount of the waste fees from citizens and vacationers was used as revenues; services provided by civic amenity site (sales of a commodity, take-back)

Results - after calculating the NPV for 20 years of the project´s life, where the value was negative, it was not possible to calculate the IRR and the payback period. This model would imply a financial loss to the investor, and under market conditions, the project is unacceptable. This model would imply a financial loss to the investor, and under market conditions, the project is unacceptable.

2nd version:

Costs – unchanged operational costs of the civic amenity site,

Revenues – an increase of the waste fees from citizens and vacationers by 200 CZK – 50% of total amount of the waste fees was used as revenues, services provided by civic amenity site (sales of a commodity, take-back)

Results - raising revenues and their share on the operation of civic amenity site while maintaining costs mean a significant shift. After 35 years of project life, the NPV is 129,660 CZK and it means that in 2050, the project would be effective. The IRR is 0.68% and the payback period with the discounted value of the money would occur in the 32nd year of the investment.

Since 2024 limited landfills will be minimized and all waste will be used for energy or recycled and used under the so-called “Circular economy”, a fee of 1,850 CZK/tonne of municipal waste will be set. In order to avoid large sums and, possibly, fines for a high amount of MMW, a municipality must force its citizens to separate more waste. I have created two version again.

1st version:

Unchanged amount of waste and its impact on the financial side of the municipality

- If the amount of MMW was the same in 2024 as in 2017 (224.80 tonnes), the municipality would pay 1,139,789 CZK due to a new fee for landfilling waste.
- Together with revenues of 768,977 CZK (unchanged remuneration from EKO-KOM, unchanged charges for citizens), the municipality would pay off 364,472 CZK

2nd version:

The highest possible reduction in the amount of waste by 2024 (according to the Energy Audit) and its positive impact on both finances and environment.

- When reducing the amount of waste by 89 tonnes from 2017, the municipality would pay 992,819 CZK for its removal and disposal.
- Together with revenues of 1,060,734 CZK (increased charge by 200 CZK and EKO-KOM remuneration), the municipality would be in surplus by 67,915 CZK.

When comparing these two versions, the second option clearly shows the positive effect of the increased amount of separated waste and a slightly higher fee for the citizens. (surplus by 432,387 CZK). The sum of cash flow and cost savings in 2nd variant, the amount of 988,651 CZK tells us how much the municipality would save on unchanged costs such as operating costs, costs of purchasing new equipment or tax burden, along with adequately set limits for revenue growth.

A solution that would help the municipality to reduce the cost of waste management is, for example, reducing the amount of the MMW by rigorously classifying or considering the introduction of a longer frequency of collection of the MMW containers. In the case of biodegradable waste, separated the biological component of the waste from the mixed waste. At the same time, it is necessary to systematically prepare for the issue of the prohibition of landfilling of the MMW by 2024. For higher quantities of sorted components, it is possible to add a number of collection points or number of containers as necessary and adjust the frequency of their waste. Equally important is to ensure the cleanliness of the sorted ingredients with regards to remuneration and market use (Circular economy). Finally, it will greatly help to reduce the volume of the separated commodities, especially in the case of plastic and paper (economical storage in containers). In the case of interest, it is possible to provide containers for collecting slight metals, etc.

Municipality of Herálec operates waste management in accordance with valid legislation while eliminating negative environmental impacts. There is a need for the municipality to continue this trend while increasing the number of separated commodities and reducing the amount of produced mixed municipal waste. For this reason, it should raise awareness among citizens, for examples leaflets, a lecture at the local kindergarten and elementary school, chat with citizens, or basic information on the municipality´s website. At the same time, it is important to involve all inhabitants of the community system.

