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# Food Waste and Sustainable Food Waste Management in the Baltic Sea Region

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# Food Waste and Sustainable Food Waste Management in the Baltic Sea Region

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# Preface

Today, the amount of food thrown away worldwide, reaches around 1.3 billion tonnes per year. This book presents the findings of an extensive piece of research on the state of the problem of food waste in Belarus, Estonia, Germany, Latvia, Lithuania, Poland and Sweden. The results show that the scale of the problem with regard to food waste varies between each country and is limited by an insufficient number of studies in the area. In all countries except Germany and Sweden, the problem is most prevalent in the area of food waste generated by the manufacturing sector, mostly stemming from unused or inefficient use of by-products. In Germany and Sweden, the main problem is food thrown away by households that is still suitable for human consumption. The values reach 47–65 % and 35 %, respectively. The method to reduce or prevent food waste most often applied across the seven countries is the donation of food. In addition, Germany has initiated a large number of engagement campaigns and activities aimed at reduction of food waste, whereas, Sweden has launched projects only focused on single organisations or institutions. The other reduction and prevention methods are similar to those used for biodegradable waste in the countries included in this study. The results gathered in this study show some potential measures/methods and areas, which may be considered in future work in order to reduce the amount of food waste generated in each of the countries included in the study.

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# Contents

# Abbreviations

| | |
|---|---|
| ABPR | Animal By-Product Regulations |
| AD | Anaerobic digestion |
| BAT | Best Available Technology |
| BMELV | German Federal Ministry of Food Agriculture and Consumer Protection |
| BMW | Biodegradable Municipal Waste |
| BOGOF | Buy one get one free |
| CBI | Centre for the Promotion of Imports from developing countries |
| CEWEP | Confederation of European Waste-to-Energy Plants |
| CHP | Combined Heat and Power |
| Defra | Department for Environment, Food and Rural Affairs |
| EAUC | Environmental Association for Universities and Colleges |
| EC | European Commission |
| ECN | European Compost Network |
| EEA | European Environment Agency |
| EU | European Union |
| EWWR | European Week for Waste Reduction |
| FAO | Food and Agriculture Organization |
| FEBA | European Federation of Food Banks |
| FFV | Fresh Fruits and Vegetables |
| FSC | Food Supply Chain |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gases |
| IEEP | Institute for European Environmental Policy |
| IES | Institute for Environment and Sustainability |
| ISO | International Standard Organisation |
| ISWM | Integrated Solid Waste Management |
| IVC | In-vessel composting |
| JRC | Joint Research Centre, Institute for Environment and Sustainability |
| MBT | Mechanical-Biological Treatment |
| MRL | Maximum Residue Level |

| | |
|---|---|
| MS | Member States |
| MSW | Municipal Solid Waste |
| NSW | New South Wales |
| RDF | Refuse-Derived Fuel |
| RFID | Radio Frequency Identification technology |
| SHR | Swedish Hotel and Restaurant Association |
| TPR | Temporary Price Reduction |
| US EPA | United States Environmental Protection Agency |
| UK | United Kingdom |
| UN | United Nations |
| UNECE | United Nations Economic Commission for Europe |
| US | United States |
| Vito | Vision on Technology |
| WFD | Waste Framework Directive |
| WRAP | Waste and Resources Action Programme |

# Chapter 1
# Introduction

The rapidly changing world also has a great impact on food production and consumption patterns. Attitudes of society towards food has shifted over the years due to rising income per capita, demographic shifts, changing lifestyles, and moral and social values. Technological innovations and competition in the international food market have driven changes in the variety and availability of food products (BIO Intelligence Service et al. 2011). Nevertheless, the issue of food accessibility and affordability still remains as topical today as it did decades ago. Today, globally, 9 million people die of hunger each year, and 800 million are undernourished (BIO Intelligence Service et al. 2011).

At the same time, according to the FAO estimations, approximately 30 % of all food produced for human consumption is lost or wasted throughout the global food supply system (from initial agricultural production to final household consumption). Food waste amounts to approximately 1.3 billion tonnes per year (Gustavsson et al. 2011). Breaking it down into different food categories, globally, roughly 30 % of cereals, 40–50 % of root crops, fruits and vegetables, 20 % of oilseeds, meat and dairy, and 30 % of fish are discarded annually (FAO 2012b). Worldwide, retailers throw away 1.6 million tonnes of food per year (Institution of Mechanical Engineers 2013).

