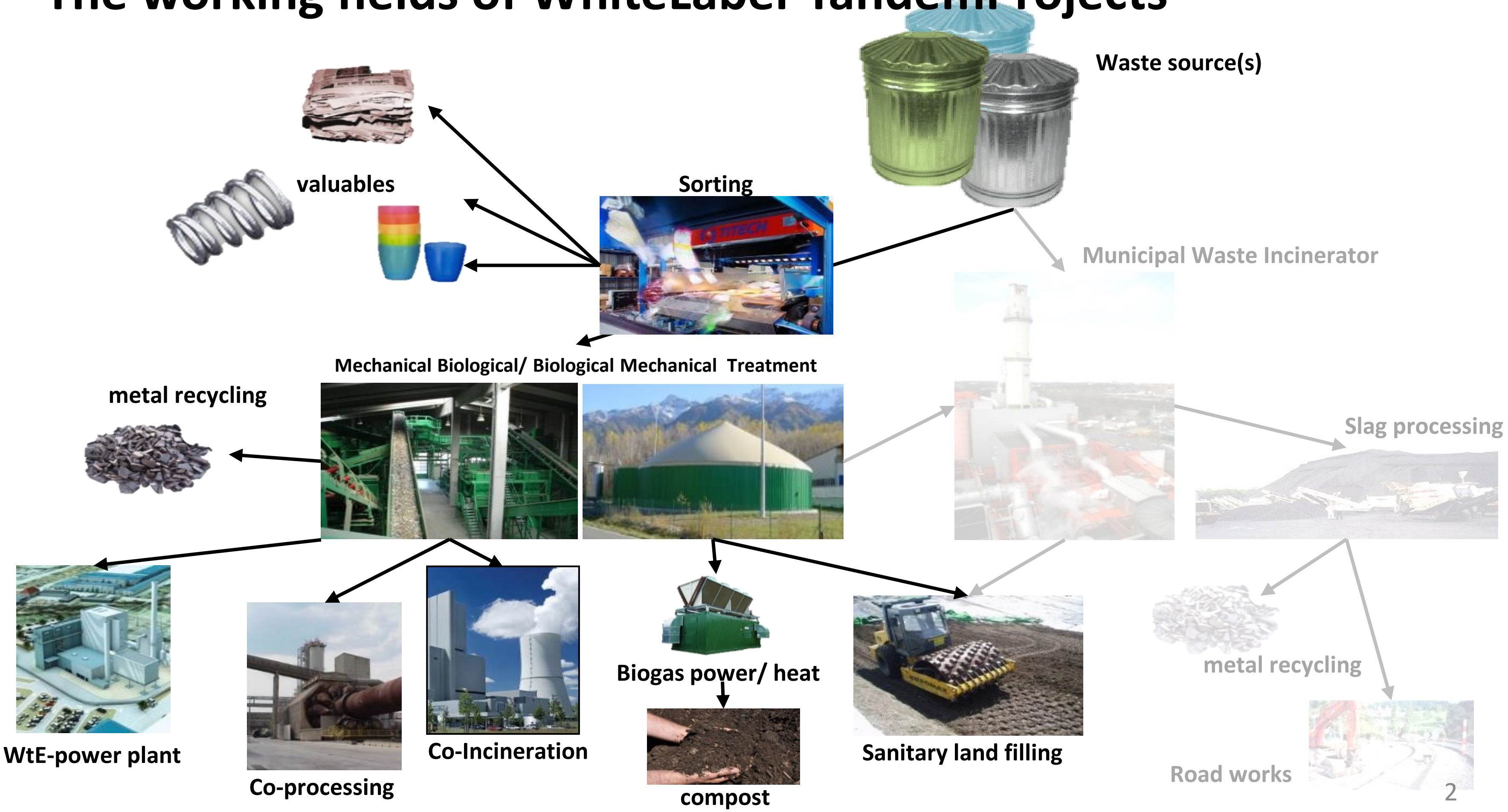
The role of AFs in a sustainable MSW management

Main challenges and opportunities of AFs in the context of decarbonisation of the cement industry

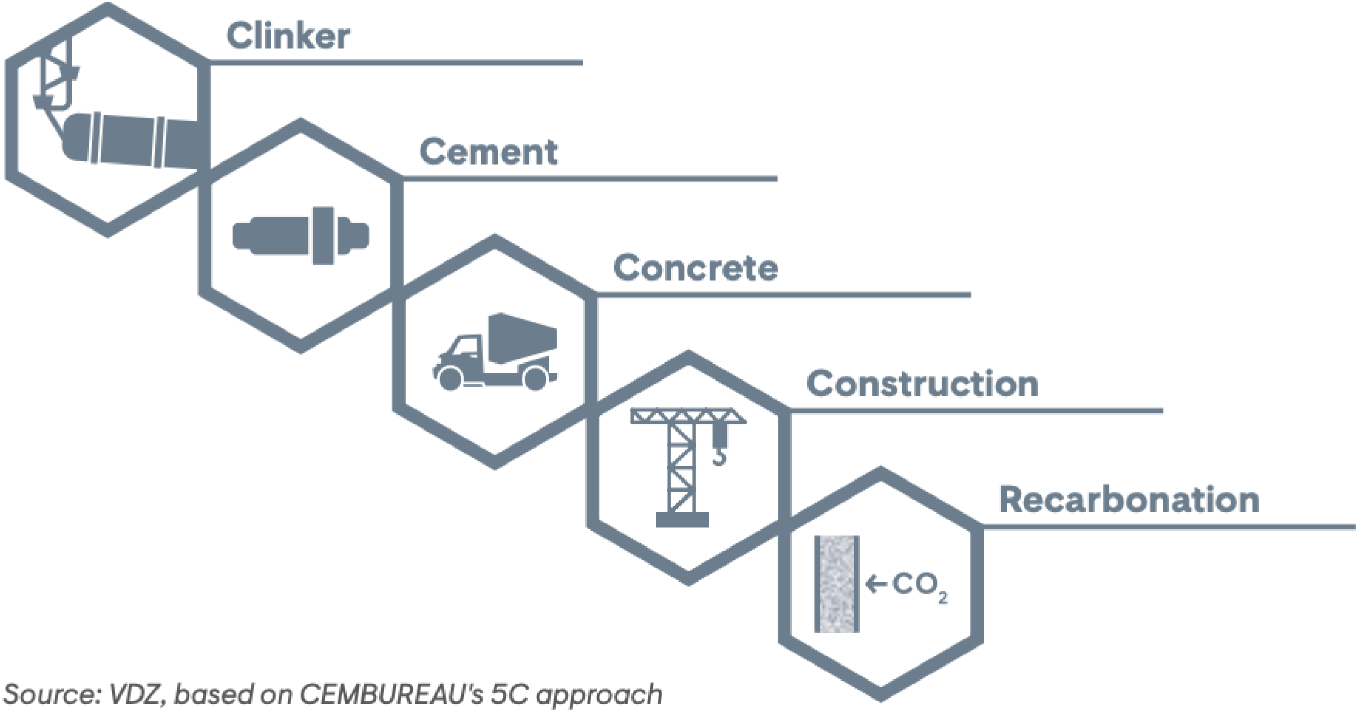
17.03.2022

A contribution offered by WhiteLabel-TandemProjects e.U.

