

# Pretreatment of Waste for Biomass – Co-Gasification

Production and Utilization Options for Solid Recovered Fuels, Copenhagen, May 17, 2018

Giovanni Ciceri, RSE, Manuela Wexler, Dieter Stapf, KIT

IEA Bioenergy

Task 36

**Integrating Energy Recovery into Solid  
Waste Management Systems**

- Reference: High quality wood based fluidized bed gasifier
  - Gasifier fuel specification ?
  - Syngas requirements (Energetic or material utilization) ?
- Two country specific case studies
  - Italy: Mechanical Biological Treatment MBT (Solid Recovered Fuel SRF according to EN 15359)
  - Germany: Mechanical treatment (Refuse Derived Fuel RDF that fulfills reference gasifier energetic utilization requirements)
- Investigation of pretreatment potential
  - Pretreatment cost vs. waste incineration gate fee
  - Gate fee: €100/t - €120/t
  - Wood based gasifier feedstock: ca. €80/t

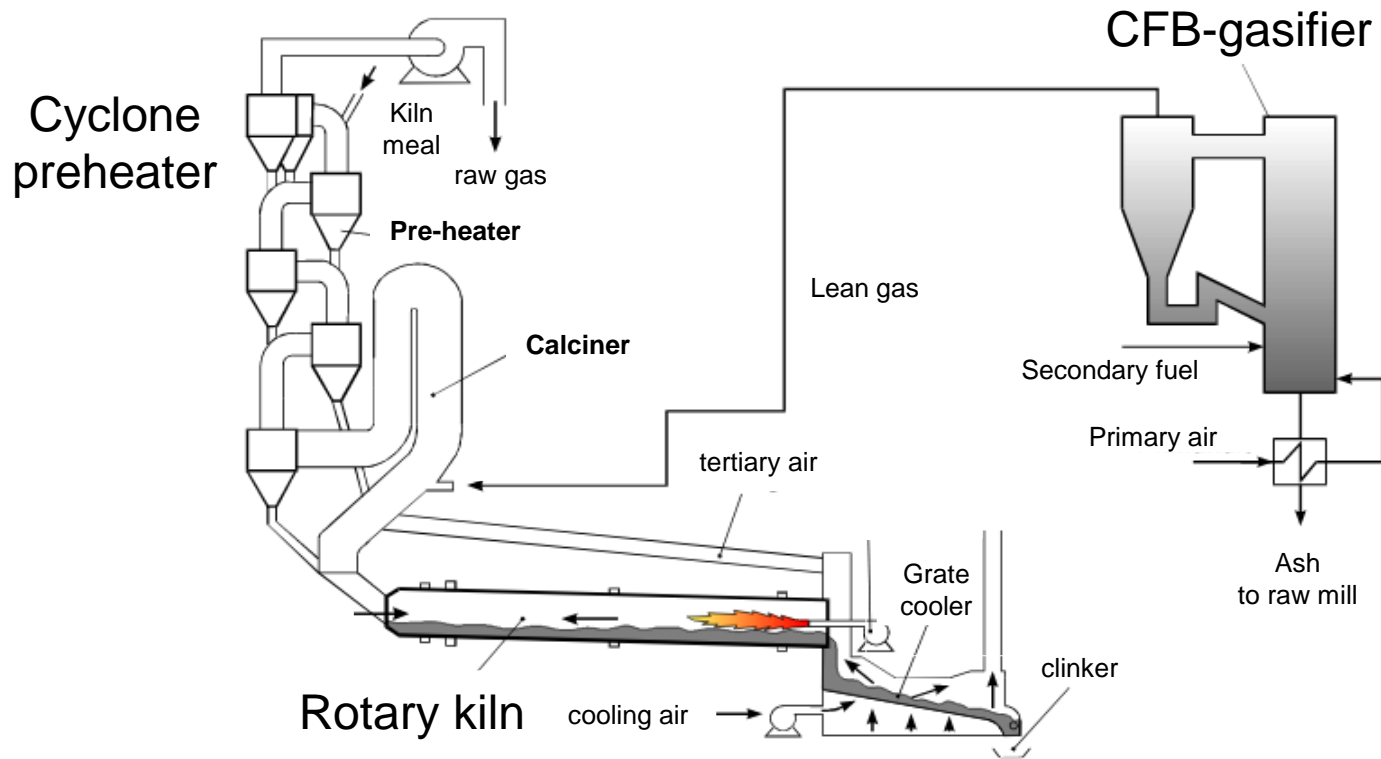
Pretreatment of waste for biomass – co-gasification:  
Joint study of task 36 (waste to energy) & task 33 (gasification)

