Training course MBT and project calculation

Mechanical and Biological Treatment (MBT) of Municipal Solid Waste (MSW)

Part 2 **MB** - **T**echnology

Kosice 02.10.2017 – 05.10.2017

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Background of MBT Technology

- The technical idea of mechanical biological waste treatment is to use the organic content to mineralize and/or dry the waste based on an exothermic aerobic degradation. The following MBT applications has been created:

Type	aim	Landfill flow	RDF flow	Recycling flow
A	reducing CH_4 potential	X		
B	reducing CH_4 potential + energy recovery	X	X	
C	Energy recovery + mass loss		X	
D	Energy recovery + mass loss + Recovery of recyclables	(X)	X	X
E	reducing CH_4 potential + energy recovery + recovery of recyclables	(X)	X	X

Background of MBT Technology

Type	name
A	Composting, landfill disposal
B	Composting + RDF production
C	Drying and RDF utilization
D	Composting + RDF + Recycling
E	Type B or D + Biogas production

Access to the organic potential in MSW

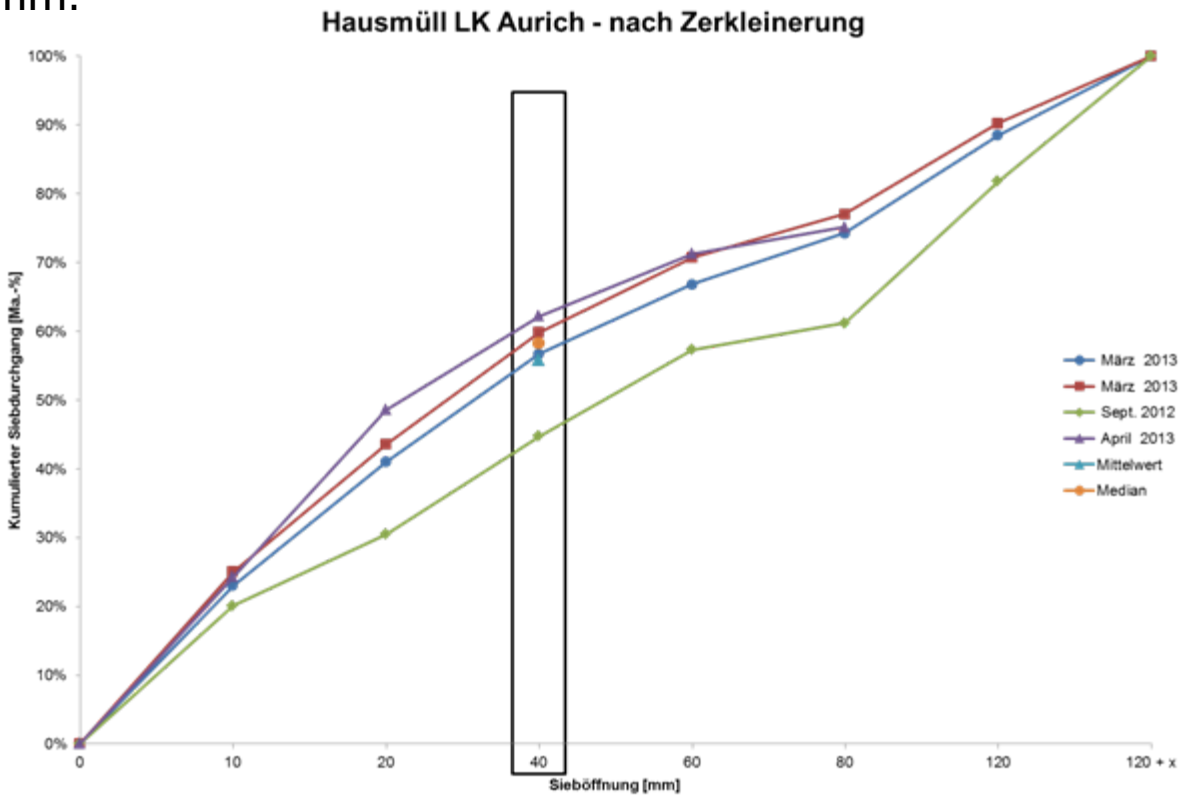
- Most of the organics in MSW concentrates in a fine fraction < 60 mm
- Most of the moisture is bound to organic components and other fine particles due to their large surfaces and moist matrix
- Bags used in households for the kitchen waste collection must be opened to achieve access to the organic ingredients
- Most MBT processes start with the two main processes:

  - shredding in order to open small bags and to reduce the maximum particle size to about 300 mm

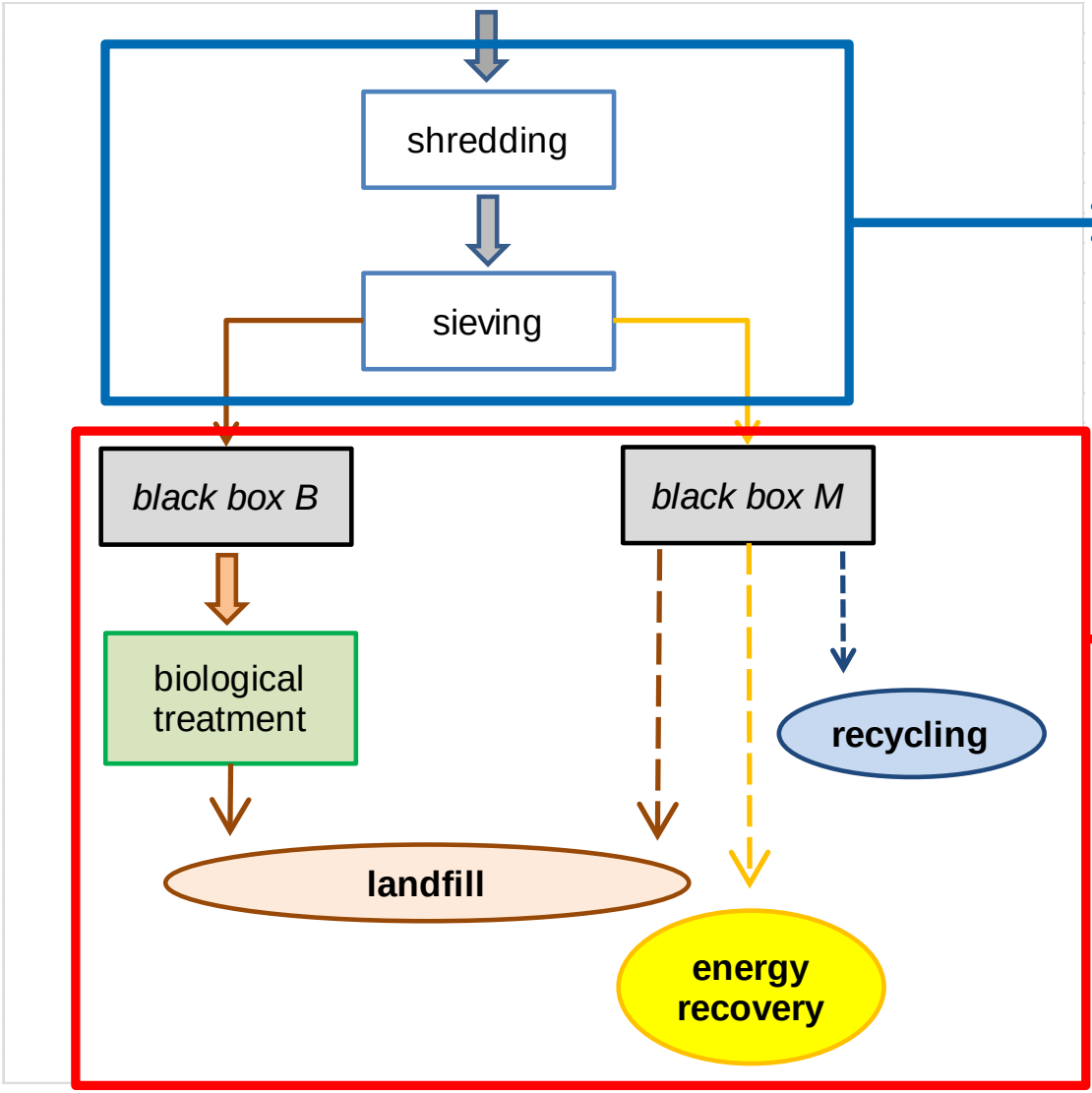
  - sieving to separate the organic content as a fine fraction < 60 mm (depending on the biological treatment process the separation size is chosen between 40 and 80 mm)

Access to the organic potential in MSW

- Particle size distribution of MSW after a pre-shredding process. The following sieving is done with a sieve cut of 40 mm and separates, depending on sieving efficiency and waste composition, about 50 % fines < 40 mm.



