PROCESSING & SORTING OF PACKAGING WASTE

APPLICATION OBJECTIVE
Processing the separately collected packaging waste from households and commercial sources to generate unpolluted recyclable fractions of metals, plastics and composite materials and other marketable material streams.

OUTLINE ON APPLICATION FRAMEWORK

PARTICULARLY APPLICABLE FOR WASTE TYPES

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Glass</th>
<th>Light-weight packaging</th>
<th>Mixed household waste</th>
<th>Biowaste</th>
<th>Biodegradable waste</th>
<th>Bulky waste</th>
<th>Electrical and electronic waste</th>
<th>C&amp;D waste</th>
<th>Waste wood</th>
<th>Old paint &amp; lacquer</th>
<th>Waste tyres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper / paperboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrap metal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch specific waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other waste material</td>
<td>x2</td>
<td>Small-sized waste items of similar composition/material like packaging (e.g. toys)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SPECIAL CHARACTERISTICS AND REQUIREMENTS OF THE APPLICATION

Pre-treatment of the input material:
No particular requirements of pre-treatment as long as the separate collection of the packaging waste or of the dry waste components at source is ensured.

Options for the utilisation of the generated output:
Part of the different fractions of recyclable material obtained in the sorting can be directly used for recycling (e.g. metals, cardboard). Especially plastic components may require further treatment and refining steps before they are suited for material recycling. Also their energetic use is possible and can have advantages.

Options for the disposal of process output and/or residues:
Sorting residues must be properly disposed of. Those with a high calorific value usually suit for producing a refuse derived fuel material which can be co-incinerated in industrial processes (see fact sheet on “industrial co-incineration”). If not possible an incineration with energy recovery (see fact sheets on “Grate combustion” and “Fluidized bed incineration”) should be considered, the inert fraction can be deposited at landfills.

Protective needs:
Of particular importance is protection from fire and the operational safety resp. accident prevention at installations with driven equipment (forklift), moving parts (conveyor belts) and loads (baled recyclables).

Potential health risks:
During sorting operations higher levels of exposure to infectious germs, spores and contaminations can occur in the direct working environment. Precautionary and protective measures such as aeration and ventilation, wearing of protective equipment and breathing masks need to be implemented to reduce the health risks for the workforce and closer surroundings.

RESTRICTIONS OR INFLUENCE OF EXTERNALITIES ON THE APPLICATION

Infrastructural conditions:
Installations must be well accessible and possess of good connections to main transport lines resp. routes.

Climatic conditions:
Sorting facilities have to be protected from weather effects which means that especially storage and operating areas shall be sheltered from the influence of wind and rainfall.

1 source separated dry fraction of the household waste only

2 the source-separate collection of mixed packaging material may be combined with that for small-sized waste of similar nature (system of commingled collection of mainly plastic, metals and wood known in Germany as the “bin for recyclables” respectively “Wertstofftonne”-concept (www.wertstofftonne-berlin.de). Pilot tests have confirmed this option and the possibility of a subsequent separation and processing of the different fractions.
**Employment potentials:**
The sorting of packaging waste in many cases can be manually performed. This opens up good employment opportunities whereby it is also possible to employ personnel with lower levels of education and technical qualification.

**Others:**
The process can be economically viable where a high output quality is obtained and good markets exist for it. Otherwise re-financing mechanisms such as packaging fees or licensing schemes similar to the Green-dot system which is used by many European countries may have to be implemented (see the concept of „Der Grüne Punkt“/The „Green Dot“-trademark)

### TECHNICAL DETAILS

#### GENERAL OVERVIEW

**ABSTRACT**
The process generally comprises a mechanical processing with a varying degree of automation in order to make the different materials accessible to subsequent sorting operations and to separate the input into its recyclable material fractions. Basis is the purposeful arrangement of various, consecutive steps of comminution, screening and classifying by more or less sophisticated technical means and equipment. This may also include manual sorting operations.

**BASIC REQUIREMENTS**
- The input must be separately collected packaging not commingled with moist materials from commercial and household waste or the source separated dry fraction from the household waste

**EXPECTED RESULTS**
- marketable fractions of recyclable material of a defined quality
- (partly) automated separation of different polymers PE, PP, PET and PS for further processing
- optional: ready for use plastics granule obtained where sorting is directly combined with a finishing process

**SPECIFIC ADVANTAGES**
Are differently assessed depending on the employed process scheme and plant configuration

- **Basic configuration**
  - simple techniques, thus relatively moderate capital costs
  - very reliable, i.e. little failure prone (95% effectively available)
  - rather flexible and easily adjustable to market developments

- **Advanced configuration**
  - higher throughput as compared to basic configuration
  - more effective separation
  - slightly reduced personnel demands
  - relatively flexible

**SPECIFIC DISADVANTAGES**
Are differently assessed depending on the employed process scheme and plant configuration.

- **Basic configuration**
  - labour demanding (higher personnel needs)
  - comparatively low throughput

- **Advanced configuration**
  - more energy consuming and capital intensive
  - higher qualification needs of the personnel
  - more difficult to adjust