In medium- and high-income countries food is to a significant extent rejected at the consumption stage due to wasteful behaviour by consumers, as a result of an excessive amount of purchased food. In low-income countries food is mostly lost or wasted during the early and middle stages of the food supply chain (e.g. harvesting, transportation) and much less at the consumer level. However, overall, on a per capita basis, much more food is thrown away in the industrialized world than in developing countries (Gustavsson et al. 2011).

Such wasteful behaviour jeopardises not only the current, but also the future state of food security in the world. This becomes evident in the light of the projected 60 % increase in the global demand for food by 2050, effects of climate change, natural resource constraints (e.g. water scarcity), losses in yield and land area as a result of environmental degradation, and competing demands, especially, for the production of biofuels (Nellemann et al. 2009; FAO et al. 2012). Today, 60 % of the world's major ecosystems have already been degraded or are used unsustainably



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(European Commission 2011). The demand for food will also be driven by global population growth: a larger number of wealthier people and required additional resources to produce products for their more varied, high-quality diet (Foresight 2011).

In addition, food which is grown and produced but uneaten has significant environmental and economic costs (FAO 2013). It leads to waste of resources used in production, such as land, water, energy, fertilizers, as well as to unnecessary $CO_2$ emissions, and has a direct and negative impact on the income of both farmers and consumers (Gustavsson et al. 2011; Institution of Mechanical Engineers 2013). At the European level alone, at least 170 million tonnes of $CO_2$eq. (approximately 3 % of total EU-27 emissions in 2008) are emitted annually, along all steps of the life cycle of disposed of food, namely agricultural steps, food processing, transportation, storage, consumption steps and end-of-life impacts (BIO Intelligence Service et al. 2011). Moreover, conservative estimates of water loss caused by discarded food indicate that about half of the water withdrawn for irrigation is lost (World Economic Forum 2009).

The direct economic cost of lost or wasted agricultural products (excluding fish and seafood), based on producer prices only, is approximately EUR 548 billion (USD 750 billion), which is equivalent to the GDP of Switzerland (FAO 2013). US businesses and consumers lose about EUR 145 billion (USD 198 billion) per year because of discarded food (Venkat 2011). In the UK thrown away food which is suitable for human consumption costs EUR 12.4 billion (£10.2 billion) per year (WRAP 2008).

The exact causes of rejected food are significantly dependent on the conditions and local situation experienced by a country (Gustavsson et al. 2011). For instance, in low-income countries, these causes are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems (Gustavsson et al. 2011).

Whereas in medium/high-income countries the causes relate to consumer behaviour (e.g. insufficient purchase planning, confusion of date labels, lack/insufficient knowledge/information), quality standards (e.g. not perfect shape, size, colour or time to ripeness of a food item), legislation, a lack of coordination between different actors in the supply chain that leads to oversupply and overproduction, technical malfunctions and challenges to forecast consumer demand.

Unfortunately, the retail model views food disposal as a necessary part of the business (Gunders 2012).

In the area of food service, the causes of food waste are large portion sizes and undesired accompaniments, inflexibility of chain-store management and pressure to maintain enough food supply to offer extensive menu choices at all times (Gunders 2012).

The available statistics regarding amounts of discarded food in a single county or region is ‘impressive’. USA, Canada, Australia, and New Zealand collectively dispose of 38 % of grain products, 50 % of seafood, 52 % of fruits and vegetables, 22 % of meat, and 20 % of milk (Gunders 2012).

According to FAO, lost or wasted food per capita in Europe and North-America amounts to 280–300 kg per year (Gustavsson et al. 2011). The European studies bring a value of 179 kg per capita that in total comprise 89 million tonnes (BIO Intelligence Service et al. 2011).

In developing countries, 35–50 % of lost or wasted food is caused by inefficiencies in the entire value chain of food products (mainly: harvesting; storage; transportation and processing stages; World Economic Forum 2009).

In Asia, these amount to 10–37 % for cereals and oilseed, and to approximately 50 % for some perishable staples (World Economic Forum 2009).

In the United States approximately 7 % of planted fields are typically not harvested each year (Gunders 2012).

In the EU, the manufacturing sector generates 39 % of the total of food related waste, or approximately 35 million tonnes (BIO Intelligence Service et al. 2011) which is almost the same amount as in the USA—36.3 million tonnes (U.S. EPA 2013).