Basic MBT flow sheet



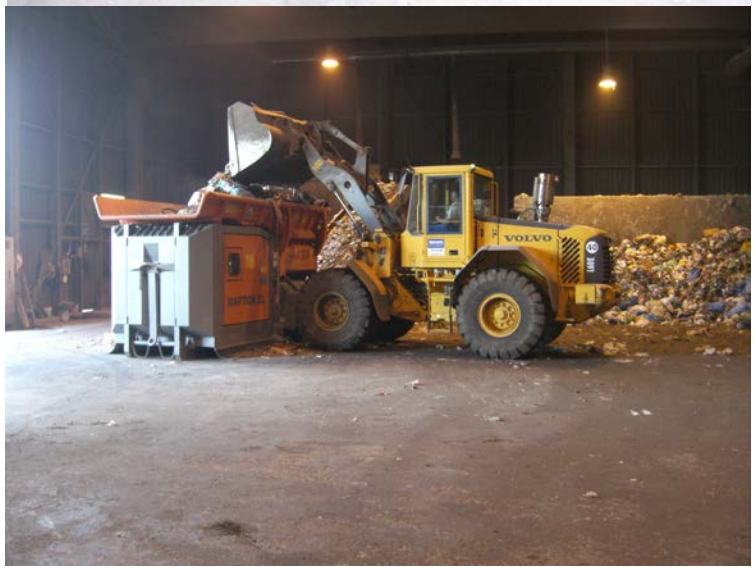
Basic mechanical pre-treatment of MSW

Specific technical application depending on local waste management strategy

Flexible Design!

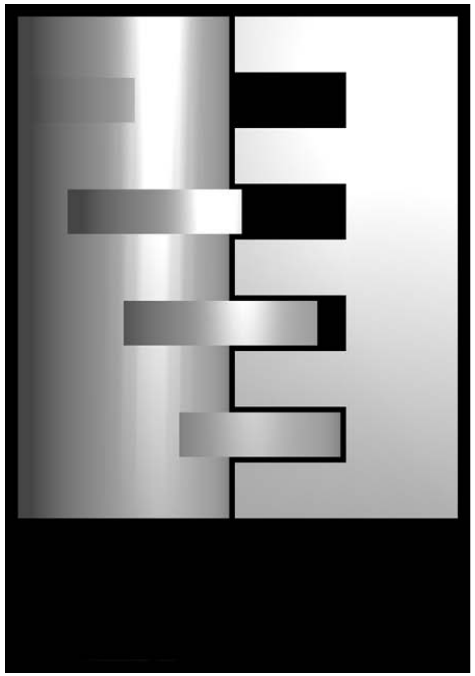
Basic mechanical pretreatment

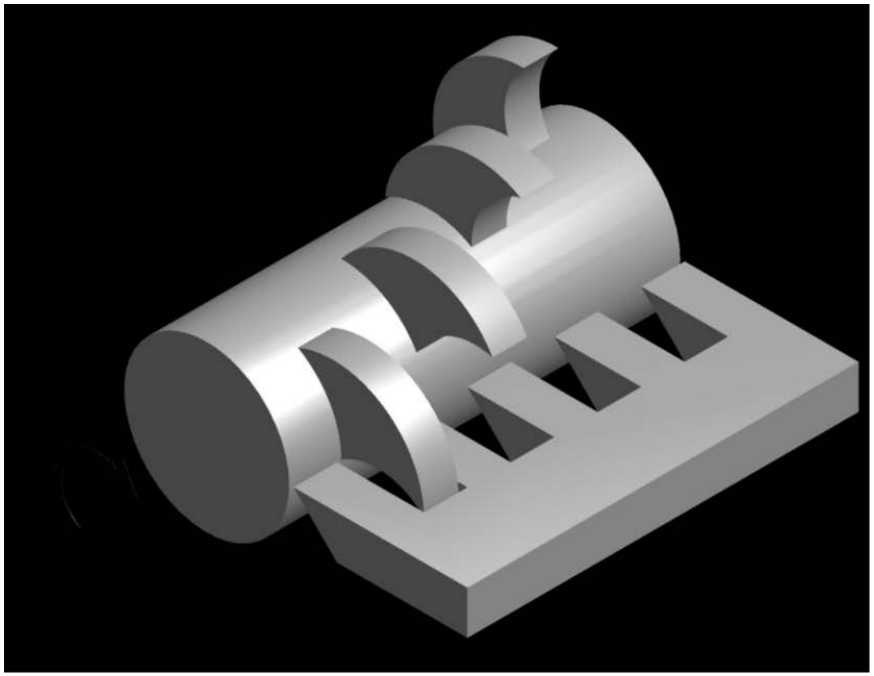
- Reception hall, temporary storage area, feeding site



Basic mechanical treatment

- Shredders to reduce particle size to d_{95} < 300 mm; Capacity 20 – 60 t/h for feedstock with bulk density ~ 300 kg/m³
- Mobile, semi-mobile and fixed types available
- Tearing stress with blade clearance in cm, not 0.1 mm like cutting systems!, shaft Ø 600 – 800 mm, 1 – 5 m/s circumferential velocity





Basic mechanical treatment

video

Video not for dedicate souls

Basic mechanical treatment

- Drum screen or specific waste screen, openings possible between 300 and 40 mm

video

Basic mechanical treatment

- Drum screen or specific waste screen, openings possible between 300 and 40 mm

Basic mechanical treatment

- Drum screen or specific waste screen, openings possible between 300 and 40 mm

video

MBT type A 1

- After biological treatment the whole residual mass is landfilled.
- Biological treatment processes are:

  - **open pile composting**, active aeration not obligatory; process time 18 – 26 weeks, depending on local climatic conditions!

MBT type A 1 - open pile composting

Left: Pile composting of mixed shredded MSW

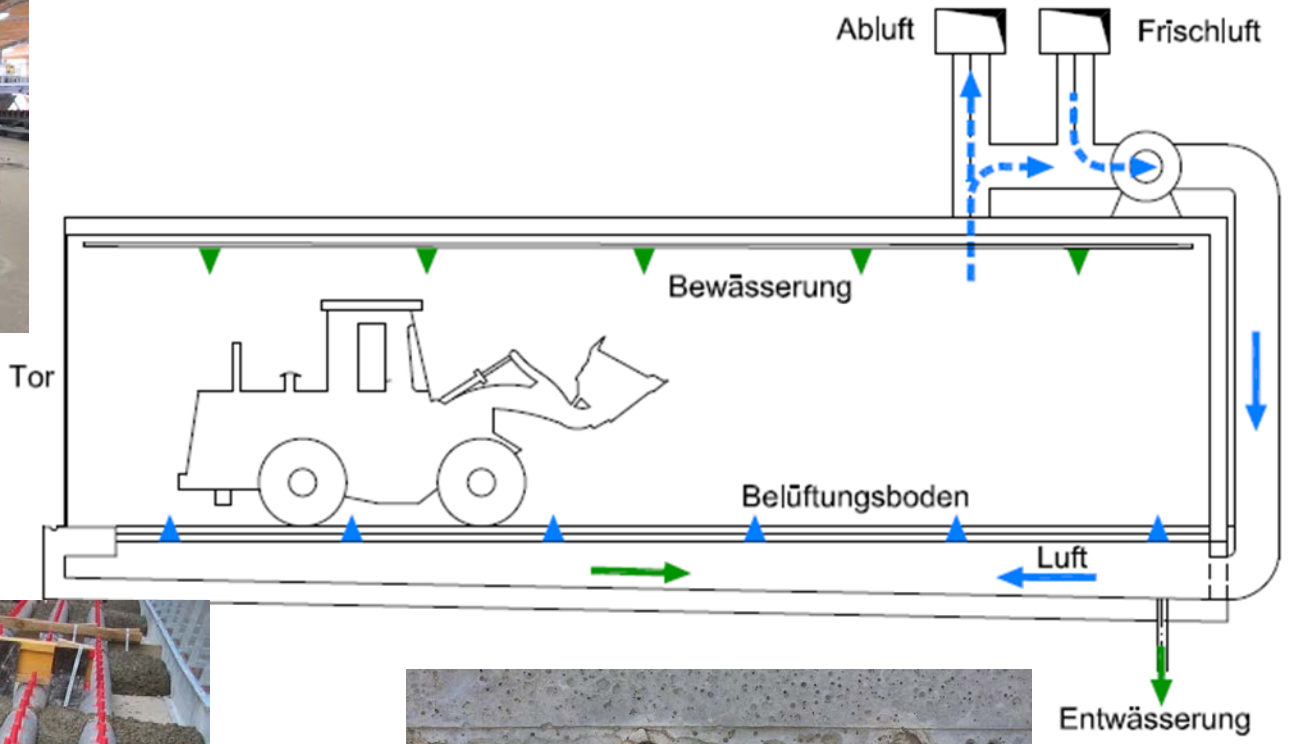
Right: landfill product < 60 mm after sieving

MBT type A 2 (Windrow or heap systems)

- covered and fully encapsulated composting system, process time 6 – 12 weeks, depending on legal quality demand for landfilled waste!