## Case study Germany:

### Mechanical processing of MSW as feedstock of a circulating fluidized bed gasifier



# Reference Cement Plant @ Rüdersdorf: Operation of a Circulating Fluidized Bed Gasifier



- |                     |             |             |  |
|---------------------|-------------|-------------|--|
| ■ Commissioning:    | 1996        | ■ Lean gas: | 60,000 m <sup>3</sup> (NTP)/h              |
| ■ Thermal capacity: | 100 MW      | (Syngas)    | 900 – 960 °C                               |
| ■ Secondary fuel:   | 20 – 30 t/h |             | LHV: 3,000 – 5,000 kJ/m <sup>3</sup> (NTP) |

# Requirements for Fuels to be used in the CFB Gasifier

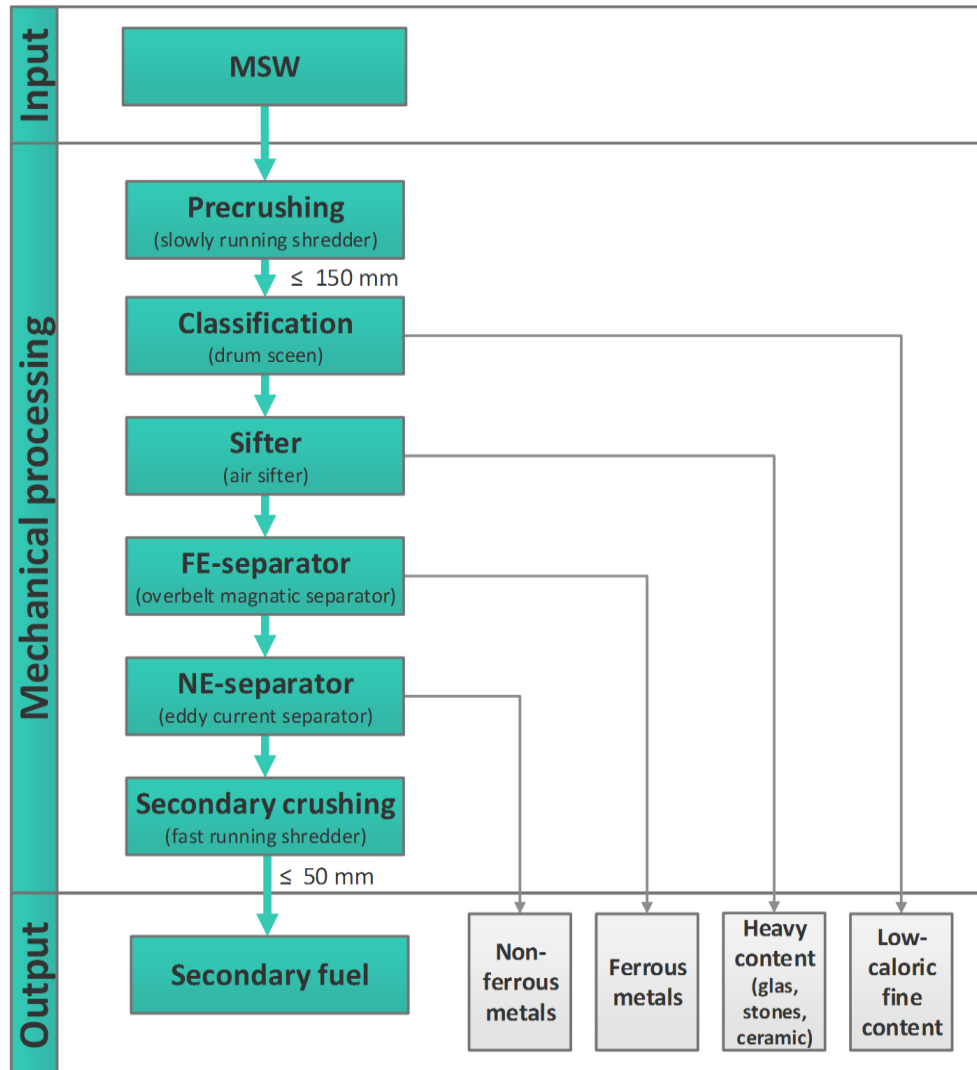
- Legal obligations, e.g. emissions
- „No“ impurities, e.g. metals, glas or PVC
- Maintenance of product quality in upstream cement processing

Parameter		CFB - Feedstock	Municipal Solid Waste (MSW)
Particle size			
maximum diameter	mm	50	> 300
Proximate analysis			
Moisture content	wt-%	≤ 35	15 - 35
Volatile matter	wt-%	≤ 75	
Ash content	wt-%	≤ 25	25 - 35
Elemental analysis			
Sulfur	wt-%	< 1	0.3 – 0.5
Chlorine	wt-%	< 2	0.4 – 1.0
Mercury	mg/kg	< 1.5	0.5 - 11
Ash melting point	°C	≥ 960	
LHV	MJ/kg	~ 14	7 - 15
Bulk density	t/m <sup>3</sup>	0.3	0.1