In the industrialised countries, the amount of food that is discarded by retail, food service and household sectors raise the biggest concern. In 2008, in-store food loss or waste in the United States was estimated to be 19.5 million tonnes: equivalent to 10 % of the total food supply at the retail level. Approximately 4–10 % of food purchased by restaurants becomes kitchen loss, both edible and inedible, before reaching the consumer (Gunders 2012). In the EU-27, the wholesale/retail sector generates close to 8 kg of food loss or waste per capita, representing around 4.4 million tonnes per year. The food service sector generates an average of 25 kg per capita, 12.3 million tonnes overall (BIO Intelligence Service et al. 2011).

At consumer level, the industrialised countries discard about 222 million tonnes, which is almost as high as the total net food production in sub-Saharan Africa (230 million tonnes) (Gustavsson et al. 2011).

A consumer in Europe and North America discards on average between 95 and 115 kg per year, while in sub-Saharan Africa and South/Southeast Asia a consumer will only discard of 6–11 kg per year on average (Gustavsson et al. 2011).

In the United States 40 % of food goes uneaten. Today, the average American consumer wastes up 50 % more food than American consumers in the 1970s. American families throw out approximately 25 % of purchased food (Gunders 2012). The same value is true for consumers in the UK.

In the EU, households produce the largest fraction of food related waste overall, at about 42 % of the total or about 38 million tonnes (BIO Intelligence Service et al. 2011). A detailed country-level study conducted in the UK showed that 61 % or 4.1 million tonnes of food are discarded because it had not been managed well. 46 % of the wasted food is in a fresh, raw or minimally processed state, 27 % having been cooked or prepared in some way and 20 % ready to consume when purchased.

45 thousand tonnes of rice, 33 thousand tonnes of pasta and 105 thousand tonnes of potato are thrown away each year, suggesting people prepare too much. Over one quarter (nearly 1.2 million tonnes per year) of food is discarded in its packaging, either opened or unopened. Annually, 2.9 billion whole and untouched fruit items,

1.9 billion whole vegetables and 1.2 million bakery items are thrown away (WRAP 2008).

The experts claim that only in the EU, the total amount of discarded food expected to rise by 40 % by 2020 (European Parliament Resolution (2011/2175 (INI)) 2012). Addressing the problem, the EU and UN have signed the 'Joint Declaration Against Food Waste', where they commit to reduce the amount of wasted food by 50 % by 2025 (Weber et al. 2011). In addition, the European Parliament designated 2014 as the 'European year against food waste' (Gunders 2012). It is noted that halving the current global amount of discarded food could reduce the food required by 2050 by an amount approximately equal to 25 % of today's production (Foresight 2011).

However, despite a number of studies undertaken which make the case for tackling the problem, actual precise data on food loss and waste generation, avoidance and management and its ultimate fate is scarce, sparse, fragmented, disaggregated and difficult to verify, both on the global and national levels. This indicates the need to conduct additional research in the area.

*The goal* of this book is to investigate and make a thorough review of the state of the problem of food waste in the following countries in the Baltic Sea Region: Belarus; Estonia; Latvia; Lithuania; Poland; Germany and Sweden. It includes an analysis of the following aspects: the amount of food waste generated; its composition; stages in the food supply chain where the biggest quantities are accumulated; causes and applied treatment methods. Finally, the thesis will provide a suggestion of possible measures necessary to be taken in order to reduce the amount of food waste generated, based on the obtained results.

The seven countries mentioned above represent differing economies with differing consumer purchasing power. Therefore, the data on the amount of food waste generated in each country gives a foundation to support or refute a *hypothesis* that there is a strong negative dependence between an amount of household food waste and a share of food expenditures, i.e., consumers who spend a smaller amount on food generated a larger amount of food waste.

## 1.1 Scope

The complexity and, to a lesser extent, the ambiguity of the term 'food waste' makes it difficult to bring the results of many related studies to one common basis, and reduces the possibility for comparison. Confusion around the definition of the term 'food waste', the lack of a harmonized version of the term and the need to establish such a term are also noted in the resolution of the European Parliament (2011/2175(INI)) (European Parliament Resolution (2011/2175(INI)) 2012). In order to define the scope of this work, firstly, it is necessary to build a topology of what today is referred to 'thrown food'. An analysis of available studies and reports has shown that researchers define wasted food by using a number of crossover,