The working fields of WhiteLabel-TandemProjects

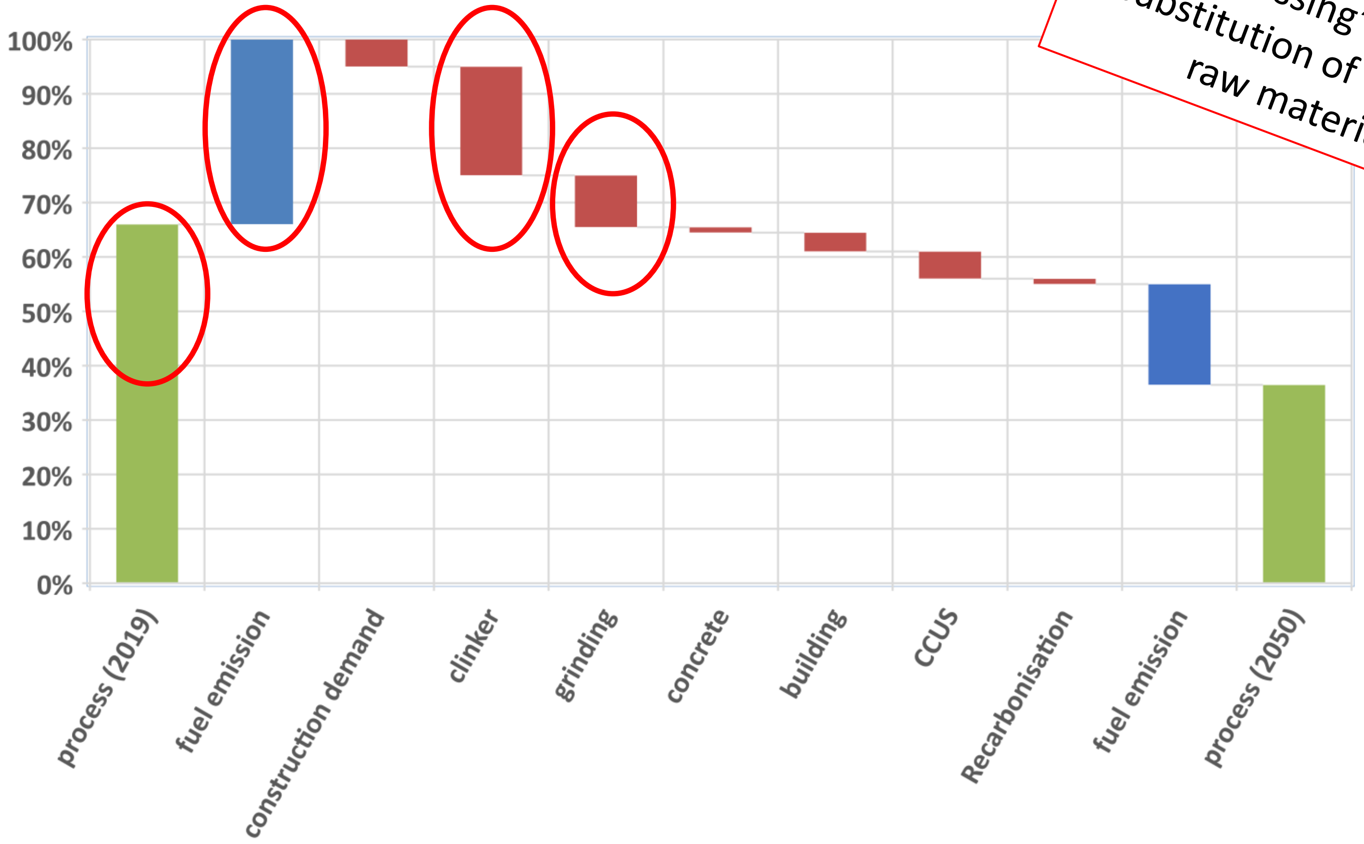


CO_2 reduction along the value chain



Source: VDZ, based on CEMBUREAU's 5C approach

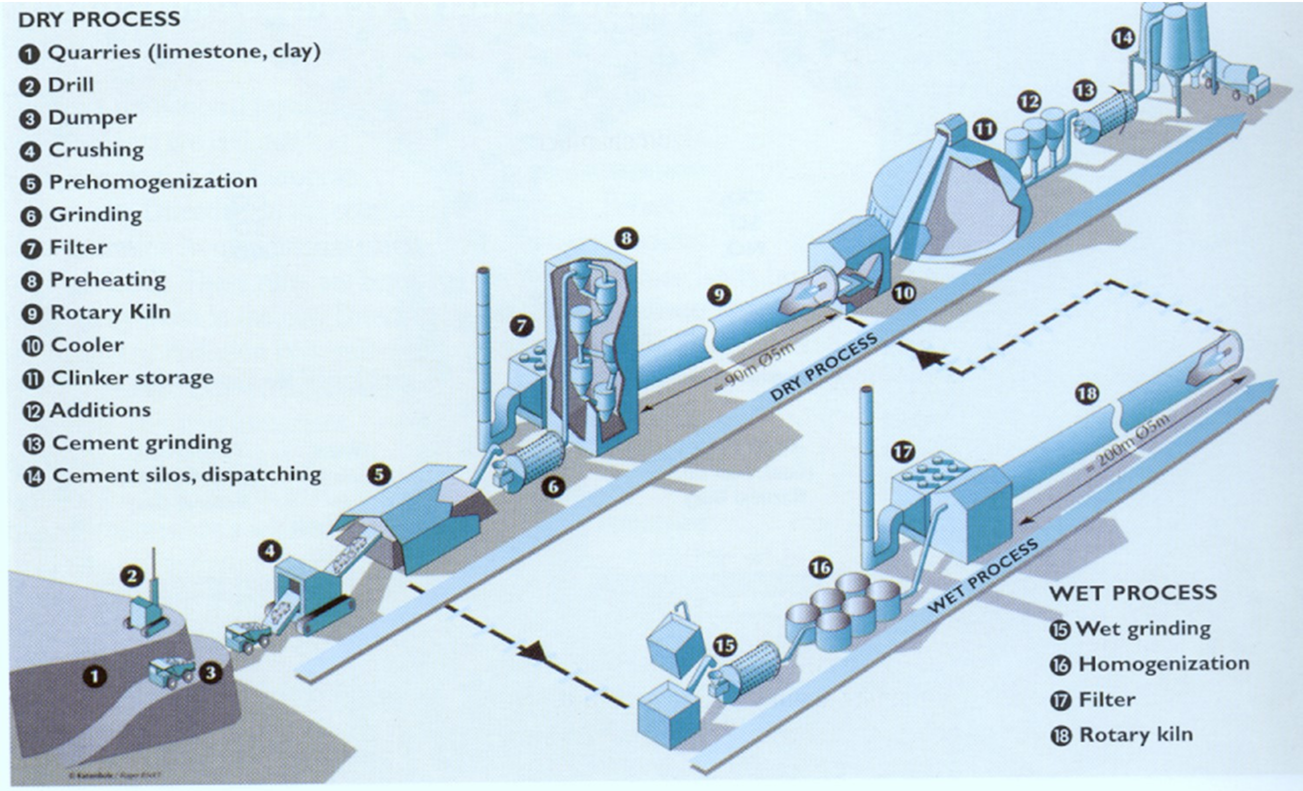
CO_2 reduction along the value chain by 2050



"Co-processing" means the substitution of fuels and raw materials

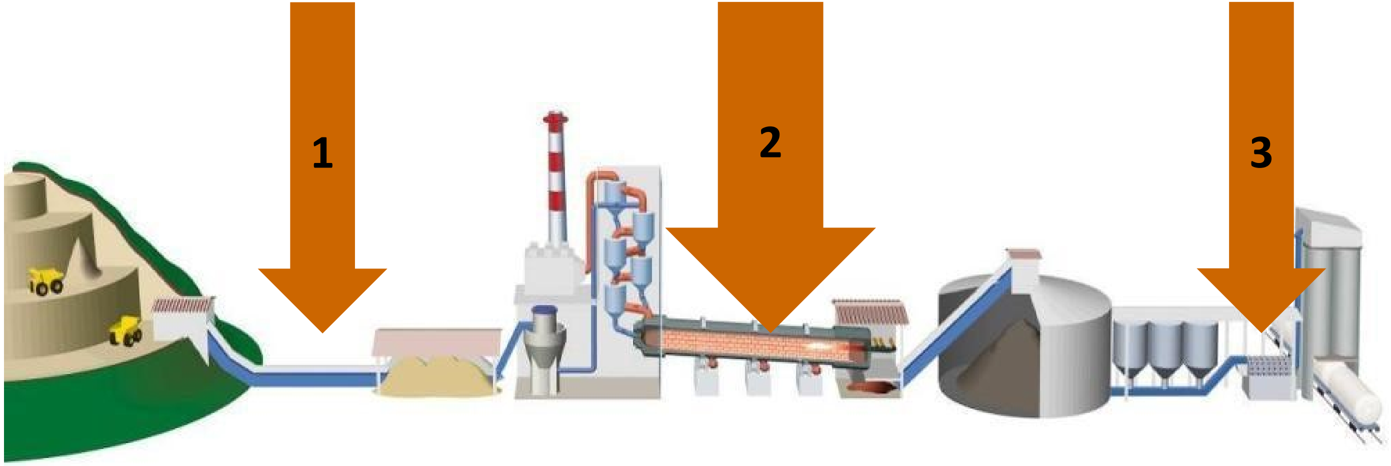
Data adapted from WBCSD, VDZ and WLTP

The cement manufacturing process



credit: CEMBUREAU

Co-processing



“Co-Processing” is the substantial + thermal use of waste derived alternative fuels and raw material

1: mineral waste as an alternative raw material in accordance to the chemistry of clinker formation

2: using fuels and its ashes as energy and for clinker formation

3: mineral grinding compound in accordance to the cement standards

General rule of co-processing

The **fundamental difference** between **waste** and **waste-derived alternative fuels** is that **untreated waste cannot be used as a fuel** in a thermal production process.