CEMEX Deutschland AG -  
Einsatzmöglichkeiten für gefährliche Abfälle

Scholz, Beckmann, Schulenberg, Abfall-  
behandlung in thermischen Verfahren (2001)

# Process Description: Mechanical Treatment of MSW



- Boundary conditions
    - Output: ~ 20 t/hr
    - LHV  $\geq 10$  MJ/kg
  - Input: 30 t/hr MSW
  - 95 % of electrical power needed for crushing
  - Separated fractions
    - 1.5 wt-% non-ferrous metals
    - 1.8 wt-% ferrous metals
    - 10 wt-% heavy content
    - **20 wt-% fine content**
    - 2 wt-% water during process
- each referred to the initial MSW composition

# Estimated Costs: Price of Secondary Fuel

- Annual costs of Mechanical Treatment Plant
  - Depreciation Period: 10 years
  - Depreciation: 10 % of invest per year
  - Capital costs 10 % of invest per year
- Operating hours: 8,000 h/a

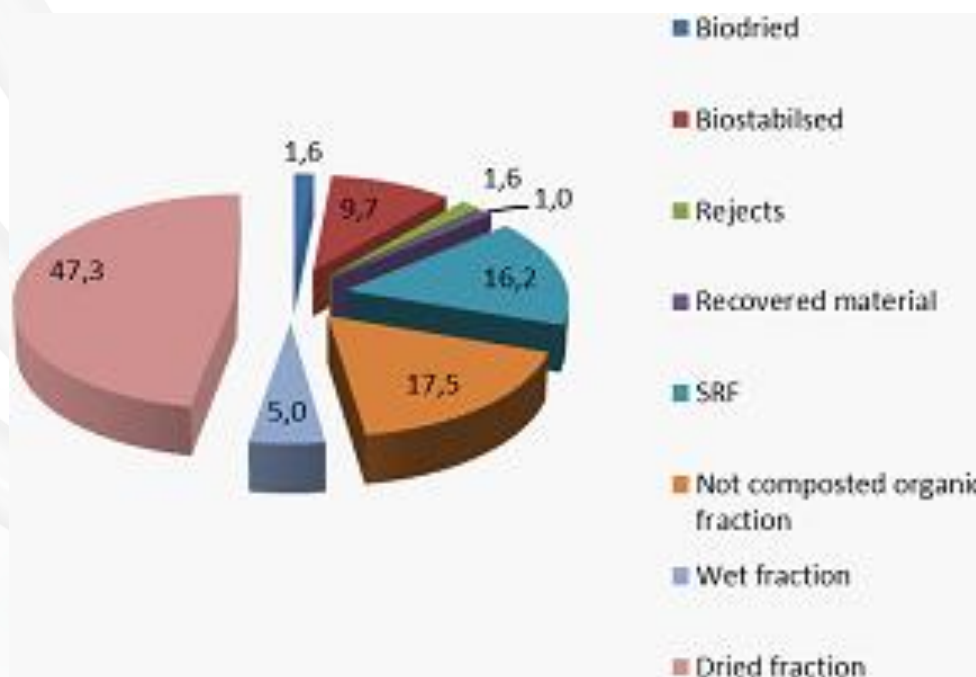
	Basic costs	Variation Range of sensitivity analysis
Annual Costs: Treatment Plant	25 % of Invest	+/- 25 %
Electricity	0.1 €/kWh	+/- 50 %
Revenue: Ferrous Metals	25 €/t	+/- 20 %
Revenue: Non-Ferrous Metals	250 €/t	+/- 20 %
Landfill Fees: Heavy Content	30 €/t	+/- 25 %
Gate Fees: Fine content	100 €/t	+/- 25 %

**Mechanical Treatment Costs: 45.5 €/t Secondary fuel**  
(Range: 30.6 – 60.5 €/t)

# Case Study Italy – Mechanical Biological Treatment



- In Italy the terms RDF and SRF are synonymous, as all the RDF must meet the EN 15359 requirements.
- The SRF output from MBT plants is ca. 16.2 % of the MSW input.
- The total amount sent to incineration and co-incineration is 27.4 %, including other combustible waste not meeting the EN 15359 standard.
- Assuming that all the SRF produced can be used in gasification and co-gasification plants, the potential would be 1.78 Mton/year.