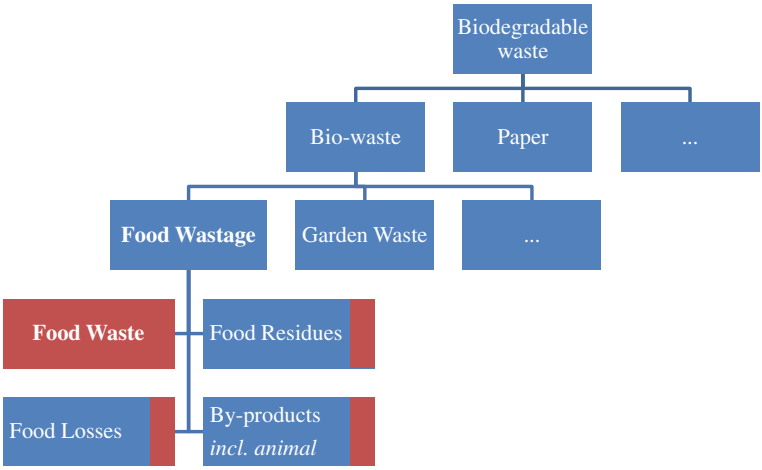


**Fig. 1.1** Biodegradable waste hierarchy

interchangeable or, mutually exclusive terms such as 'food loss/es', 'food waste', 'food wastage', 'food residues', 'bio-waste', 'biodegradable waste' etc.

The topology below (Fig. 1.1) is built based on a foundation in the literature terms and definitions regarding discarded food.

At the top of the hierarchy is biodegradable waste, of which one of the constituents is bio-waste. Bio-waste could be divided into a number of sub-types. One of these is 'food wastage'. The term includes all types of food or food products that have been produced (e.g. grown, manufactured, cooked) for human consumption and then thrown away. 'Food wastage' includes the following types of discarded food:

### *1.1.1 Food Losses*

Food losses are wholesome edible material intended for human consumption that is instead lost as an unintended result of agricultural processes, lack of technology or technical limitations in storage, packaging, and/or marketing, poor infrastructure and logistics, insufficient skills, knowledge and management capacity of supply chain actors (FAO 2012a; Lipinski et al. 2013) or consumed by pests (Foresight 2010; Lin et al. 2013; Pfaltzgra et al. 2013). These take place all along food supply chain (FAO 2012b). Food losses may occur at the production, storage, processing, distribution, retail stages, as well as before, during or after meal preparation (BIO Intelligence Service et al. 2011).

### 1.1.2 Food Residuals

Food residuals are unavoidable inedible and partly avoidable wastes such as skins, bones, stalks, shells and leaves (WRAP 2009; Foresight 2010; BIO Intelligence Service et al. 2011). They also include residues generated in restaurants, pubs, coffee shops and certain food production facilities no longer intended for human consumption (Lin et al. 2013).

### 1.1.3 By-Products, Including Animal By-Products

By-product is a useful and marketable product or service deriving from a manufacturing process that is not the primary product or service being produced (EEA 2013). Food by-products are edible material that generated during food processing and manufacturing, and usually diverted away from the human food chain and fed to animals (Foresight 2010). Animal by-products are "entire bodies or parts of animals or products of animal origin … not intended for human consumption, including ova, embryos and semen" (European Parliament and Council of the European Union Regulation (EC) 1774/2002).

### 1.1.4 Food Waste

Food waste belongs to the category of avoidable waste. Discarded food still has value and is very often fit for consumption (FAO 2012a). Food waste is food that is spilled, spoiled, bruised or wilted. It may include whole or unopened packets or individual items of food which are not eaten at all (WRAP 2008). Food waste arises at any point in the food supply chain (Foresight 2010) as a result of inappropriate behaviour of food chain actors (e.g. producers, retailers, the food service sector, consumers) (FAO 2012b) as well as resulting from a lack of existing preventative technologies. A share of each of the aforementioned food wastage sub-types could be avoided by applying latest available instruments, therefore, until then, it might be considered as food waste.

Based on the analysis presented above and the hierarchy which exists, the current work will center on the 'food waste' sub-type.

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# Chapter 2
# Literature Review

Every year 11.2 billion tonnes of solid waste are collected worldwide (UNEP 2011). In upcoming years the amount of accumulated waste will continue to increase together with growing population, an urbanization rate, overall economic and GDP/GNI per capita growth, an increase in production and consumption, and changes in a consumption pattern. Furthermore, the latest World Bank report predicts that annual global solid waste management costs will increase from USD 205.4 billion to about USD 375.5 billion by 2025 (Hoornweg and Bhada-Tata 2012). However, there is a positive aspect to this waste—its huge economic potential. Today the world waste market, from collection to recycling, is estimated at USD 410 billion a year, not including the sizable informal segment in developing countries (UNEP 2011).