Be aware:

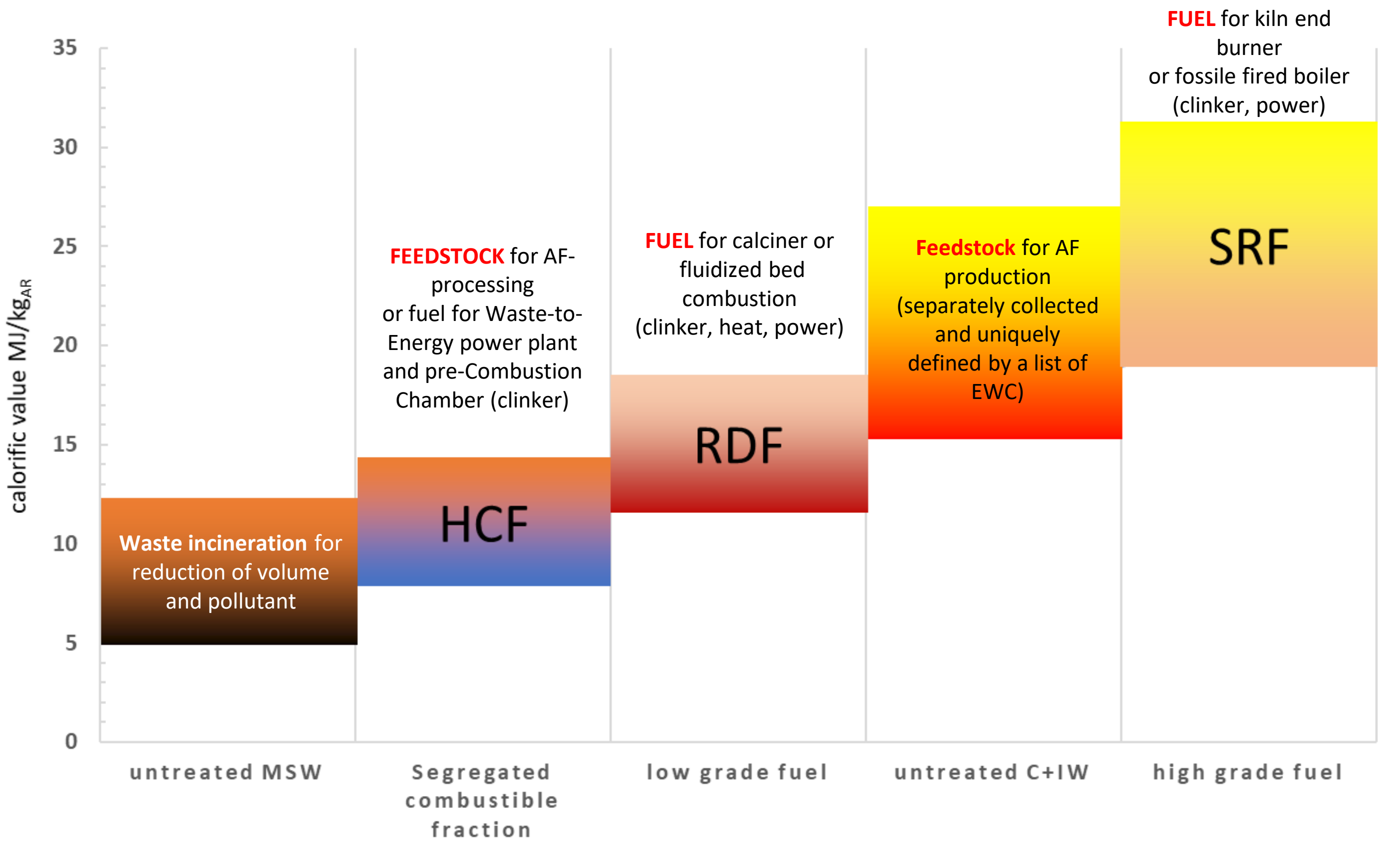
A cement manufacturing process is not a disposal process!

The conditioning and the resulting quality of the AFs must meet the requirements of a continuously running manufacturing process regarding:

1. **thermal performance**
2. **product quality**
3. **pollution control**

Thermal Performance

of untreated waste and waste derived Alternative Fuels



The minimum requirements

1. Basic determination

1.1 Definition

1.2 Economical frame

1.3 Waste assessment

1.4 Technical process assessment

1.5 Permission

1.6 Designing the pre-treating process

2. Conditioning

2.1 Source & Composition

2.2 Treating haz./non-hazardous waste

2.3 Equipment

2.4 Quality assurance

2.5 AF and CO_2

2.6 Logistics

3. Materials Handling

3.1 AFR Systems

3.2 Truck unloading

3.3 Conveying and screening

3.4 AF storage

3.5 Weighing and feeding

3.6 Pneumatic conveying

3.7 ATEX directive

4. Co-processing

4.1 Kiln process

4.2 Feeding points

4.3 Co-processing

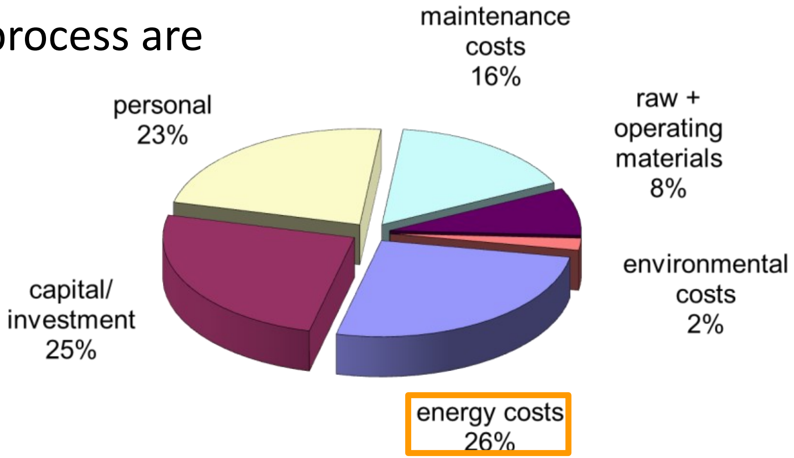
4.4 Awareness of Impacts

4.5 Faulty operation

Economical Framework

Production costs:

Roughly 26% of the cement manufactoring process are energy costs.



Depending on the technology the clinker burning process varies from ~6 kJ/kg$_{clinker}$ (wet process) to ~3 kJ/kg$_{clinker}$ (dry process).

Since the first oil price „shock“ (1979) the cement industry started to seek for cheaper energy, and switched to lignite, which also marks the specification of proper waste derived SRF today.

The thermal substitution rate (TSR) indicates the use of alternative fuels against fossil fuels standardized to its net calorific value.

The benefit of AF is by saving primary energy costs and to substitute AFs against those with a better gate fee.

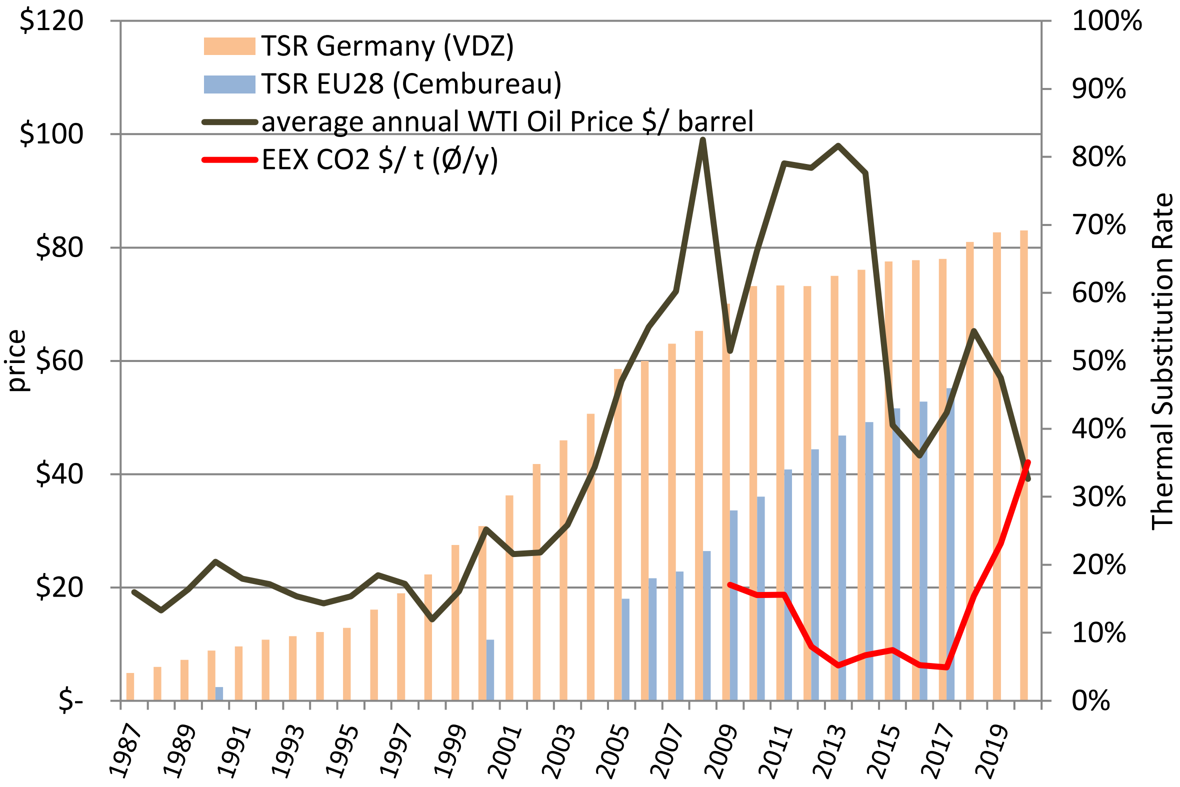
Economical Framework

Primary energy price:

The current oil price is still higher than in 1998 (14,39$/bbl) when the German Cement Industry starts its dog run to get the pole position before landfilling is prohibited by law from June, 2005.

Since the oil price peak in 2013 the profitablity of AF projects are regionally made on the individual bench mark test.