6. Discussion

Whatever humans do, it produces waste. Worldwide waste production is enormous and steadily rising. There seems to be no way to stop or at least slow down this steep growth. According to the Czech Statistical Office, 25,000,000 tonnes of waste were produced in 2016, which is 1,200,000 less than in 2015, yet it is a huge amount of man-made waste in just one year. (Czech Statistical Office, 2017)

Sorting waste aims to reduce the environmental impact of packaging production. The purpose of waste sorting is to sort out the municipal waste from the components which can be further utilized to provide them with the processors for recovery. Many people have a good feeling knowing that they properly sort waste. They are interested in whether it is necessary to remove labels from bottles or to remove content from the detergent. Paradoxically, it´s a vicious circle. Waste sorting and recycling do not save the world at all. The only reliable way to reduce the amount of waste produced is to prevent waste generation. How to do it when we are a loving materialism consumer society.

6.1. Zero Waste

The best solution is to prevent the generation of waste. At present, there are shops in the Czech Republic where you can weigh the raw materials into your own jar or bottle in the dish cleaner. This is a purchase with no package (“Bez obalu”). In the interest of protecting the environment, reducing the production of plastic packaging and reducing food prices, this is the concept of retailers selling retailer able goods, called “Zero Waste”. The reasons for this move are both ecological and economic. The less waste you produce, the less you need to separate, and less it will end up in landfills. In addition, buyers should save for packaging when shopping them. Zero Waste is an approach that seeks to reduce the production of waste in the lives of individuals, communities, businesses, and states. This philosophy says that all resources should be reused as is should happening in nature.

Zero Waste International Alliance (ZWIA) uses followed definition:

"*Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use"* (ZWIA, 2015)

The Zero Waste concept is not only about food but also about the way of life. For a life without waste, one basic and fundamental rule is: "Do not bring home what would end up in a waste bin." Not all waste has to end up in a landfill or incinerator, many can be composted or recycled, but it is not a long sustainable solution. Composting is well suited for biological residues, but the decomposition of other materials is usually a long process in which poisonous substances get into the soil. In the end, never ended recycling is perhaps only glass. Zero Waste concept can be applied to your entire household – across the kitchen, the bedroom, and the bathroom. Even wardrobe can be arranged in the style of zero waste. Buy pieces that are well-suited to each other.

Bea Johnson, from California, first came up with the Zero Waste concept. Thanks to it, an increasing number of people start to notice that the meaning of life does not have to be more and more possessive. On the contrary – we find that the more we own, the less we live. The more we buy, the more we are forced to earn. We notice that the vast amount of waste that is a consequence of our current lifestyle destroys the planet and human health. According to Mrs. Johnson, we can turn the waste off with the 5R rule:

- Refuse what you do not need;
- Reduce what you do need;
- Reuse what you consume;
- Recycle what you cannot Refuse;
- Rot (compost) the rest. (Zero Waste Home, 2018)

Picture 10: Johnson family´s trash for 2017

Source: Zero Waste Home, 2018

This way of life may appear at first sight in the way that it is only a certain trend in the current world. Live healthy, minimalist. This lifestyle also leads to significant health benefits and to save money and time. The most effective way to stop to bring useless things into your house in the future is to constantly ask: What do I need if for? When do I use it?

6.2. The End of the Plastic

When you go shopping, do you take your own shopping bag? We are overwhelmed by plastic bags and plastics in general. Big companies and supermarkets have also begun to notice this problem and the paper bags replace those from plastic. You do not get a straw on each drink and people have already found their way to before-mentioned shopping with no cover.

The Czech Republic, as well as other countries, are already struggling with the problem of excess waste and packaging. BusinessInfo.cz has published an article dated November 27, 2017, which mentions the ban on the import of 24 types of waste into China. These include, for example, “Plastic Waste”, “Unseparated Paper Waste”, “Waste Textile Material”. (BusinessInfo.cz, 2017) The Czech Trade website published an article on July 3, 2017, which states that the purpose is to prevent environmental pollution in China, which according to the local government is largely due to the import of waste into China and its processing on site. This is due to the fact that the local waste recycling industry is highly decentralized, strangely regulated and is characterized by extremely poor preventive security