According to the Eurostat data, the European Union alone generates about 3 billion tonnes of waste annually, and due to the OECD projections by 2020, this amount will increase by 45 % in comparison to 1995 (European Commission 2013b). Such a quantity of waste and its complexity not only have a significant adverse environmental impact, causing pollution, greenhouse gas emissions, and posing threats to human health, but also wastes a huge amount of material and energy resources (European Commission 2010; EEA 2013b).

Highly dependent on imported raw materials, Europe, in its long-term goals and strategies strives to reduce the amount of waste generated by improving its resource efficiency through recycling, avoiding waste and using unavoidable waste as a resource wherever it possible (European Commission 2010).

Waste prevention has been identified as one of the top priorities in the EU's Sixth Environment Action Programme (European Commission 2013b) as well as in the proposal of the European Commission for the 7th Environment Action Programme and the Roadmap to a resource efficient Europe (EEA 2013a).

The European Union's approach to waste management is based on the following principles:

- Waste prevention, which is closely linked with improving manufacturing methods and influencing consumers to demand greener products and less packaging.



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- Recycling and reuse as an alternative to waste prevention in cases when it is not possible.
- Improvement of final disposal and monitoring as the last option, where waste is safely incinerated or landfilled (European Commission 2013b).

## 2.1 Legislation

These principles are reflected in the European framework of waste legislation. The framework includes a variety of requirements and technical standards for waste management in general (for all waste streams), for specific waste streams (e.g. packaging waste) and for specific waste treatment modes such as landfill and waste incineration (Neubauer 2007; EAUC 2013). All of these standards are implemented through a large number of EU Directives and Regulations, the cornerstone of which is the EU Waste Framework Directive considered as the "basic law" of the EU Waste Policy. The Directive dates from 1975 and was re-edited in 2006 (Neubauer 2007) as a result of the 2005 Thematic Strategy on Waste Prevention and Recycling (European Commission 2010).

The Thematic Strategy on the Prevention and Recycling of Waste (COM (2005) 666) adopted in 2005 (Commission of the European Communities Communication COM (2005) 666 2005) became a main driver for reforming out-dated principles and requirements of the EU waste legislation and bringing a new approach which is dictated by the realities of the world today. The Strategy defines the long term goal of switching the EU to a recycling society that seeks to avoid waste and uses waste as a resource. It promotes prevention, recycling and re-use measures as well as an application of a life-cycle orientated approach to waste management. It sets minimum EU standards for recycling activities and a framework for specific national policies. Moreover, the document recommends an improvement of the knowledge base on the impact of resource use, waste generation and management (Commission of the European Communities Communication COM (2005) 666 2005).

According to the Strategy, the Revised Waste Framework Directive (2008/98/EC) (2008) sees waste as a valued resource by strengthening its economic value and sets out targets for EU Member States to recycle 50 % of their municipal waste by 2020 (European Commission 2010). The countries are also required to introduce legislation on waste collection, reuse, recycling and disposal (European Commission 2013b). In addition to the definition of key concepts related to waste management, the document clarifies the difference between waste and by-products, sets criteria and conditions for situations when waste ceases to be waste and focuses on reducing the environmental impacts of waste generation. The Directive extends producer responsibilities and requires that the Member States establish waste management plans as well as waste prevention programs (Directive 2008/98/EC 2008).

However, based on the review of the progress towards achieving the Strategy's objectives, experts have stated that despite an improvement of legislation, increased

recycling rates, a reduction of the amount of waste going to landfill and of the relative environmental impacts per ton of waste treated, after 5 years, the Strategy's main objectives still remain valid (European Commission Report COM (2011) 13 2011).

Another important directive that sets out the main requirements for waste disposal is the EU Landfill Directive (1999/31/EC) (Council Directive 1999/31/EC 1999). It is necessary to stress that by defining the term 'waste' the directive refers to the Council Directive on waste (75/442/EC) from 1975 (Council Directive 75/442/EEC 1975). The document includes a definition of waste types with no reference to the waste list adopted in Commission Decision 2000/532/EC (2000) (Commision Decision 2000/532/EC 2000), which could result in collisions, confusions, and a necessary revision of the Directive.