H_u WTI Oil: 41,9 GJ/t
1t = 7,33 barrels



Economical Framework

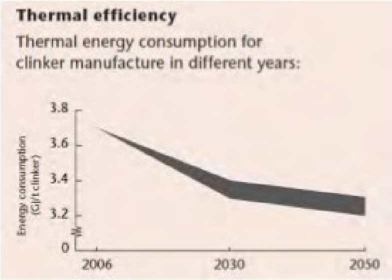
Greenhouse Gas Emission-Trading-System (GHG-ETS)

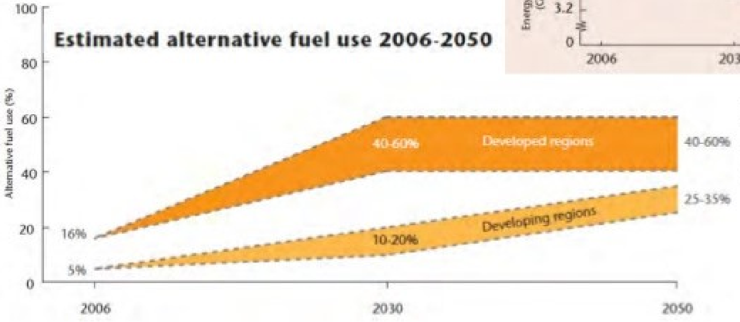
To date, 191 countries have ratified the Kyoto Convention on Climate Change.

The US has not ratified the Kyoto Protocol, whilst Canada withdrew in 2013.

The cement industry members of the World Business Council for Sustainable Development (WBCSD) committed themselves to enforce the Kyoto Protocol by reduction of GHG emissions.

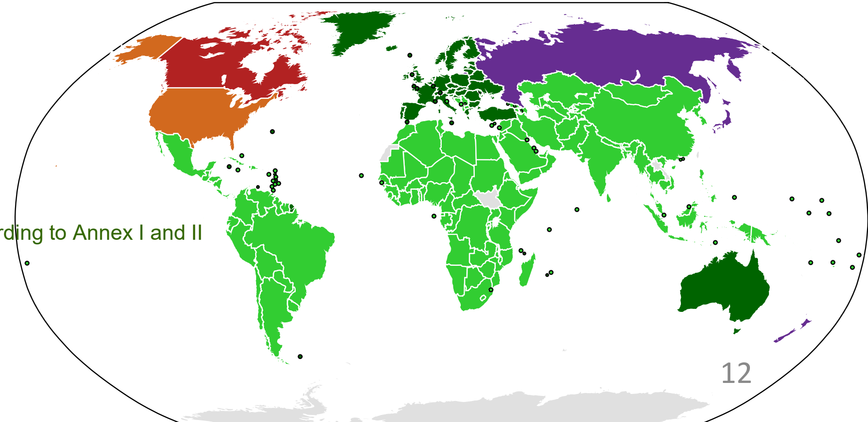
Clinker content:
78% (2006) → 71% (2050)





Source: WBCSD/IEA Cement Roadmap, 2011

Status of the Kyoto Protocol 2013-2020:
signatory countries with mandatory targets according to Annex I and II
developing countries without binding targets
not joined, position open
withdrawn
signatory states without binding targets



Economical Framework

Greenhouse Gas Emission-Trading-System (GHG-ETS)

A lot of options are identified such as to increase energy efficiency, clinker substitution or the intensive use of alternative fuels.

The anticipated effect awakening. The values fluctuation for trading CO_2-allowances had been an additional "icing on the cake" and did not play a crucial role in the past.

But, currently (2022) the European Emission Allowances Chart make AFR-projects more profitable.

Source: Finanz.net 2022

Economical Framework

Polluter-Pay-Principal/ disposal fee

Mostly financial authorities levies the disposal fee by a certain percentage of consumption of e.g. water, gas or estate taxes and transfer the responsibility inclusive money to private disposal companies (danger of vulnerability to corruption).

In Europe the waste disposal management companies are awarded by tender, and mandatorily certified and controlled by the authorities due to the legal regulations.

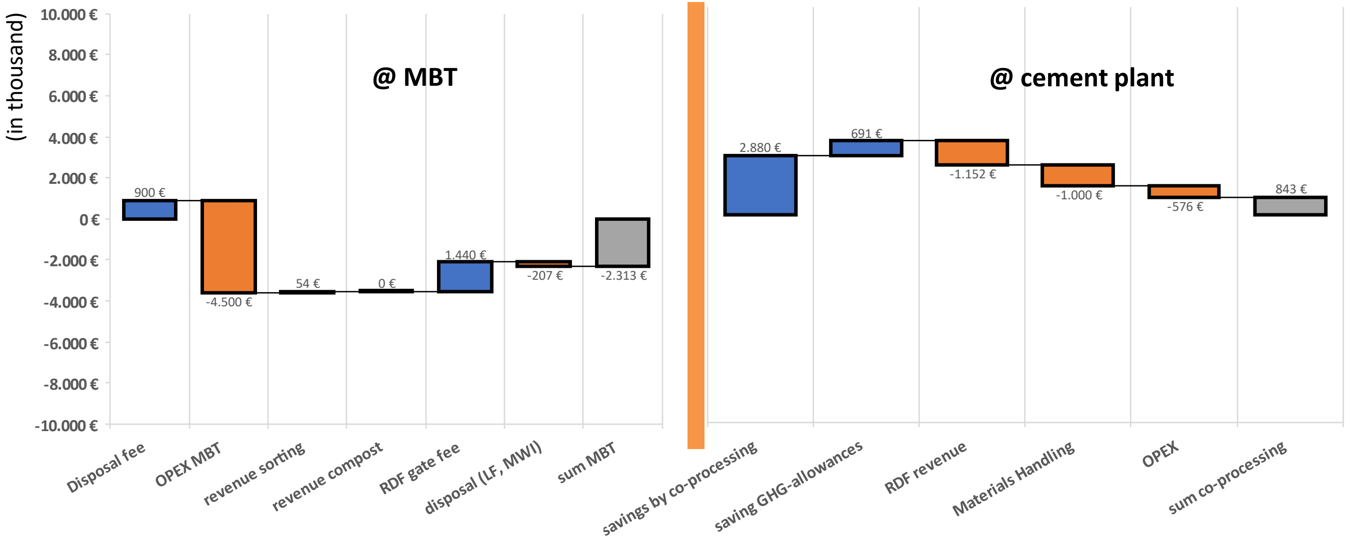
Additionally, the waste producer is the responsible owner and has to cover **ALL** the costs for a safe and environmental friendly disposal to enforce a consequent waste reduction.

In the case waste cannot be avoided all subjects such as stuff management, collection, transport, sorting, recycling, conditioning until quality monitoring, thermal use, waste incineration and sanitary landfilling are subsumed in this disposal fee.

The financial budget will be gained by disposal fee.

Gate fee vs. Revenue vs. Disposal fee

Low disposal fee and RDF-production subsidized by cement plant



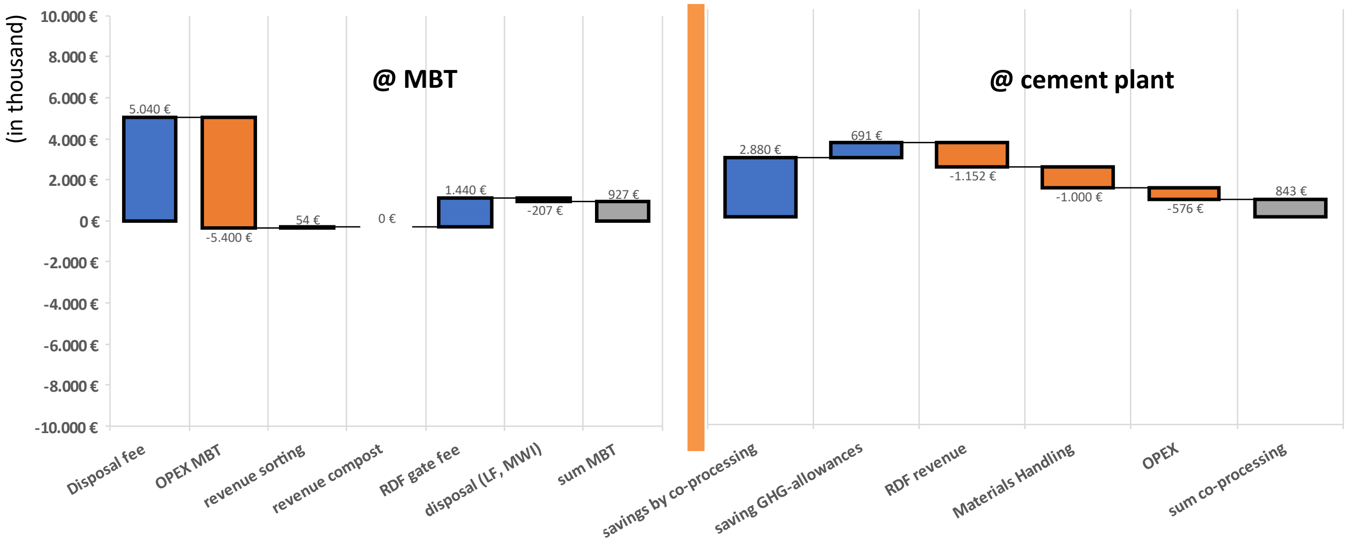
			t/y	€/t	T€/y
		Disposal fee	180.000	5 €	900.000 €
		OPEX MBT	180.000	-25 €	-4.500.000 €
amount	2%	revenue sorting	3.600	15 €	54.000 €
amount	35%	revenue compost	31.500	0 €	0 €
	40%	RDF gate fee	72.000	20 €	1.440.000 €
		disposal (LF, MWI)	41.400	-5 €	-207.000 €
		sum MBT		-13 €	-2.313.000 €

			t/y	€/t	T€/y
thermal loss	25%	savings by co-processing	57.600	50 €	2.880.000 €
biomass content	40%	saving GHG-allowances	23.040	30 €	691.200 €
		RDF revenue	57.600	-20 €	-1.152.000 €
-3.000.000 €	3,0	Materials Handling	172.800	-17 €	-1.000.000 €
		OPEX	57.600	-10 €	-576.000 €
		sum co-processing		15 €	843.200 €