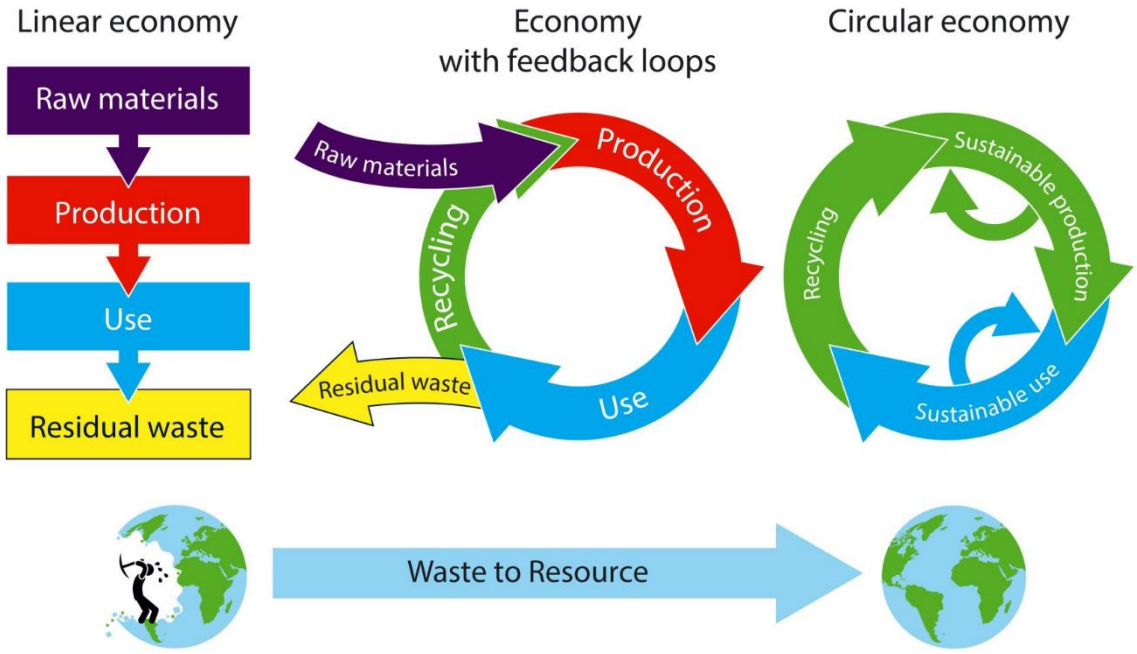
measures for employees and the frequent handling of non-recyclable waste. The Chinese government is trying to prevent restrictions on the supply of waste from abroad, more frequent inspections of operations and introduction of severe penalties. (Czech Trade, 2017)

The ban on imports of plastics has affected and marked many worldwide countries together with the Czech Republic. The Czech Republic, which has also become a leading country in the separation of waste, is struggling with the problem of plastering plastic. Plastics end up in landfills and an increasing amount of sorted plastic waste is incinerated in incinerators along with mixed waste. The most that start to experience that are the municipalities where the waste collected company begin to charge a higher price just for the removal and disposal of waste, but there is no place to store them. It seems that Chinese politics will go even further in this regard, i.e. it also affects the import of paper and board. But this situation could force Europe to make a revision of its own waste policy and start to tackle where the waste is going to be stored. (Radio Praha, 2018)

The European Union can take an example from British company "Re-Gen Waste", which has invested two million pounds in technology that will bring better-recycled paper and will significantly increase its production. As the CEO of the company says: *"We learned from the World Trade Organisation that the Chinese Government intended to ban certain grades of paper, which we were supplying to their top three mills. In order to meet this challenge rapidly, we pumped £2 million into our R&D Department to help us install optical sorting, ballistic separators and a range of eddy currents and steel magnets, which will allow us to offer China and other markets, the higher grades of paper they are now demanding".* (Re-Gen Waste, 2017)