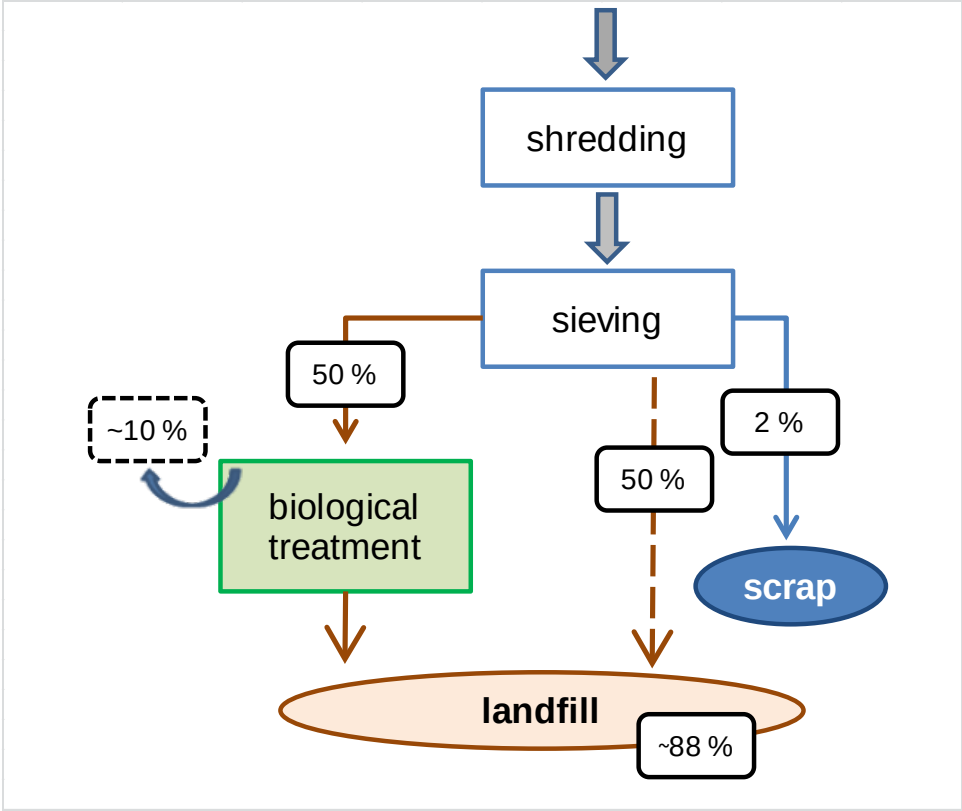
MBT type A 2 (tunnel systems)

MBT type A 2 (tunnel systems)



MBT type A

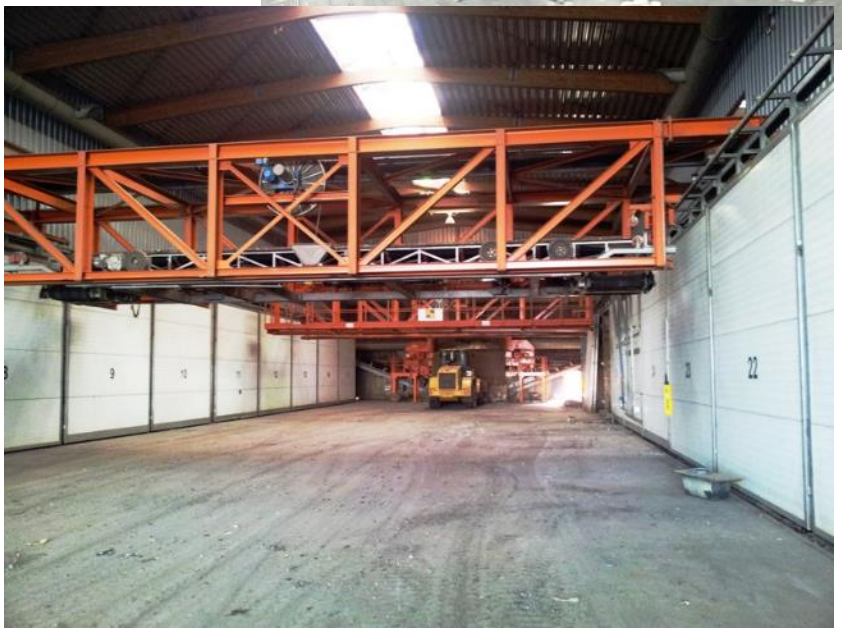
- Limited mass losses of about 20 % of the input in the biological process, limited quality of biological treated waste.
- Low savings in landfill capacity.
- Simple composting system (A 1) only for small sized plants, suitable climatic conditions and low level legal quality demands (50.000 t/y)
- For a 100,000 t capacity a closed composting system is recommended (A 2)



MBT type B

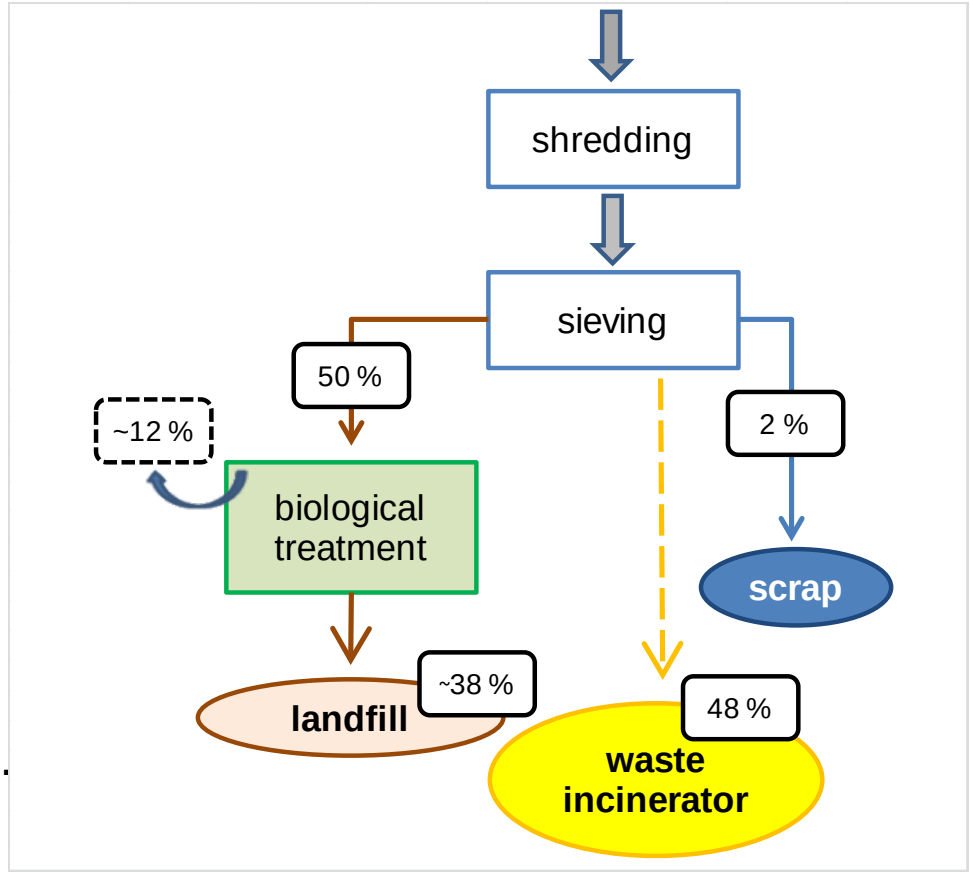
- Only the biological treated mass flow is landfilled while the residual waste (sieve overflow) is used for energy recovery in an incinerator.
- Biological treatment processes like shown before, here a tunnel system with automatic feeding and wheel loader emptying.

MBT type B



MBT type B

- optimized mass losses of about 24 % of the input in the biological process, quality of biological treated waste following German landfill regulation demands.
- Two phase composting system 2* 21 days
- Sieve overflow is treated in a waste incinerator.
- Total plant capacity 50,000 t/y, BT capacity 25,000 t/y
- RTO exhaust air treatment with natural gas demand creates add. costs of **10 €/t**.

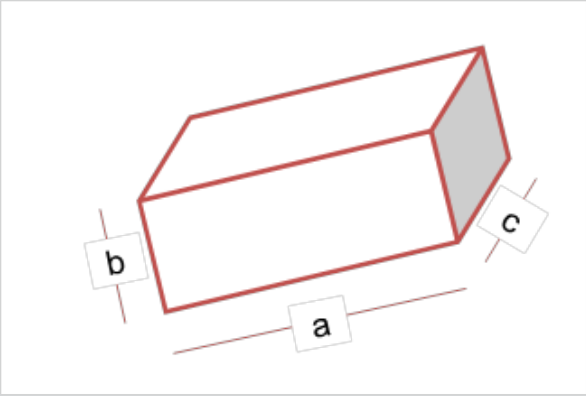


Advanced MBT technology – SRF production

- Separation of a SRF fraction with a calorific value of 11 – 14 MJ/kg

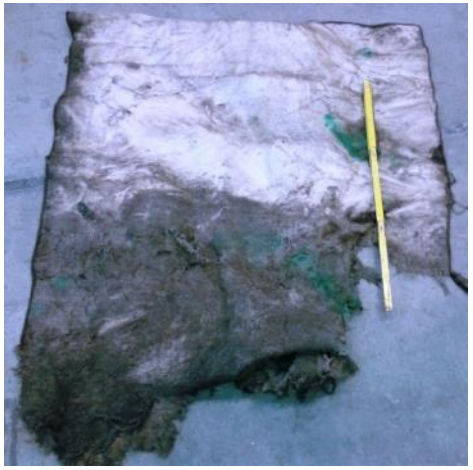
  - depending on the incinerator technology or power plant technology

  particles must have limited size and mass



3-D	a, b, c		100%	< 500	mm	
			90%	< 300	mm	
	a+b+c			< 700	mm	
				< 150	mm	minerals + metals
2-D	a / b		100%	< 700	mm	
			90%	< 500	mm	