#### APPLICATION DETAILS

**TECHNICAL SCHEME**
In the *basic configuration*, the process consists of a mechanical processing aimed at the removal of fine materials thru screening and the separation of metal components followed by a manual sorting of the different materials. Usually an arrangement according to the following scheme applies:
Figure 1: Example of the technical arrangement to sort packaging waste in a basic configuration into various material fractions including several fractions of plastics

Figure 2: Example of a sorting installation in the basic configuration

In the **advanced configuration** the process flow is similar to that of the basic configuration although more sophisticated means such as an automated sorting stage using near infrared technology and various additional separation devices (for Fe-metals, non-ferrous metals, light materials) are involved. It should be remarked that number, positioning and sequence of the individual component therein can be varied and do not follow uniform patterns. The technical arrangement commonly found in an advanced configuration can be seen in a process scheme below.
Figure 3: Example of the technical arrangement to sort packaging waste by advanced means into various material fractions including several fractions of plastics.

Process of plastics finishing:
Subsequent to the sorting of the packaging into fractions of different material a refinement (finishing) of the plastics sorted out must be performed. This step is required to obtain the ground stocks and plastic regranulates of defined quality which can eventually be reintroduced (recycled) into production. For part of the material the use as secondary raw material in production is possible at a general scale, e.g. plastic granule, aluminium, paper fibres. Some material is processed to give the feedstock in very material or product-specific recycling loops such as the case for mixed plastics or beverage container. A simplified scheme for an example of a closed loop process is the one shown in Figure 4 where pre-sorted PET bottles are processed to recycling flakes and these are used for producing PET bottles again.

Figure 4: Recycling process of the company KRONES (modified drawing from KRONES AG, www.krones.de)

---

### Quantity Aspects

- **Basic configuration**
  - the throughput rate usually ranges at around 1 Mg per hour
- **Advanced configuration**
  - the throughput rate usually ranges between approx. 3-20 Mg per hour

The following is a mass balance of a processing facility for source-separated recyclables in Iserlohn\(^\text{a}\). Obtained from an annual input of 72,000 Mg are the following material fractions:

- **Recyclable output:**
  - Ferrous metal: 8,000 Mg, Non-ferrous metal 2,200 Mg
  - PE: 2,500 Mg, PP 5,000 Mg, PS 1,800 Mg, PET 1,400 Mg
  - Foils 4,800 Mg
  - Beverage carton: 5,000 Mg
  - Card-/paperboard: 1,800 Mg

- **Output for energetical use:**
  - Mixed plastics (high-calorific value): 19,000 Mg
  - RDF feedstock (medium-calorific value): 17,400 Mg
  - Sorting residues (low-calorific value): 2,900 Mg

### Scale of Application

- Installations of the basic configuration can be small, are sometimes operated only temporarily and for different material streams whereas plants of an advanced configuration are especially set up in areas with an intensified separate collection of packaging waste, usually these facilities are of large size and operated in shifts

### Interoperability

Where sorting operations are simple and focus on a few material fractions only there is the possibility to integrate the processing as a preceding step to the actual recycling operations in a production facility itself. Where the material streams and processing are complex and involve a higher degree of automation separately erected, specialized plants often give the better solution.

### Operational Benchmarks: Resource Consumption

**Energy Balance**

- Operations in the basic configuration have a comparatively low energy demand.
- The energy demand in the advanced configuration rises with the number and kind of additionally installed technical devices

**CO\(_2\)-Balance**

- Recycling of packaging material reduces the need to consume primary resources for production and results in savings of energy and emissions the use of these primary resources would otherwise require. On the example of the reference plant with a throughput of 72,000 Mg/year in Iserlohn annual GHG emission savings equivalent to approx. 55,000 Mg CO\(_2\) have been calculated. 70% of these savings result from replaced raw materials whilst 30% are derived from the energetic use of mixed plastics and RDF in substitution of conventional fuel.

**AIDS/Additives Needed**

- No auxiliary components/material needed in sorting
- Water consumption and chemical additives become relevant in the finishing process with integrated wet-mechanical steps

**Human Resources**

- **Basic configuration**
  - about 12 persons in average
- **Advanced configuration**
  - between about 7-30 persons

**Spatial Needs**

- Surface area of about 5,000 m\(^2\) to 10,000 m\(^2\) for a plant of average size

---

### Waste treatment and material processing

**Sorting of packaging waste**

#### AFTERCARE DEMANDS

Impurities and residues which can make up about 40–55% of the input stream are mostly waste that requires final disposal, the nature and combustible properties of most of these residues render incineration as the preferential option.

#### OPERATIONAL BENCHMARKS: COST DIMENSIONS

**INVESTMENT COSTS**

- **Basic configuration**
  - the net capital need without building and other auxiliary structures can be estimated in the range of EUR 50,000–150,000 Euro for an average processing line

- **Advanced configuration**
  - depending on the use of, for example, opto-electronic and other sensor based separation units a net investment up to EUR 13 million or above must be calculated for an average processing line

**OPERATING COSTS**

Vary considerably in dependence from the configuration and techniques employed.