Another possible solution of excessive waste is the so-called "Circulation Economy". In circulation systems, the added value of products is kept as long as possible while reducing the volume of waste. Once the product in the circulating economy reaches the end of its lifetime, it remains on the farm as a source so that it can be used repeatedly in production to create the next value. Transition to a circulating economy requires changes in value chains, from product design to the creation of new business and marketing models, from new ways of waste-to-resource processing to new ways of consumer behaviour. (Brears, R., C., 2018)

Picture 11: Circular economy solutions



Source: Ministry of the Environment, 2016

2 chosen companies can be good examples of the circular economy:

SITA CZ a.s. – **50,000 tonnes of biodegradable waste composted**

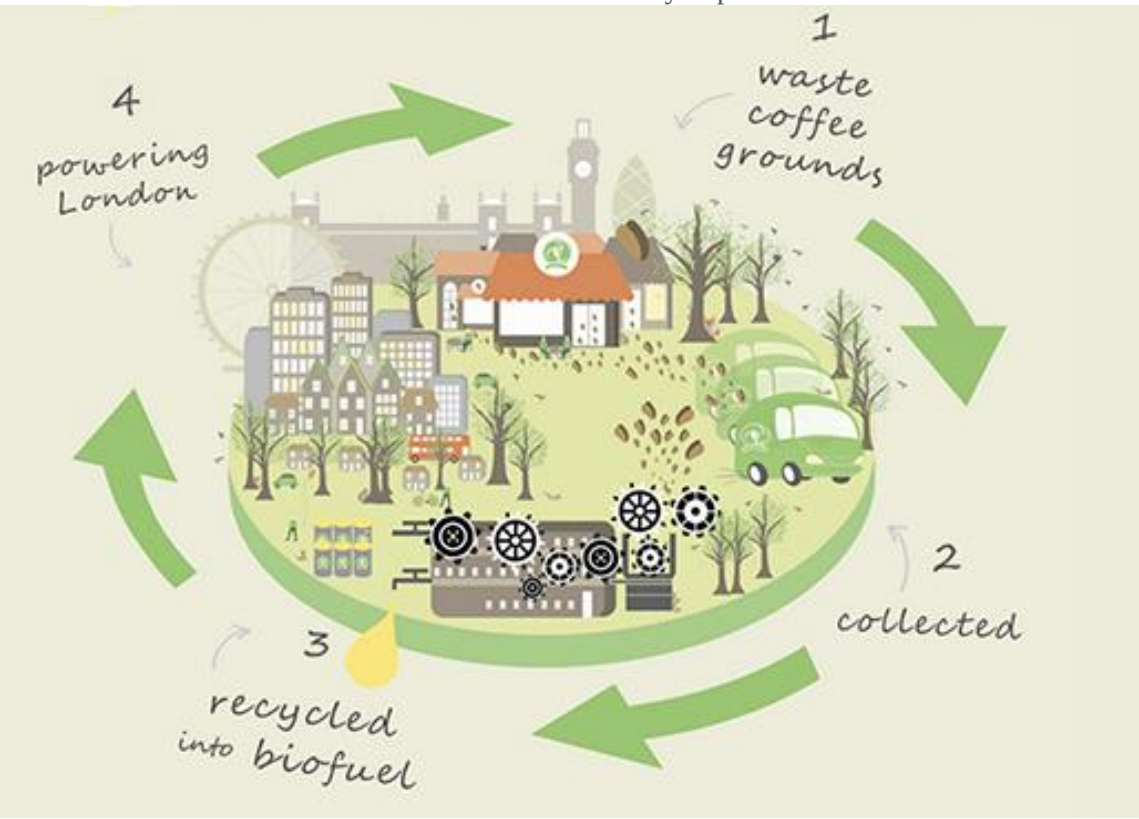
- Waste company SITA CZ, a.s. is a member of the SUEZ supranational group that provides global services for the environment in two main areas: water and waste. A trend in the waste economy is the maximum material utilization of waste materials. One of the commodities with rich and efficient use are bio waste processed by SITA CZ in the composting plants and from which it produces a good source of soil nutrients – compost. Company processes about 50 000 tonnes biologically degradable waste in its composting plants. The resulting products are organic fertilizers and substrates that meet all conditions and directives to use. Produced compost is supplied to the soil active humus, microorganisms for biological recovery soil activities and basic nutrients. (Ministry of the Environment, 2016)