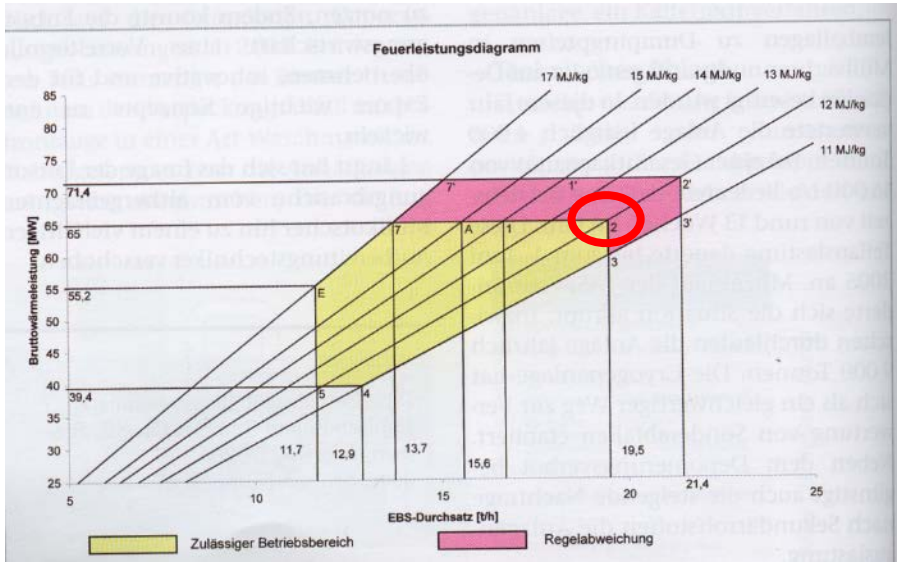
Example for Particle size demands due to feeding system



Advanced MBT technology – SRF production

Technology	Calorific Value [kJ/kg]	Mass	Size	chem. parameters
Incinerator	> 11.000	-	-	o
SRF Power Plant	Ø 14.000	+	+	+
Cement Kiln	> 20.000	++	++	++

o	Low demands , small number of parameters
+	High quality demands, ca. 10 parameters
++	Higher quality demands, specific parameters depending on users permission



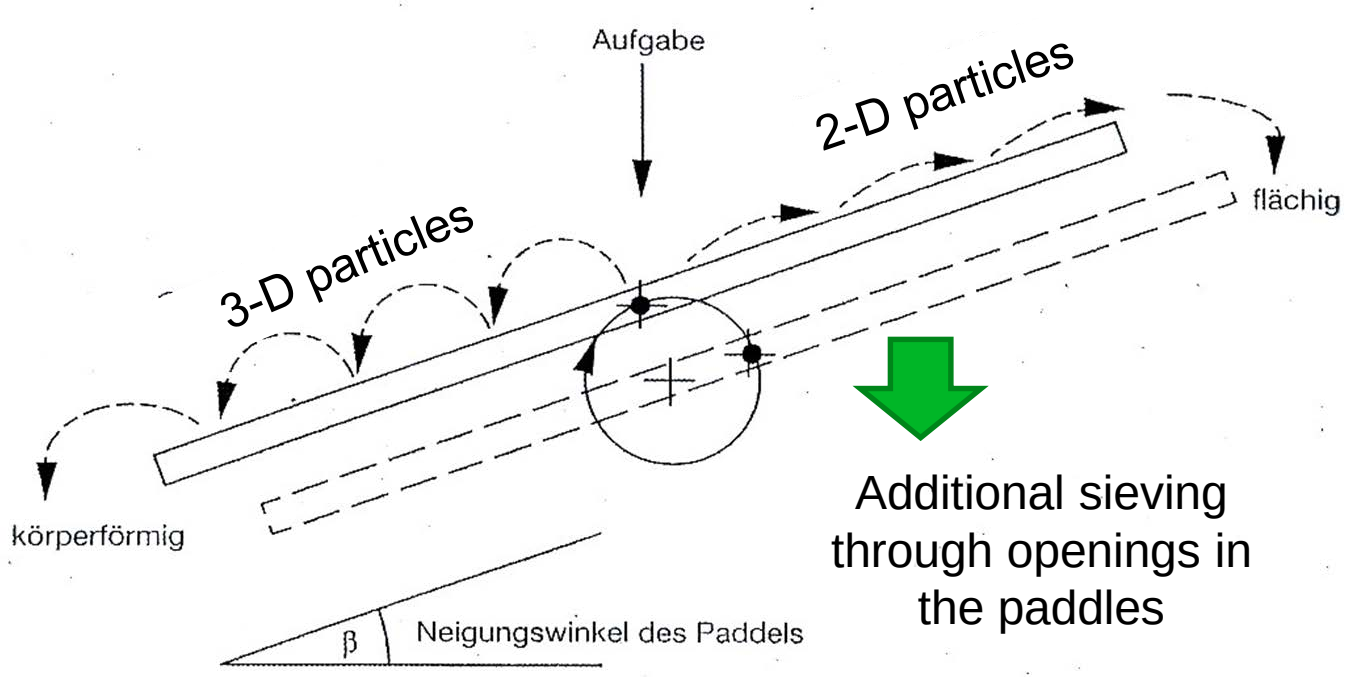
Source: Infraserv

MBT and SRF production

- If waste incineration is the last treatment step, the sieving flow + 60 mm does not need any further treatment.
- The higher the quality demand for SRF, the more technical effort is necessary to achieve the quality, in particular separation of heavy particles is obligatory.
- Second shredder step with single shaft shears and limited dimension of all particles sometimes is requested. Additional shredding process must be build twice because of low availability due to high maintenance.
- Preparation for cement kiln use is only possible with further additional sorting steps like wind sifters, the **yield** from sieve overflow will be on a level of **30 %.**

MBT and SRF production, additional processing

- Separation of heavy particles with ballistic separators



Additional sieving through openings in the paddles

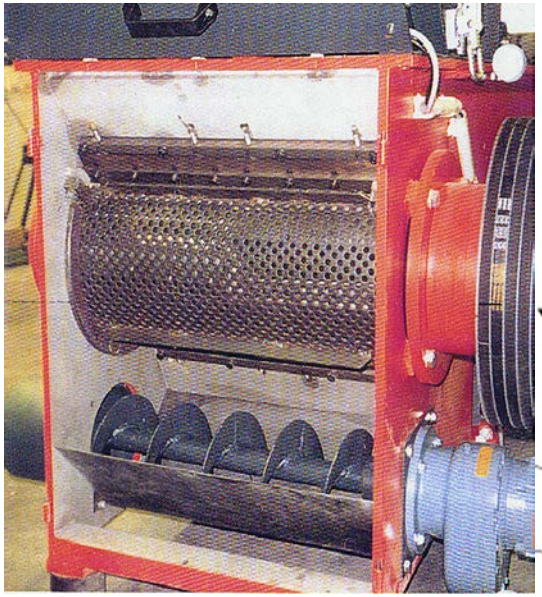
Inclination angle f(material properties)