MTB plant output in Italy in 2016



# SRF: Specifications and Classes



## Classification system of CEN/TS 15359

Classification Property	Statistical Measure	Unit	Classes				
			1	2	3	4	5
Net calorific value (NCV)	Mean	MJ/kg/(ar)	≥ 25	≥20	≥15	≥10	≥ 3
Classification Property	Statistical Measure	Unit	Classes				
			1	2	3	4	5
Chlorine (Cl)	Mean	% (d)	≤0,2	≤0,6	≤1,0	≤1,5	≤3
Classification Property	Statistical Measure	Unit	Classes				
			1	2	3	4	5
Mercury (Hg)	Median	mg/MJ (ar)	≤0,02	≤0,03	≤0,08	≤0,15	≤0,50
	80 <sup>th</sup> percentile	mg/MJ (ar)	≤0,04	≤0,06	≤0,16	≤0,30	≤1,00

Parameter (units based on dry matter is not specified)	Range	
	MIN	MAX
LHV: (MJ/kg) as received	15,4	>25
Chlorine (%)	0,26	0,65
Mercury (mg/MJ as received)	0,02	0,04
Mercury 80° percentile (mg/MJ) as received	0,04	

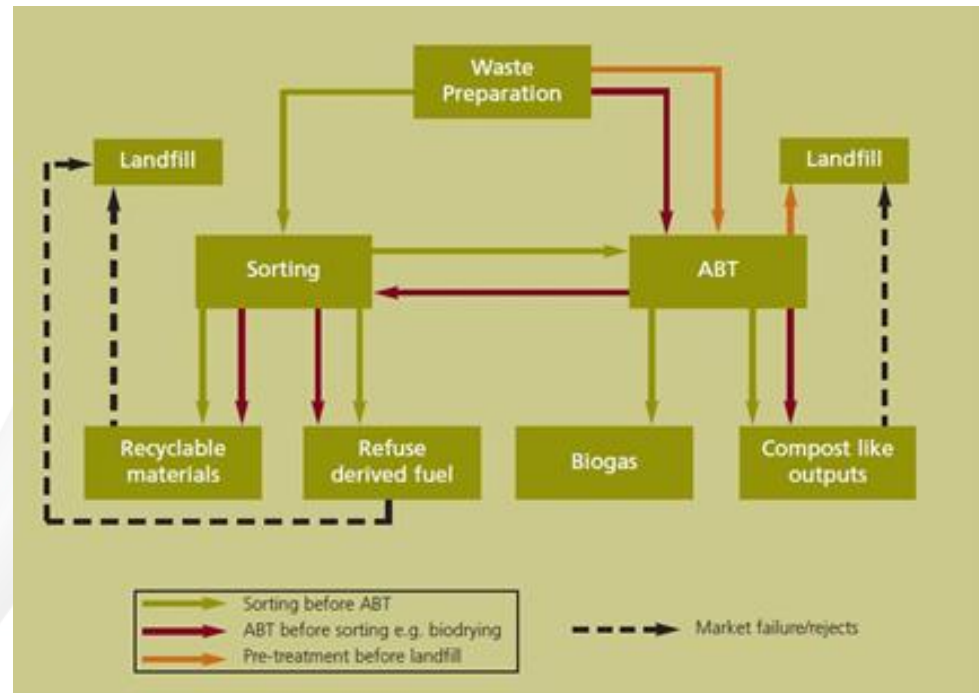
Class	
MIN	MAX
1.2.1	3.3.3

## Cost of SRF production by an MBT plant

Two kinds of MBT plants have been considered:

- Single line (mainly used for residual waste)
- Double line (separation of «wet» and «dry», usually on the base of a dimensional separation (8 -10 cm))

We considered four MBT plants operating in the North of Italy (3 plants in Lombardia) and one operating in Emilia Romagna



# Specific SRF cost of the four considered MBT Plants



Income (€/ton)	Average	Min	Max
Gate fee for income waste	119.5	97.3	142.6
Ferrous metals recovered	20	10	30
Non ferrous metals recovered	125	100	150
Outcome (€/ton if not indicated)			
Landfilling	111	83	153
SRF (highest quality)	20	0	40
SRF transport costs	11	0	20
Other combustible residues	95	90	100
Wastewater treatment	49	25	70
Electricity (€/kWh)	-	0.05	0.16
Diesel oil	1200	-	-
Labor costs	9.8	6.1	20.2
Maintenance costs	10.4	8.2	14.8
Mortgage	4	-	-
Insurance costs	0.07	-	-
<b>Treatment cost (€/ton)</b>	<b>80</b>	<b>52</b>	<b>118</b>

- Mechanical pretreatment targeted to fulfill the CFB-gasifier requirements for energetic utilization of waste in co-gasification with biomass. This pretreatment is relatively cheap. Quite large RDF amounts would be available given the current market situation in Germany: ca. 5 Mt/a @ 13 – 45 €/t (low – medium quality)
- MBT for the given situation in Italy producing a high-quality SRF as by-product. This SRF is thus more expensive due to the limited yield: 1.8 Mt/a @ 80+ €/t
- Waste pretreatment cost significantly below incineration gate fee and biomass cost -> Potential of pretreated waste to reduce gasification cost in biomass – waste – co-gasification