WhiteLabel

Gate fee vs. Revenue vs. Disposal fee

Appropriate disposal fee and RDF-production subsidized by cement plant

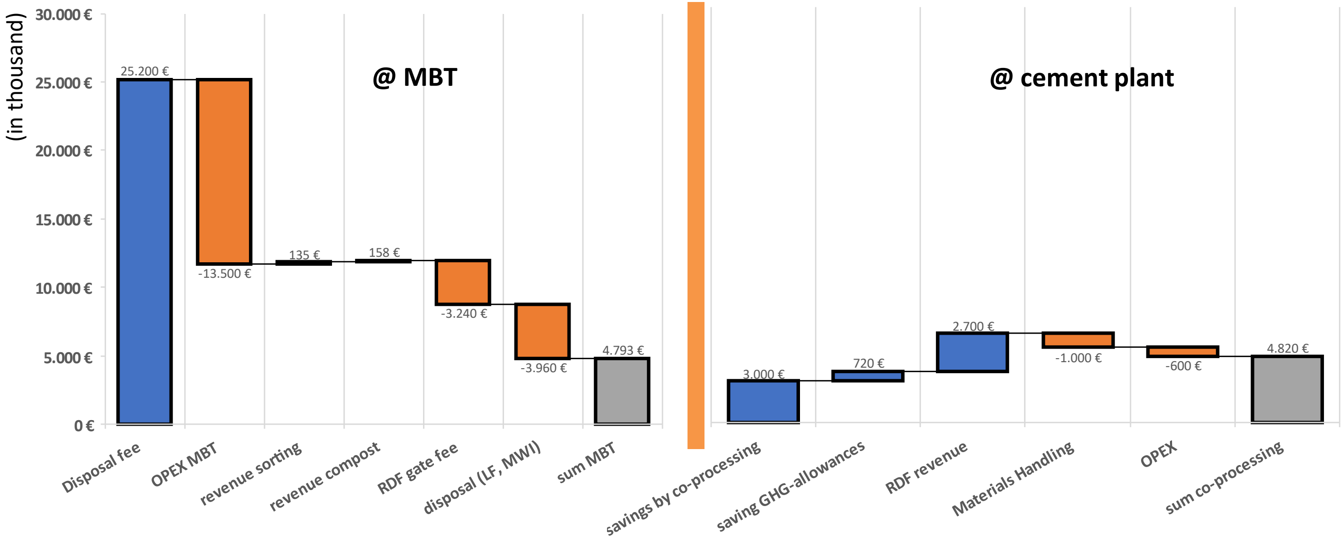


			t/y	€/t	T€/y
		Disposal fee	180.000	28 €	5.040.000 €
		OPEX MBT	180.000	-30 €	-5.400.000 €
amount	2%	revenue sorting	3.600	15 €	54.000 €
amount	35%	revenue compost	31.500	0 €	0 €
	40%	RDF gate fee	72.000	20 €	1.440.000 €
		disposal (LF, MWI)	41.400	-5 €	-207.000 €
		sum MBT		5 €	927.000 €

			t/y	€/t	T€/y
thermal loss	25%	savings by co-processing	57.600	50 €	2.880.000 €
biomass content	40%	saving GHG-allowances	23.040	30 €	691.200 €
		RDF revenue	57.600	-20 €	-1.152.000 €
-3.000.000 €	3,0	Materials Handling	172.800	-17 €	-1.000.000 €
		OPEX	57.600	-10 €	-576.000 €
		sum co-processing		15 €	843.200 €

Gate fee vs. Revenue vs. Disposal fee

RDF-production according to polluter-pay-principle incl. gate fee and orderly disposal

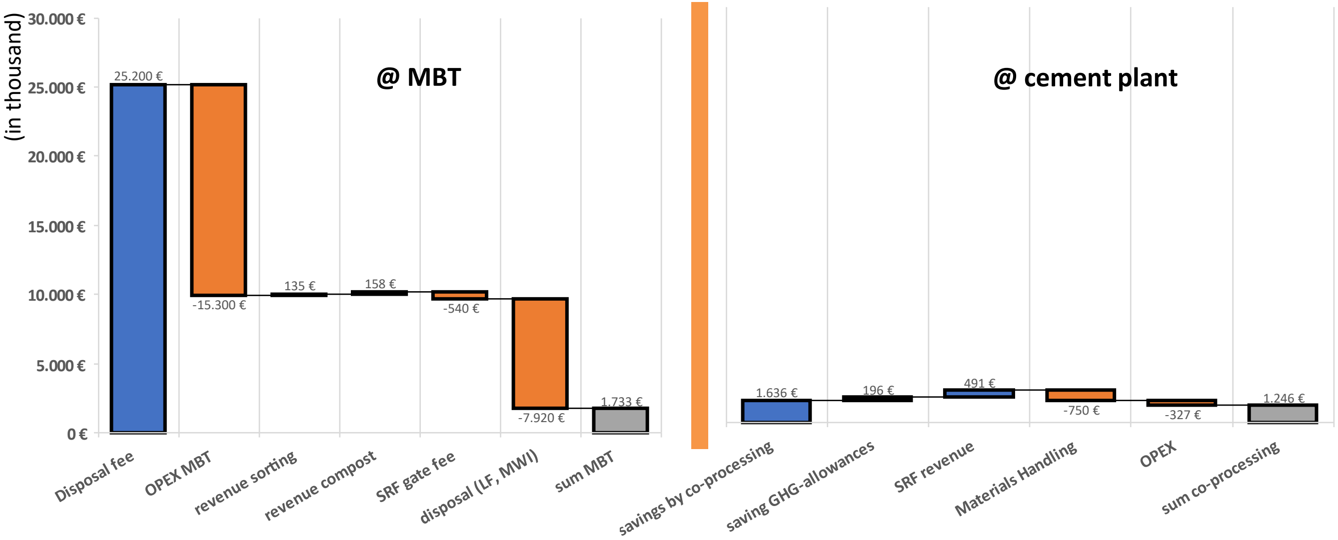


			t/y	€/t	T€/y
		Disposal fee	180.000	140 €	25.200.000 €
		OPEX MBT	180.000	-75 €	-13.500.000 €
amount	5%	revenue sorting	9.000	15 €	135.000 €
amount	35%	revenue compost	31.500	5 €	157.500 €
	40%	RDF gate fee	72.000	-45 €	-3.240.000 €
		disposal (LF, MWI)	36.000	-110 €	-3.960.000 €
		sum MBT		27 €	4.792.500 €

			t/y	€/t	T€/y
thermal loss	20%	savings by co-processing	60.000	50 €	3.000.000 €
biomass content	40%	saving GHG-allowances	24.000	30 €	720.000 €
		RDF revenue	60.000	45 €	2.700.000 €
-3.000.000 €	3,0	Materials Handling	180.000	-17 €	-1.000.000 €
		OPEX	60.000	-10 €	-600.000 €
		sum co-processing		80 €	4.820.000 €

Gate fee vs. Revenue vs. Disposal fee

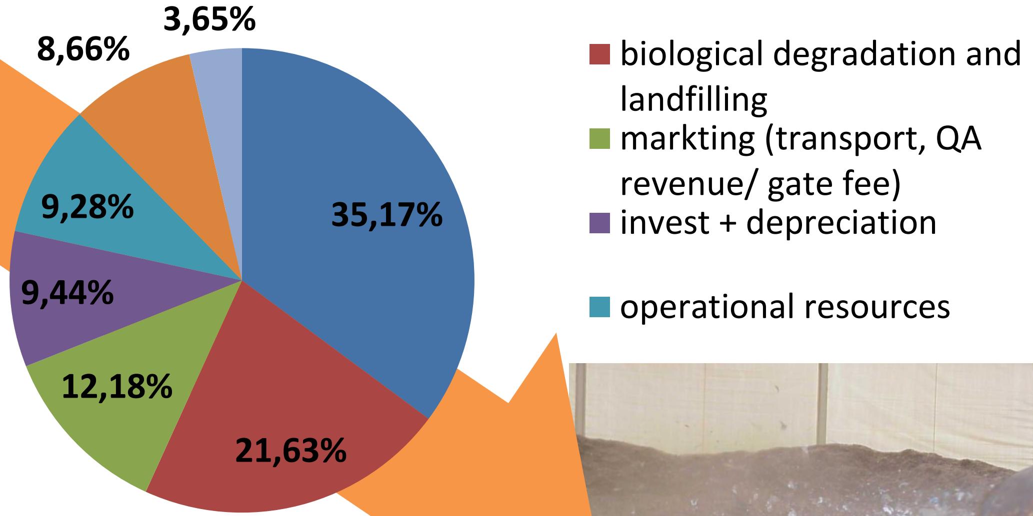
SRF-production according to polluter-pay-principle incl. gate fee and orderly disposal



			t/y	€/t	T€/y
		Disposal fee	180.000	140 €	25.200.000 €
		OPEX MBT	180.000	-85 €	-15.300.000 €
amount	5%	revenue sorting	9.000	15 €	135.000 €
amount	35%	revenue compost	31.500	5 €	157.500 €
	20%	SRF gate fee	36.000	-15 €	-540.000 €
		disposal (LF, MWI)	72.000	-110 €	-7.920.000 €
		sum MBT		10 €	1.732.500 €

			t/y	€/t	T€/y
thermal loss	10%	savings by co-processing	32.727	50 €	1.636.364 €
biomass content	20%	saving GHG-allowances	6.545	30 €	196.364 €
		SRF revenue	32.727	15 €	490.909 €
-1.500.000 €	2,0	Materials Handling	65.455	-23 €	-750.000 €
		OPEX	32.727	-10 €	-327.273 €
		sum co-processing		38 €	1.246.364 €