MBT and SRF production, additional processing ballistic separation

MBT and SRF production, additional processing

- Reducing particle size of RDF material with single shaft shears to

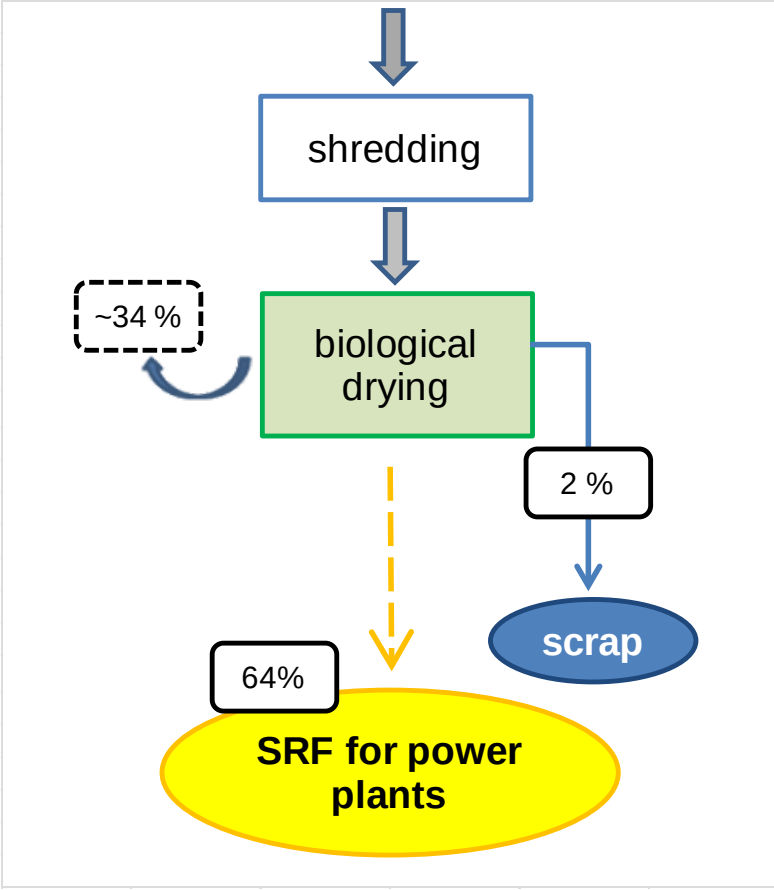
  < 100 mm (max) - < 40 mm



video

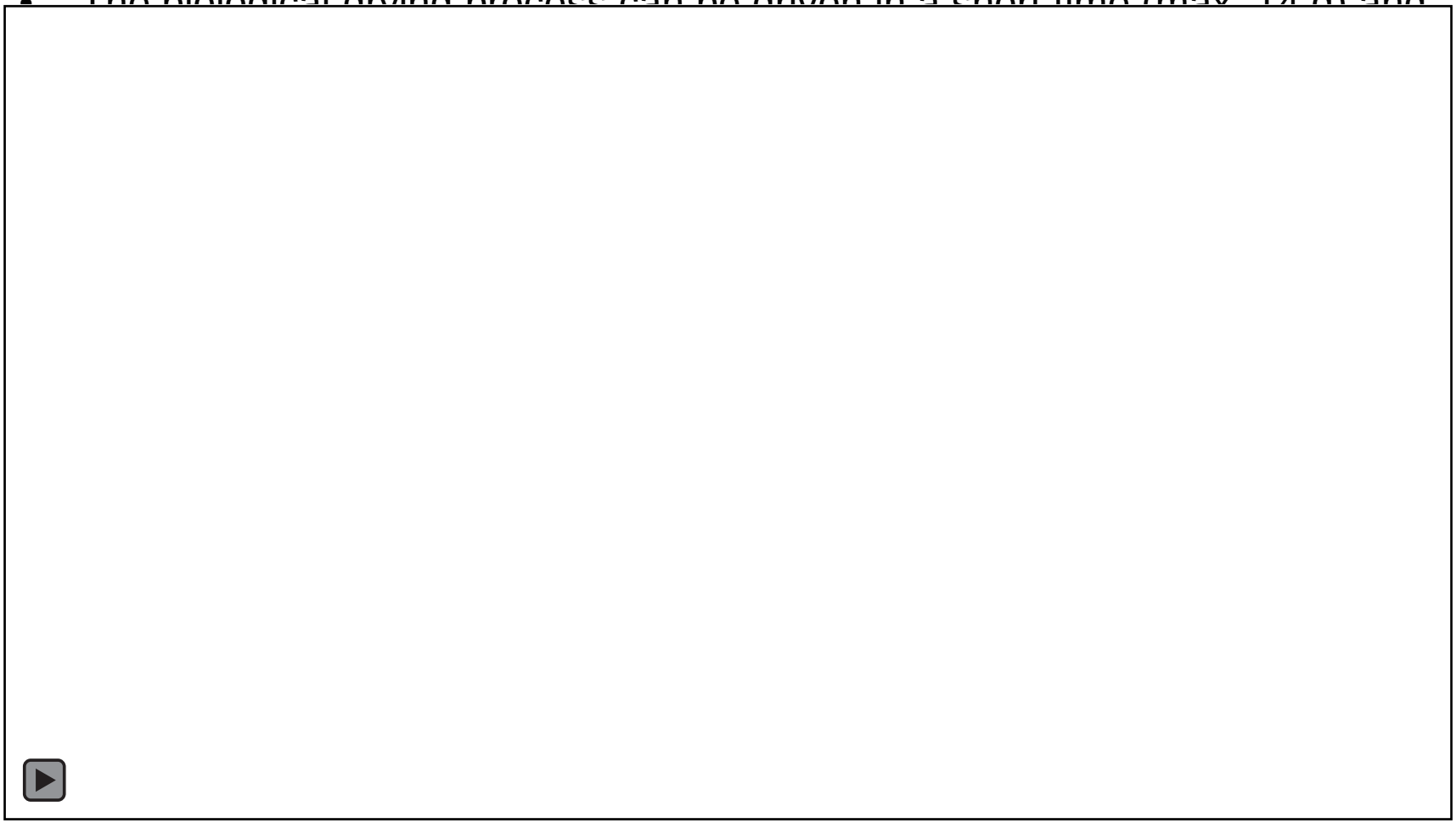
MBT type C

- maximized mass losses of about 35 % of the total MBT input
- Biological drying system with 7 – 14 days process time
- Fully automatic transport system
- Extended building quality due to included overhead crane and fully encapsulated drying boxes
- plant capacity > 100,000 t/y,
- Options of further mechanical treatment steps for sorting recyclables or improving fuel quality due to low humidity of waste output



MBT type C

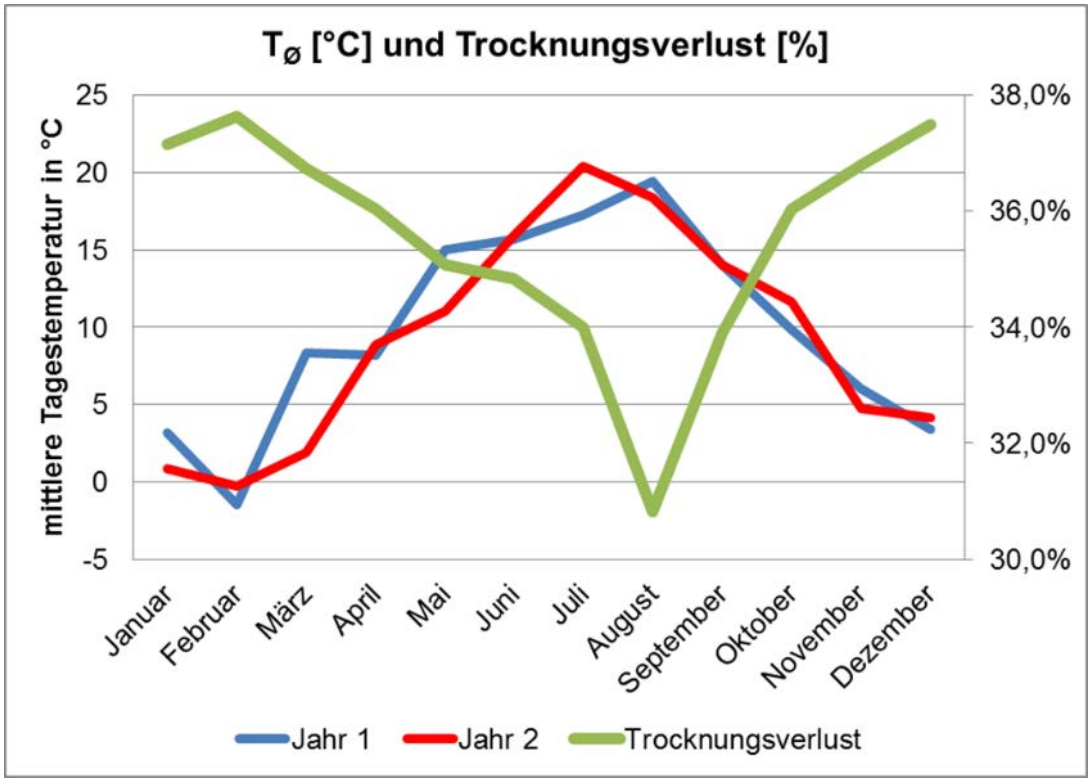
- The biological drying process can be driven in a short time (max. 14 d) and



energy plants (MARSS).

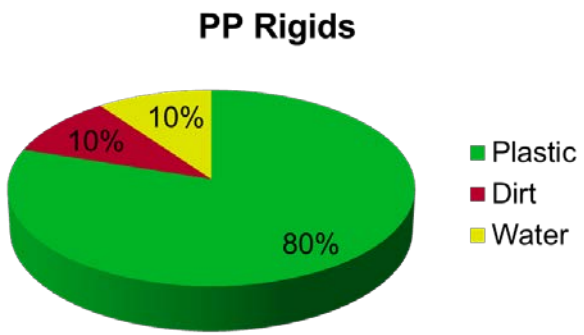
MBT type C

- The efficiency of biological drying processes depends on climatic conditions. Mass losses achieved with the same adjustment of a plant vary due to different MSW quality in winter and summertime but also due to different air temperatures.
- Air with different humidity is used for the natural drying process.



MBT type D

- Products from MBT of type D are SRF and recyclables like Fe-metals, NF-metals and plastics
- Good experience with this technology in the Netherlands (*Nascheiding*), Cyprus, Spain and some other EU countries.
- Mechanical processes to separate recyclables are placed in the overflow of the first sieving step and use ballistic separators, wind sifters, magnetic and eddy current separators as well as sensor based Sorting (NIR).