JAN BECHER (KARLOVARSKÁ BECHEROVKA) – **99% of waste recycled**

- Karlovarská Becherovka is the oldest spirits producer in the Czech Republic. It was established in 1807.

- Since its inception in 2010, it has focused on working with renowned companies in the region to help companies develop a waste sorting system to minimize the amount of municipal waste that is no longer usable. Thanks to the constant improvement in waste sorting, this goal has been achieved. Between 2010 and 2014, the share of sorted, recycled and composted waste grew steeply through individual measures and continuous improvement in sorting. While around 45% was landfilled in 2010, only 1% of the total waste produced by the company could not be used in 2014. (Ministry of the Environment, 2016)

Picture 12: Circular Economy in practice



Source: Cofeebi, 2017

7. Conclusion

The decision of the municipality to build a modern civic amenity site, which serves the citizens and especially the environment, cannot be judged from the point of view of correctness and sustainability. From an investment point of view, it would be a bad investment with a long-term return (under changed conditions). In this case, no investor would invest in such a project. After a long conversation with the mayor, it is clear that the village does not have the problem of waste management completely solved. The mayor is aware of the great potential in this field in terms of cost savings and overall improvements in the sorting of waste by citizens. As he says, citizens are getting used to the new civic amenity site and are learning to put aside waste that would otherwise end up in landfills. After construction, citizens asked why the municipality did such an invest, what is the purpose of civic amenity site? For this reason, some additional familiarization of the citizens with waste issues and benefits of the presence of a civic amenity site in the village is certainly worth it.

The most important chapter of the practical part is the calculation of the effectiveness of the construction of the civic amenity site. The investment in the implementation of the project was 1,911,797 CZK from the municipal budget. Based on the effectiveness analysis, the project is defined as a financially non-repayable and irreversible investment. In the case of normal business activity, the project would not be acceptable in any way. The investor is municipality of Herálec and it is therefore necessary to look for the benefits of the projects rather in area of socio-economic for citizens and environmental benefits.

New legislation unequivocally leads to raising of recycling, but there will also be a great relief for municipalities. When the municipality reaches a certain level of recycling, the landfill fee per tonne does not increase. “The recycling discount” will ensure that the municipality that reaches the set standards, gets back the money to keep the amount at 500 CZK per ton.

To motivate people new system must be applied. At present, many towns use barcodes to weight bins and then return money to people. With financial motivation, people immediately see that a change of behaviour is worthwhile. In addition, when people are better sorted, it is certain that landfill will significantly reduce.

The civic amenity site is the only place to legally take and leave everything that you think a waste is (furniture, carpet, car). The civic amenity site is one of the most important institutions that may allow humanity to survive for another millennium without drowning in its own waste. The objective of all civic amenity sites is to increase the recycling of waste and at the same time to reduce the amount of waste deposited in landfills.

It is not the responsibility of each municipality with a population of more than 2,000 to build up a waste collection point. In smaller municipalities, it is up to the mayors (or only one mayor) of several neighboured municipalities to agree to build such a court. When it comes to such a consensus, it is good that the village has an enlightened mayor who looks ahead and thinks of the future.

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9. Appendix

Picture 13: Metals

Source: Own source, 2018

Picture 14: Biological degradable waste, bulky waste

Source: Own source, 2018

Picture 15: Used tires

Source: Own source, 2018

Picture 16: Polystyrene

Source: Own source, 2018