Cost Structure of an MBT to processing MSW to SRF

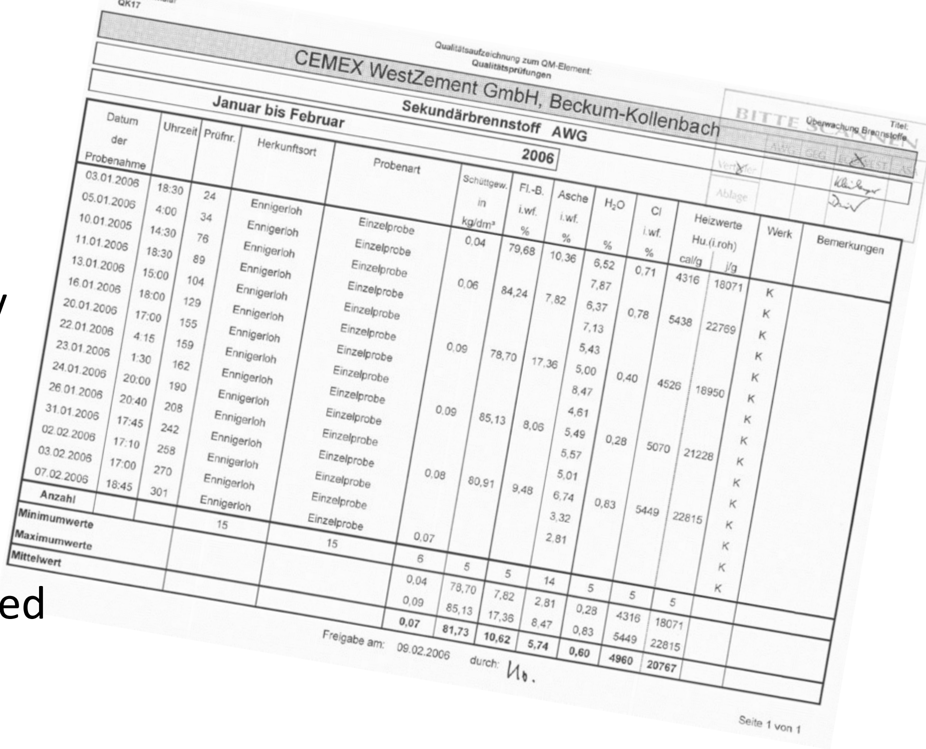


Viability

How to develop a contract for supply

When several agreed parameters and its value are analysed by norm for the delivery period, the statistical median value can be calculated from all results for the regular billing.

Finally, the settlement basis and tolerance are set in advance, so that the billing is based on the results of the deviation.



QK17

Qualitätsaufzeichnung zum QM-Element:
Qualitätsprüfungen

Titel: Überwachung Brennstoffe

BITTE SCANNEN

Verteiler

Ablage

CEMEX WestZement GmbH, Beckum-Kollenbach

Januar bis Februar — Sekundärbrennstoff AWG — 2006

Datum der Probenahme	Uhrzeit	Prüfnr.	Herkunftsort	Probenart	Schüttgew. in kg/dm³	Fl.-B. i.wf. %	Asche i.wf. %	H_2O %	Cl i.wf. %	Heizwerte Hu.(i.roh) cal/g	Heizwerte Hu.(i.roh) j/g	Werk	Bemerkungen
03.01.2006	18:30	24	Ennigerloh	Einzelprobe	0,04	79,68	10,36	6,52	0,71	4316	18071	K	
05.01.2006	4:00	34	Ennigerloh	Einzelprobe				7,87				K	
10.01.2005	14:30	76	Ennigerloh	Einzelprobe	0,06	84,24	7,82	6,37	0,78	5438	22769	K	
11.01.2006	18:30	89	Ennigerloh	Einzelprobe				7,13				K	
13.01.2006	15:00	104	Ennigerloh	Einzelprobe				5,43				K	
16.01.2006	18:00	129	Ennigerloh	Einzelprobe	0,09	78,70	17,36	5,00	0,40	4526	18950	K	
20.01.2006	17:00	155	Ennigerloh	Einzelprobe				8,47				K	
22.01.2006	4:15	159	Ennigerloh	Einzelprobe				4,61				K	
23.01.2006	1:30	162	Ennigerloh	Einzelprobe	0,09	85,13	8,06	5,49	0,28	5070	21228	K	
24.01.2006	20:00	190	Ennigerloh	Einzelprobe				5,57				K	
26.01.2006	20:40	208	Ennigerloh	Einzelprobe				5,01				K	
31.01.2006	17:45	242	Ennigerloh	Einzelprobe	0,08	80,91	9,48	6,74	0,83	5449	22815	K	
02.02.2006	17:10	258	Ennigerloh	Einzelprobe				3,32				K	
03.02.2006	17:00	270	Ennigerloh	Einzelprobe				2,81				K	
07.02.2006	18:45	301	Ennigerloh	Einzelprobe	0,07							K	
Anzahl			15	15	6	5	5	14	5	5	5		
Minimumwerte					0,04	78,70	7,82	2,81	0,28	4316	18071		
Maximumwerte					0,09	85,13	17,36	8,47	0,83	5449	22815		
Mittelwert					**0,07**	**81,73**	**10,62**	**5,74**	**0,60**	**4960**	**20767**		

Freigabe am: 09.02.2006 durch: Uo.

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This answers why there is no “market price” for alternative fuels:

Each client has **their own goals and tolerance** against impacts based on the previous assessments of the process, their product and emissions.

Viability

How to draw up a supply contract

			calorific value (inferior)	
		<16 MJ/kg	16 MJ/kg	>16 MJ/Kg
Correction factor	per t per MJ/kg	-2,00 $	0,00 $	1,00 $
			chlorine content	
Concentration		< 0,9%	0,90%	> 0,9%
Correction factor	per t per 0,1%	3,00 $	0,00 $	-3,00 $
			moisture content	
Concentration		< 20%	20%	> 20%
Correction factor	per t per %	1,50 $	0,00 $	-1,50 $
			biomass content	
Concentration		<30%	30%	>30%
Correction factor	per t per %	-2,00 $	5,00 $	2,00 $

Incidentally, this billing basis can be extended or shortened as desired for the supply contracts. And, this also shows very clearly that it is always worthwhile to assess the composition and properties of the intended waste in detail first and to align the processing plant accordingly (invest) in order to produce tailor-made qualities (quality assurance).

		calorific value (inferior)		
		<16 MJ/kg	16 MJ/kg	>16 MJ/Kg
Correction factor	per t per MJ/kg	-2,00 $	0,00 $	1,00 $

		chlorine content		
Concentration		< 0,9%	0,90%	> 0,9%
Correction factor	per t per 0,1%	3,00 $	0,00 $	-3,00 $

		moisture content		
Concentration		< 20%	20%	> 20%
Correction factor	per t per %	1,50 $	0,00 $	-1,50 $

		biomass content		
Concentration		<30%	30%	>30%
Correction factor	per t per %	-2,00 $	5,00 $	2,00 $

Settlement basis per ton (delivery contract): **10,00 $**

Example 1:		Median value/ month	in accordance to committed norms
	calorific value MJ/kg	17,32	2,64 $/t
	chlorine	1,14%	-7,20 $/t
	moisture	30,0%	-15,00 $/t
	biomass content	31,8%	8,60 $/t
			Purchase price for plant: -10,96 $/t

Example 2:		Median value/ month	
	calorific value MJ/kg	22,00	12,00 $/t
	chlorine	0,50%	12,00 $/t
	moisture	12,0%	12,00 $/t
	biomass content	15,0%	-25,00 $/t
			Purchase price for plant: 11,00 $/t

Now you should be able to bill…

- ✓ Verification of the agreed parameters
- ✓ agreed on comprehensible norms/ methods
- ✓ in accordance to the legal frame
- ✓ as an honourable merchant

Agreed base amount per ton

+ Bonus/ penalty due to process parameters

+ Bonus per increase of CO_2-neutral ingredients

- penalty per amount of fossil ingredients

- penalty per process harming impurities such as water, Cl etc.