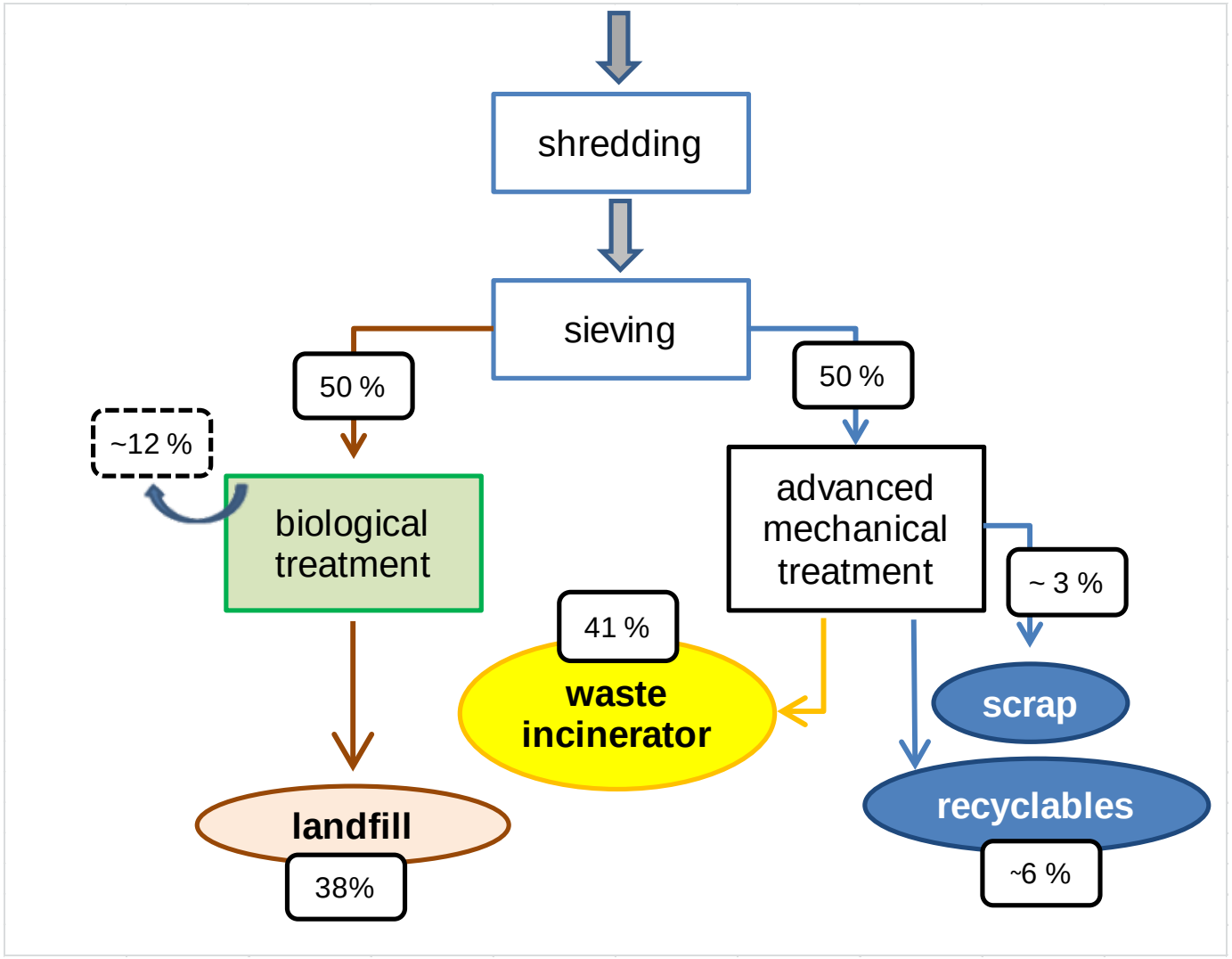


- Plastics sorted directly from MSW are of mixed and poor quality, they need further mechanical treatment.

The recovery rates allow to fulfill European requirements of the waste packaging directive.