- indicative in the range between 150–650 EUR/Mg; including
  - the costs for the disposal of process residues (at German price level) and
  - the expenses for repair and maintenance which are assessed with about 6% of the initial investment per annum

**POSSIBLE PROCEEDS**

Sorted fractions are marketable and fetch different prices depending on the quality and actual situation at the market. An example of prices paid in the market is the following for various types of plastic material:

<table>
<thead>
<tr>
<th>Kind of plastic material</th>
<th>July 2015 [EUR per Mg]</th>
<th>July 2014 [EUR per Mg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE regrind</td>
<td>620</td>
<td>620</td>
</tr>
<tr>
<td>HDPE granule</td>
<td>920</td>
<td>920</td>
</tr>
<tr>
<td>PP baled</td>
<td>260</td>
<td>290</td>
</tr>
<tr>
<td>PP regrind</td>
<td>590</td>
<td>550</td>
</tr>
<tr>
<td>PET regrind coloured</td>
<td>420</td>
<td>410</td>
</tr>
</tbody>
</table>

Special financial mechanisms can be installed to compensate the costs for packaging processing and recycling, an example for that is the Green-dot licensing scheme in Germany ([www.gruener-punkt.de](http://www.gruener-punkt.de))

**MASS SPECIFIC OVERALL COSTS**

n.a.

### MISCELLANEOUS

### MARKET INFORMATION

**REFERENCE FACILITIES**

Applications of above outlined plant configurations and techniques can be found in a number of European countries and elsewhere in the world. Examples of the above arrangements in Germany are:

- WAA Iserlohn  [www.lobbe.de](http://www.lobbe.de)
- Sorting plant Leipzig  [www.alba.info](http://www.alba.info)

Further plants of this type are listed in a database of the Federal State of Brandenburg.

**Plastics finishing/ Flake production**

- Krones AG  [www.krones.com](http://www.krones.com)
- Multipet GmbH Bernburg  [www.mp-bbg.eu](http://www.mp-bbg.eu)
- Systec Plastics  [www.systalen.de](http://www.systalen.de)

Many of the large and medium waste management providers undertake the processing of light waste packaging using different kinds of plant configurations. Companies belonging to this group are for example:

- SUEZ Deutschland (Suez Group)  [www.suez-deutschland.de](http://www.suez-deutschland.de)
- Remondis  [www.remondis.de](http://www.remondis.de)
- Alba-Gruppe  [www.alba.info](http://www.alba.info)
The aggregates and equipment used for the process belong to the pool of technical equipment which is generally available and in use for mechanical operations in the waste management sector. In particular these are:

### Conveyor/dosing installations:
- Ludden & Mennekes, Meppen [www.ludden.de](http://www.ludden.de)
- Spezialmaschinen & Recylingtechnik, Chemnitz [www sr-recyclingtechnik.com](http://www sr-recyclingtechnik.com)

### Sack opener:
- Matthiessen Lagertechnik GmbH, Krempe [www.bagsplitter.com](http://www.bagsplitter.com)

### Separators/Classifier and screening equipment:
- Mogensen GmbH & Co. KG, Wedel [www.mogensen.de](http://www.mogensen.de)
- EuRec Technology GmbH, Merkers [www.eurec-technology.com](http://www.eurec-technology.com)
- Spaleck – Förder- und Separiertechnik [www.spaleck.de](http://www.spaleck.de)

### Metal separator (Fe and Non-Fe):
- Steinert Elektromagnetbau GmbH, Köln [www.steinertglobal.com](http://www.steinertglobal.com)
- IMRO Maschinenbau GmbH, Uffenheim [www.imro-maschinenbau.de](http://www.imro-maschinenbau.de)
- Wagner Magnete GmbH & Co. KG, Heimertingen [www.wagner-magnete.de](http://www.wagner-magnete.de)

### Baler/presses:
- HSM GmbH + Co. KG, Salem [www.hsm.eu](http://www.hsm.eu)
- Bomatic – Umwelt- und Verfahrenstechnik GmbH, Hamburg [www.bomatic.de](http://www.bomatic.de)
- Erdwich Zerkleinerungs-Systeme GmbH, Kaufering [www.erdwich.de](http://www.erdwich.de)
- MeWa Recycling Maschinen und Anlagenbau GmbH, Gechingen [www.mewa-recycling.de](http://www.mewa-recycling.de)

### Sensors/Detector systems:
- Tomra Systems GmbH [www.tomra.de](http://www.tomra.de)
- Sesotec GmbH [www.sesotec.com](http://www.sesotec.com)

### ADDITIONAL REMARKS AND REFERENCE DOCUMENTS

Further detailed information on the processing of packaging and packaging recovery system with links to relevant firms in Germany are available from:
- Bundesverband Sekundärrohstoffe und Entsorgung: [www.bvse.de](http://www.bvse.de)
- Website der dualen Systeme: [www.recycling-fuer-deutschland.de](http://www.recycling-fuer-deutschland.de)
- Fachverband Kunststoffrecycling: [www.kunststoff-verwertung.de](http://www.kunststoff-verwertung.de)
- Industrievereinigung Kunststoffverpackungen e.V.: [www.kunststoffverpackungen.de](http://www.kunststoffverpackungen.de)