____

gate fee to/ revenue from cement plant

The minimum requirements

1. Basic determination	2. Conditioning	3. Materials Handling	4. Co-processing
1.1 Definition	2.1 Source & Composition	3.1 AFR Systems	4.1 Kiln process
1.2 Economical frame	2.2 Treating haz./non-hazardous waste	3.2 Truck unloading	4.2 Feeding points
1.3 Waste assessment	2.3 Equipment	3.3 Conveying and screening	4.3 Co-processing
1.4 Technical process assessment	2.4 Quality assurance	3.4 AF storage	4.4 Awareness of Impacts
1.5 Permission	2.5 AF and CO_2	3.5 Weighing and feeding	4.5 Faulty operation
1.6 Designing the pre-treating process	2.6 Logistics	3.6 Pneumatic conveying	
		3.7 ATEX directive	

Technical Assessment

Credit: WLTP

The technical assessment shall serve you to determine the bottle necks for co-processing:

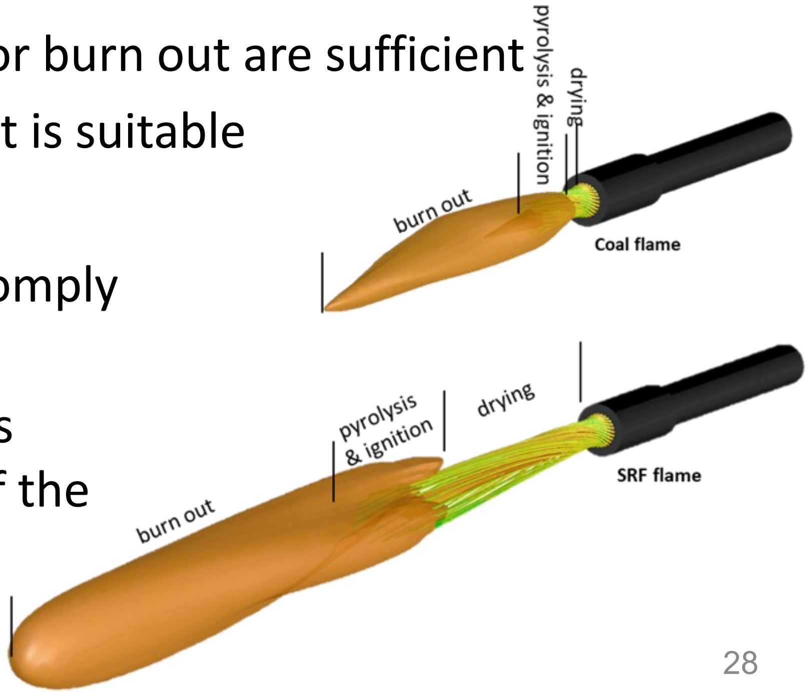
1) Type of kiln and needs for plant revamp and modernizing
2) Limitations according the raw material and fuel(s)
3) Limitation according to air pollution control (permission)
4) Energy demand and materials handling
5) options for finding your own position and business model, and
6) to strengthen your position against traders, or to negotiate with waste conditioners and suppliers, environmental authorities, publicity, and your cement clients

Technical Assessment

Unlike disposal, waste derived alternative fuels must comply with the combustion conditions of the kiln process.

Particularly, it is important to ensure that

- the particle size and residence time for burn out are sufficient
- the oxygen supply at the feeding point is suitable
- micro-mixing is ensured
- the trajectories of the SRF particles comply with the momentum of the burner
- the burn-out time of the RDF particles corresponds to the type and length of the calciner loop



Source: PROCESS // Optimization - ZKG 02 2012

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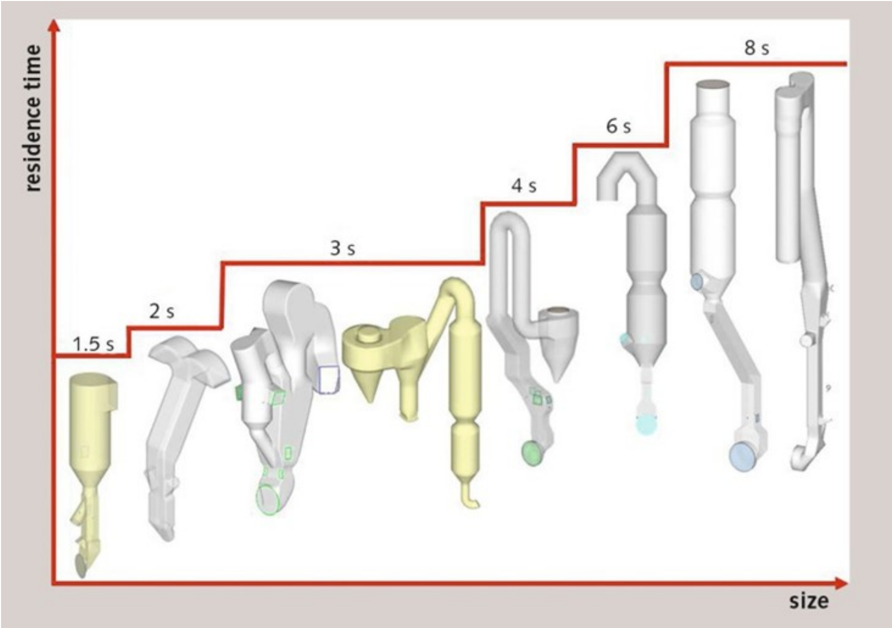
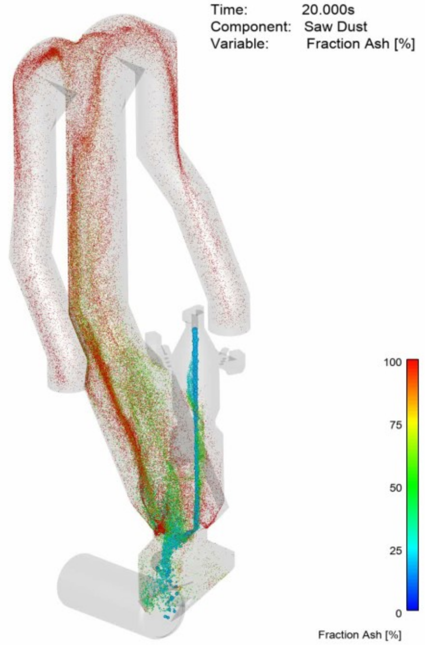
Technical Assessment



Credit: KHD



Credit: aisergee

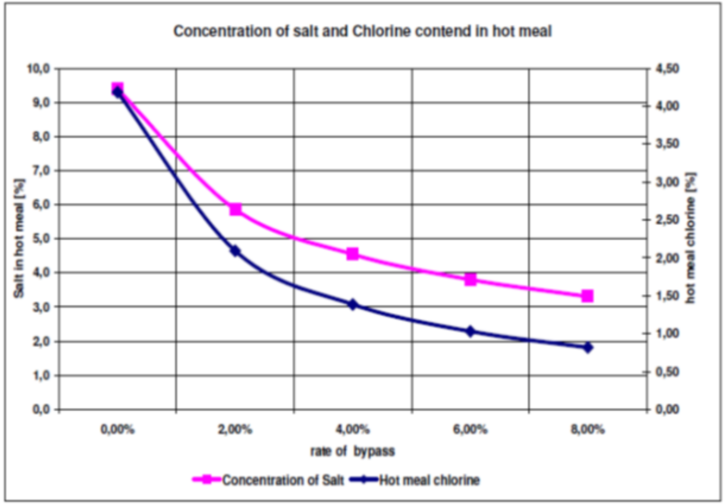
The residence time, oxygen distribution and the point of feeding defines the grain size of RDF for designing the pre-processing right.
Vice versa a CFD simulation can guide to the best point of feeding for the pyroprocess.