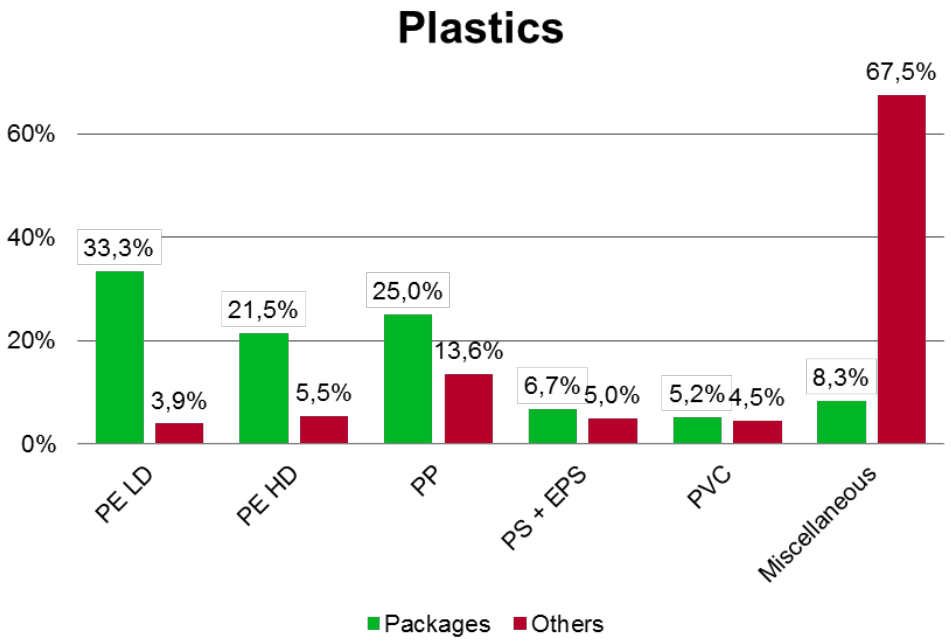
MBT type D

Video Herhof Sofia



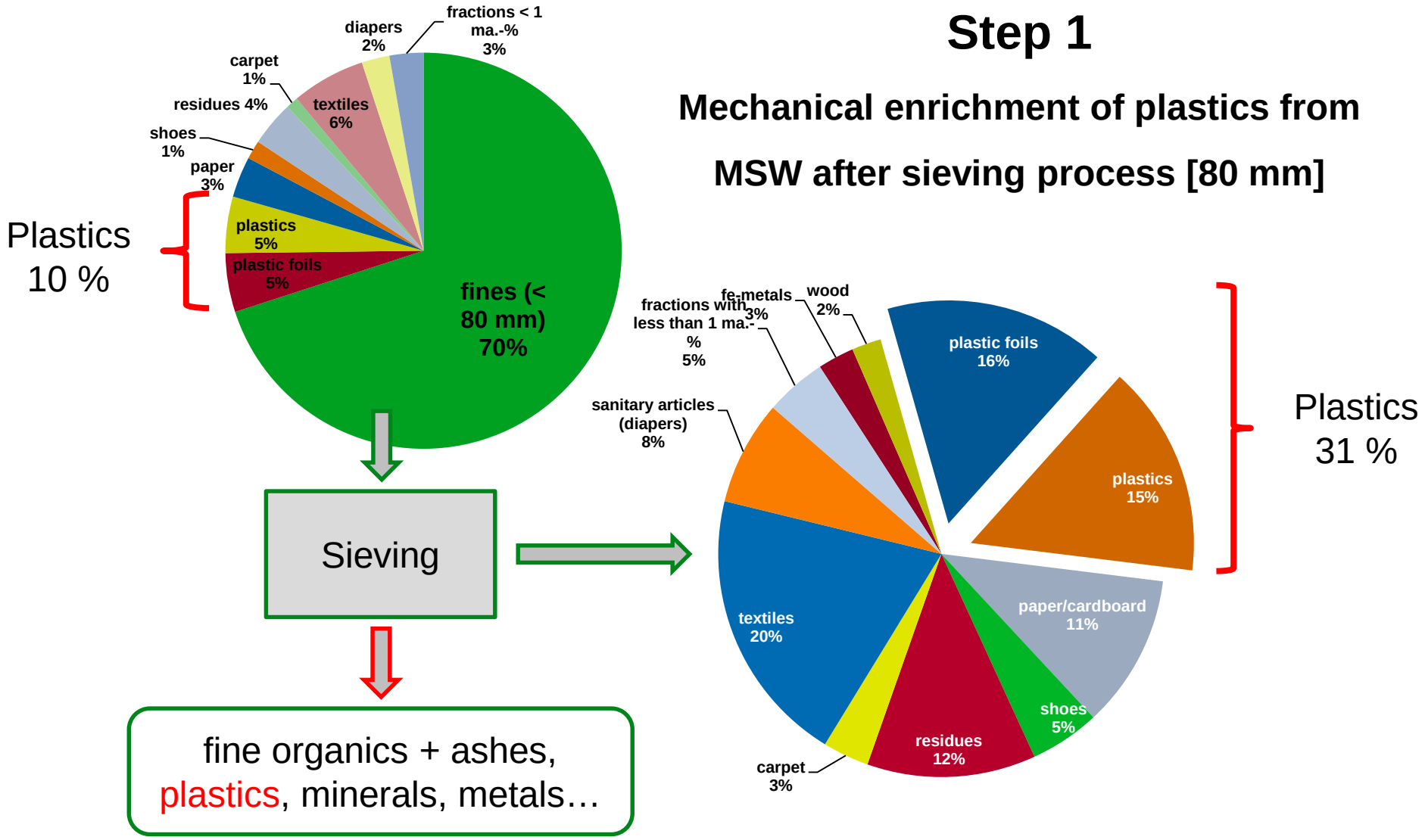
MBT type D

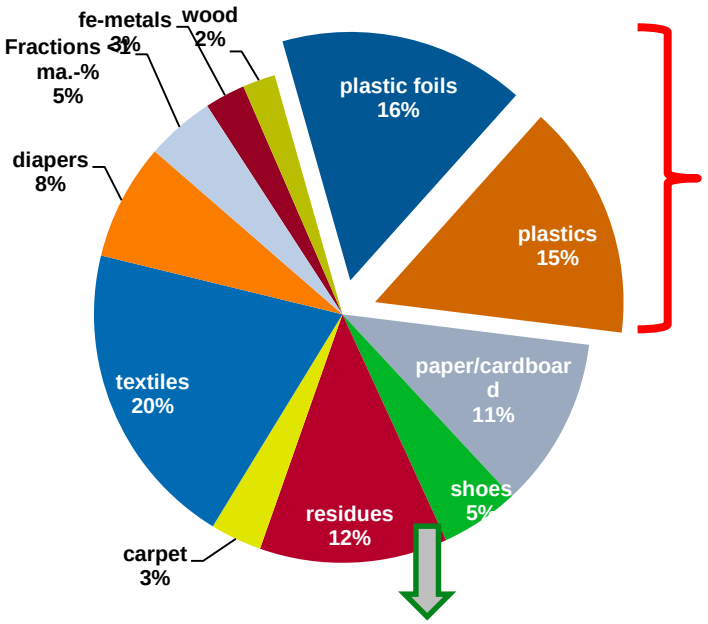
- Why plastic packaging sorting from MSW?
- To avoid the big efforts of separate collection and limited participation of the households as the waste producers.
- Sorting from MSW gives the opportunity of getting access to nearly 100 % of the plastic resource.
- Most of the plastics in MSW is PO quality, where recycling technology is state of the art.
- Technical enrichment of plastics from MSW sieve overflow is state of the art based on proven technology.



Step 1

Mechanical enrichment of plastics from MSW after sieving process [80 mm]





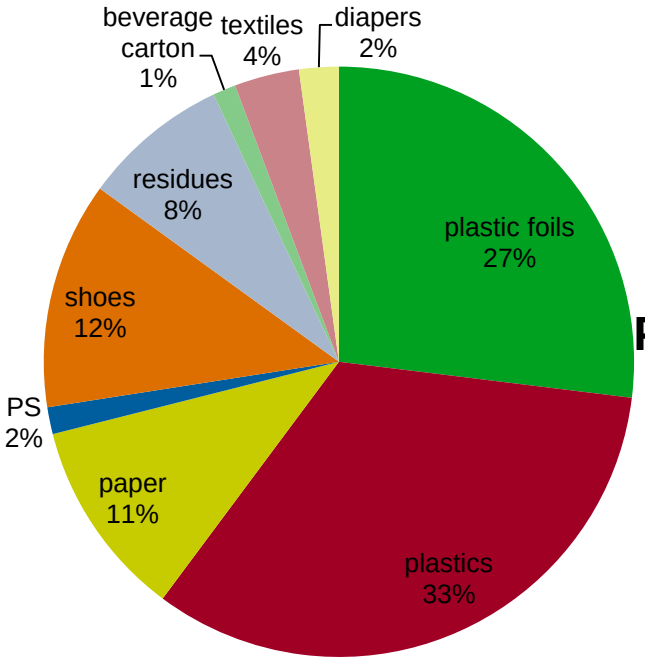
Plastics 31 %

Conditioning

Textiles, Shoes, Nappies, Minerals, Paper, Metals, Plastics….

Step 2

- Wind-sifting (2 *)
- Metals separation
- Ballistic separation [2-D / 3-D]



Plastics 60 %

Step 3 NIR - Sorting + Purification Process [PO]

Plastics 60 %

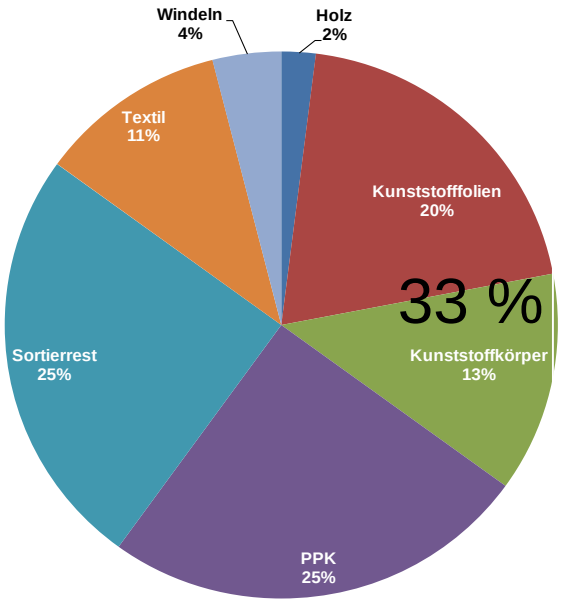
Sorting / Purification

- Sensor Sorting [2-D / 3-D]
- NIR Mono Sensor + Multi-Sensor System
- > 30% losses of plastics in rejects

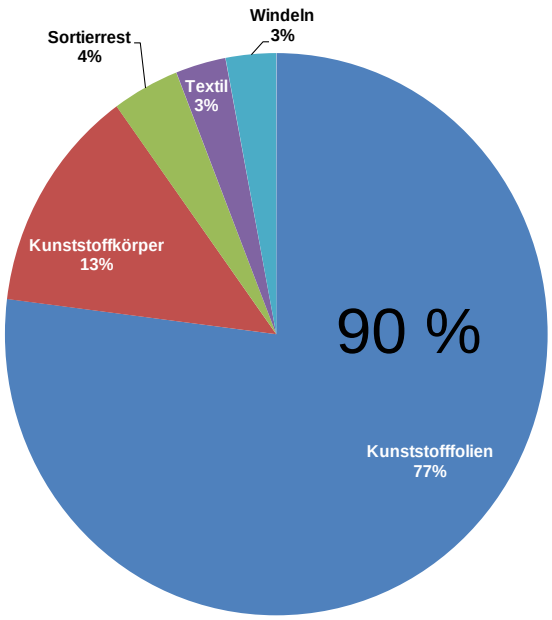
PO- Plastics 95 - 97% purity* as feedstock for recycling process

* including humidity and dirt on surface

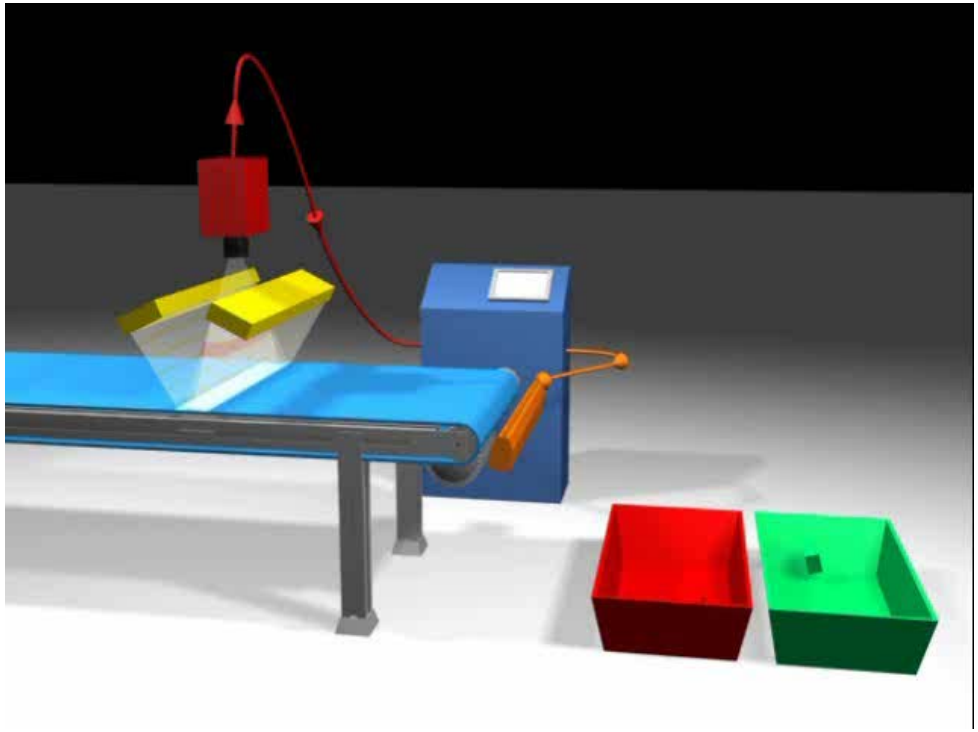
SORTING rejects



CLEANING rejects



Step 3 NIR - Sorting



Technology based on purification of agricultural products, in Europe more than 50,000 units in operation (e.g. potato chips)