The Directive sets maximum capacities for landfill sites and defines targets for the reduction of biodegradable municipal waste (BMW) going to landfills. It also bans certain waste streams from being put into landfill sites. The document requires the member states to set up a national strategy for operations aimed at the reduction of BMW, such as recycling, composting, recovery and biogas production. It contains requirements for opening and maintaining a landfill during its operational and after-care phases (Council Directive 1999/31/EC 1999).

However, the results of the assessment of achievements in this area show that in 2010 despite significant successes in increasing material recycling the majority of the European countries still send more than half of their municipal waste to landfill (EEA 2013a).

The next significant document is the Directive (94/62/EC as amended by 2004/12/EC 2004) on packaging and packaging waste (European Parliament and Council Directive 94/62/EC 1994; Directive 2004/12/EC 2004), which takes precedence over the Waste Framework Directive where packaging and packaging waste are concerned (Arcadis et al. 2010). The document clarifies the definition of the term 'waste', by introducing a number of additional criteria and defines such operations as 'recovery', 'recycling', 'energy recovery', 'organic recycling' and 'disposal'. It also obliges the member states to set up return, collection and energy recovery systems, and to encourage the use of materials obtained from recycled packaging waste. A reduction of the overall volume of packaging is stated as the best means of preventing the creation of packaging waste. The document discusses a necessity of a harmonized reporting technique and clear guidelines for data provision. It also requires implementation of preventive measures with an emphasis on the minimization of environmental impact (Directive 2004/12/EC 2004).

## 2.2 Waste Management Hierarchy

Looking at food waste historically, The early 1970s could be considered as a turning point for waste management in Europe. The 1972 Report to the Club of Rome and the oil crisis in 1973 drew attention to an issue of the scarcity of raw materials. These events induced the change in societys' perception of the term

'waste', methods of waste handling and necessary transitions in waste management (Kemp and van Lente 2011). In 1979, a Dutch politician Ad Lansink developed a priority list for the various waste management methods, which became known as 'Lansink's Ladder' and became official policy in 1981 (Raven 2007). At the top of the Ladder is 'prevention of waste', followed by 're-use (of products)', 'recycling (of materials)', 'incineration (with energy-production)' and 'landfilling' as the last option (Kemp and van Lente 2011).

Today's waste prevention framework, which uses the 'Lansink's Ladder' as a prototype, is widely used in various waste related areas such as legislation and numerous projects, initiatives and strategies. The current framework is a five-step hierarchy of waste management and waste treatment options ordered according to what is best for the environment (UK Department of Energy and Climate Change and Defra 2011). It is a set of rules for waste management planning, qualified waste collection and treatment (Neubauer 2007). Such a framework is helpful for understanding how management approaches can be used to influence materials as they flow through the material life cycle (U.S. EPA 2009). However, in each particular case the hierarchy passes through "modifications". Having waste prevention as a final goal, different expert groups and institutions adjust the waste hierarchy by extending or narrowing the content of its stages.

In the US it is implemented by the U.S. Environmental Protection Agency (EPA). The EPA works under the Resource Conservation and Recovery Act, primary law, which governs the disposal of solid and hazardous waste in the country. Under this law the EPA encourages practices that reduce the amount of waste needing to be disposed of, such as waste prevention, recycling, and composting (U.S. EPA 2013b). The agency has ranked the most environmentally preferable options for waste management from 'source reduction' (including reuse) to 'treatment and disposal', with 'recycling', 'composting' and 'energy recovery' between (Fig. 2.1) (U.S. EPA 2012b).

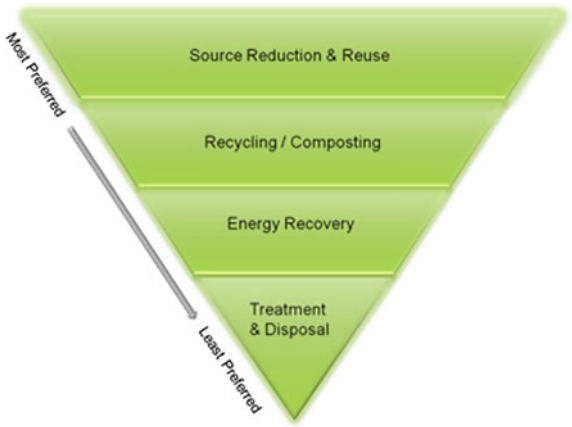


**Fig. 2.1** Waste Management Hierarchy (U.S. EPA 2012b)