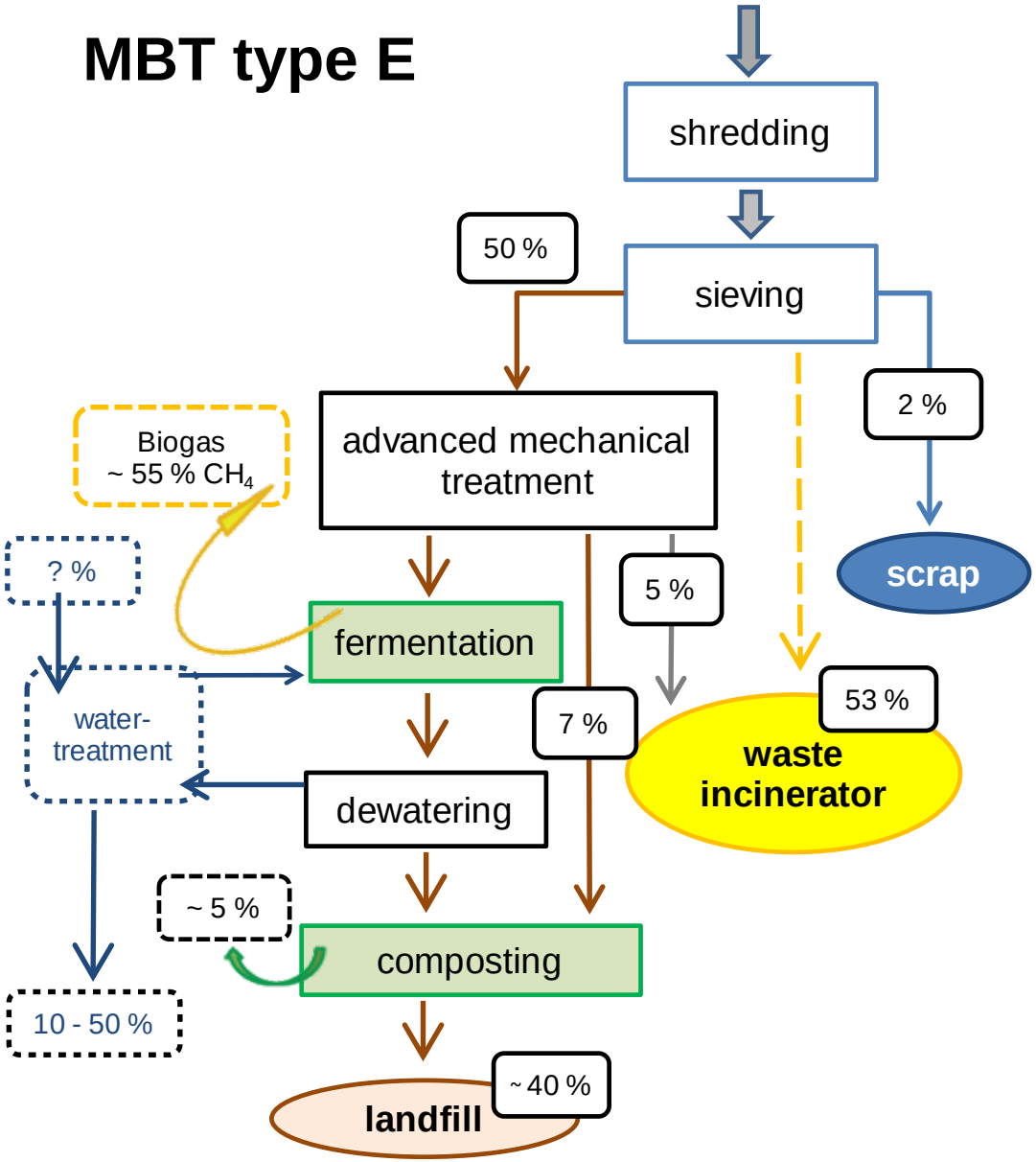
Currently NIR technology and enhanced systems using VIS and Induction-detectors are state of the art in mechanical waste processing. > 5,000 units are in operation in EU

If pre-processing is done successfully even difficult materials can be treated like sieve overflow from composting process

MBT type E

- MBT type E is focused on optimized waste to energy yield.
- Energy is produced both from sieving overflow by incineration and the organic fraction by digestion.
- Preparation of the fine fraction has to respect the quality demand of fermentation processes, both dry and wet type.
- Therefore additional mechanical treatment is needed to minimize the content of heavy particles (glass, sand, ceramics, metals) as well as floatable particles like plastic films or EPS.
- Because fermentation is driven with dry matter content between 10 and 30%, the fine fraction has to be watered down from 50 % and after the digestion process a dewatering process is essential.

MBT type E



Video Dranco Wijster (NL)

Video Smartferm

Advanced treatment of fine fraction

- Due to the low solid density (10 – 30 %) inside the digester, the marginal movement of the slurry and the long process time of some 21 days the conditions for sedimentation are very good. Even very small heavy particles like sand sink down to the bottom of the biochemical reactor.
- Sagged particles build a continuously growing bottom layer until the function of the reactor is blocked and the vessel must be discharged completely.
- Sedimentable particles must be removed with a very high yield (> 99 %).
- Floatable particles are building a swim layer preventing the perculation of biogas to the discharge unit on top of the vessel.
- Both types of impurity must be kept out of the feedstock very efficiently.

Advanced treatment of fine fraction

- Sufficient removal of heavy fine particles and light material like film plastic is a really challenging task.
- If “wet” digesting technology can be used, density separation for the sorting is available due to the low dry matter content of the feeding slurry of < 10%
- Modern “dry” digesting technology works with dry matter contents of ~ 30% to avoid waste water treatment. In case of dry sorting technology the water content prevents efficient separation due to fine organic particles sticking on the surfaces of light material and waste materials like fruits and other food with similar properties as real impurities.
- Actually many plants type E failed or dealing with daily difficulties

Advanced treatment of fine fraction

- Actually many plants type E failed or dealing with daily difficulties
- Picture shows MBT La Coruna (Spain), built 2002 with 4 digesters each with 4,500 m³ volume
- Accidents sometimes with complete damage by reason of heavy layers or swimming layers due to limited sorting efficiency

Advanced treatment of fine fraction

Left: “heavy” fraction from ballistic separator

Right: feeding unit for the digester

Dewatering

1. Screen type centrifuge

2. Belt filter

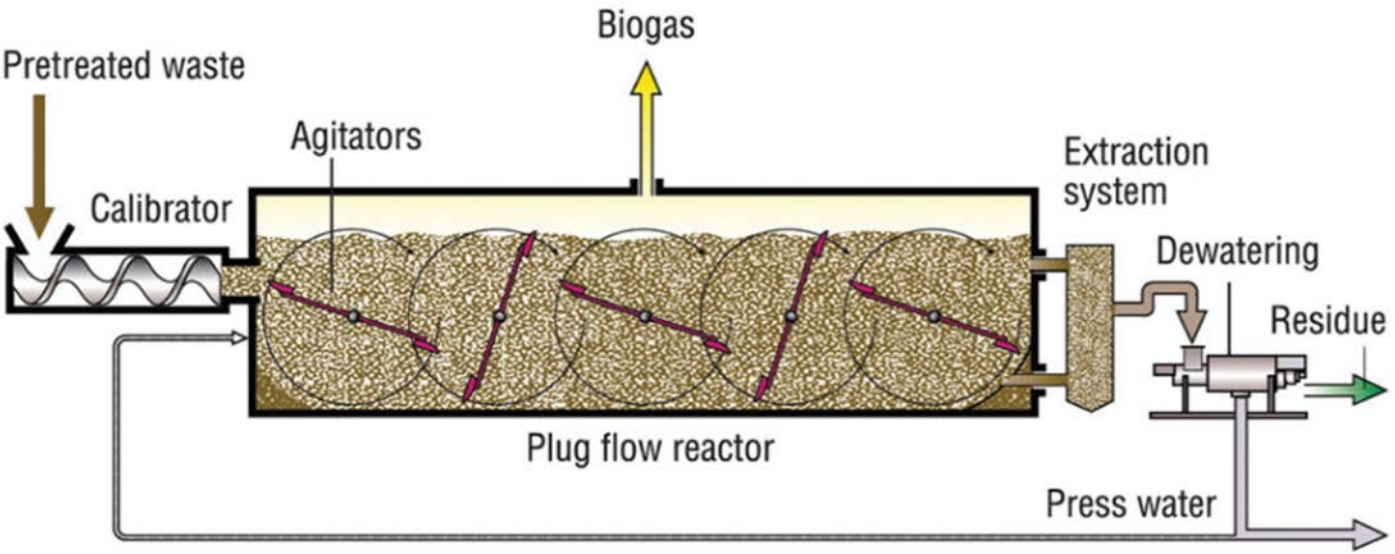
3. Solid bowl centrifuge for process water cleaning

Digester technology

Hopper for continuous feeding 7 days per week

horizontal dry fermentation reactor type for continuous process over 21 days, feeding with some 30 % dry matter content, output with > 20 % DM content

Figure 2. Schematic of the Strabag LARAN® dry plug flow reactor



Digester technology