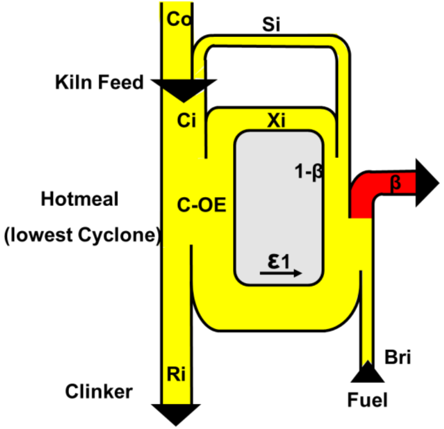
RDF is passing through the SLC

Alkalines, chlorine, sulphure

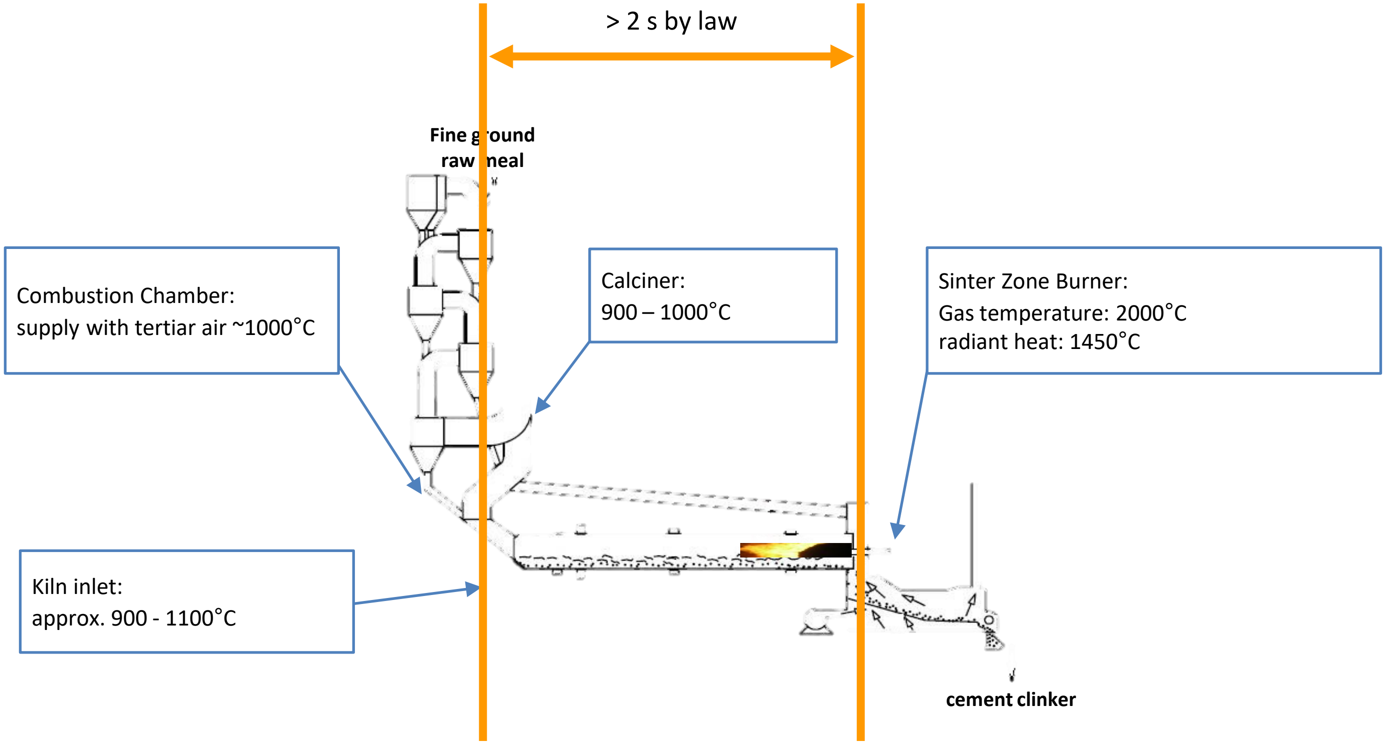
Prior to the design of the waste conditioning a heat balance and a mass balance with regard to the tolerance against chlorine, sulphur and alkalines has to be executed to find bottle necks or freedom as well.

Content of salt	Kritisch	Erhöht	Erhöht	Normal	Normal
Cl-Content	Verstopfung	Verstopfung	Ansatz	Ansatz	Kein Ansatz
stickiness (S & Cl)	Verstopfung	Verstopfung	Starker Ansatz	Starker Ansatz	Unkritisch
flow rate	Kritisch	Kritisch	Kritisch	Unkritisch	Unkritisch





Feeding Alternative Fuels



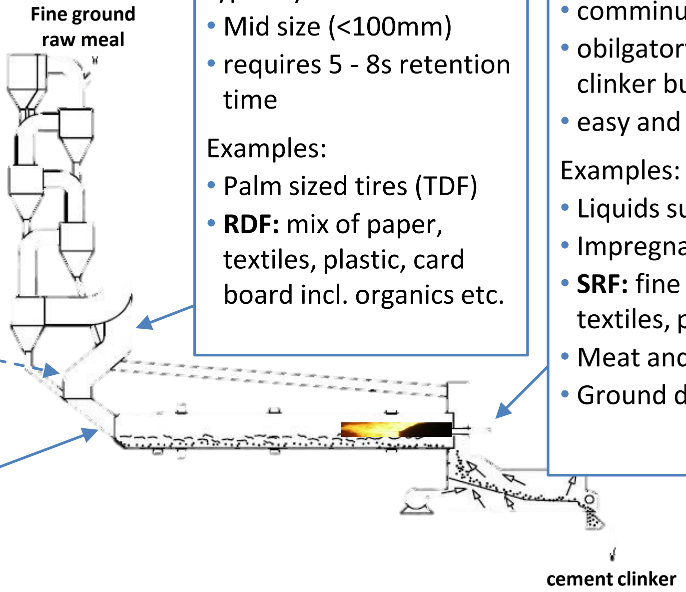
Feeding Alternative Fuels

Pre-processed fuel for a combustion chamber at the calciner is typically:
- extreme large
- requires long dwell time for burnout
- hard to pre-process

Examples:
- **HCF** (300mm)
- chopped wind blades, tar paper etc.
- biomass like wood, kernel, nutshell etc.

Fuel for the kiln inlet is typically:
- coarse (<800mm)

Examples:
- whole tires
- biomass



Fuel for the calciner is typically:
- Mid size (<100mm)
- requires 5 - 8s retention time

Examples:
- Palm sized tires (TDF)
- **RDF:** mix of paper, textiles, plastic, card board incl. organics etc.

Fuel for a main burner is typically:
- comminuted to a small particle size or sprayable
- obilgatory free of 3-D impurities, which effect the clinker burning process (reductive burning)
- easy and fast to ignite (<2 s)

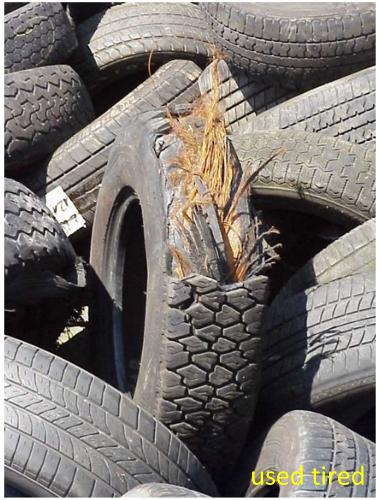
Examples:
- Liquids such as solvents or used oil,
- Impregnated saw dust
- **SRF:** fine treated, 2-D-fraction mixed paper, textiles, plastic, card board etc.
- Meat and Bone Meal (**MBM**)
- Ground dry sewage sludge (**DSS**)

The minimum requirements

1. Basic determination	2. Conditioning	3. Materials Handling	4. Co-processing
1.1 Definition	2.1 Source & Composition	3.1 AFR Systems	4.1 Kiln process
1.2 Economical frame	2.2 Treating haz./non-hazardous waste	3.2 Truck unloading	4.2 Feeding points
1.3 Waste assessment	2.3 Equipment	3.3 Conveying and screening	4.3 Co-processing
1.4 Technical process assessment	2.4 Quality assurance	3.4 AF storage	4.4 Awareness of Impacts
1.5 Permission	2.5 AF and CO_2	3.5 Weighing and feeding	4.5 Faulty operation
1.6 Designing the pre-treating process	2.6 Logistics	3.6 Pneumatic conveying	
		3.7 ATEX directive	

Sources


wild dumping


used tired


sewage sludge


sludge


used oil/ solvents

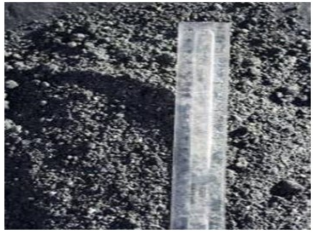

Rice husks

Tailor-made alternative fuels

High grade SRF

Tire Derived Fuel

dried sewage sludge



dried sludge

used oil/ solvents

Rice husks

Waste Catalogue List

EWC	Name
02 01 04	waste plastics (except packaging)
03 01 05	sawdust, shavings, cuttings, wood, particle board and veneer
03 03 02	green liquor sludge
03 03 05	de-inking sludge
03 03 07	mechanically separated rejects from pulping
03 03 08	waste from sorting of paper, cardboard destined for recycling
03 03 10	fibre rejects, fibre-, filler- and coating-sludges
04 02 09	wastes from composite material (impregnated textiles, elastomer, plastomer)
04 02 21	waste from unprocessed textile fibres
04 02 22	waste from processed textile fibres
07 01 04*	other organic solvents, washing liquids
07 02 04*	other organic solvents, washing liquids
07 02 13	waste plastic
07 03 04*	other organic solvents, washing liquids
07 04 04*	other organic solvents, washing liquids
07 05 04*	other organic solvents, washing liquids
07 06 04*	other organic solvents, washing liquids
07 07 04*	other organic solvents, washing liquids
…	

In the EU different types of waste are listed in the so called **E**uropean **W**aste **C**atalogue (EWC), where the waste ist fully defined by its six-digit code.

The first two digits identify the source generating the waste from chapter 01 (exploration, mining, mineral treatment etc.) until chapter 20 (municipal wastes incl. similar commercial, industrial and separate collected fractions).

The two middle digits identify the sector, and the last two digits the type of waste.

For example:

04 wastes from leather and textile industries

04 02 wastes from textile industry

04 02 09 wastes from composite materials (impregnated textile, elastomer, plastomer)

A code with an asterisk (*) marks the hazardous waste.

Waste Assessment and sensefull design

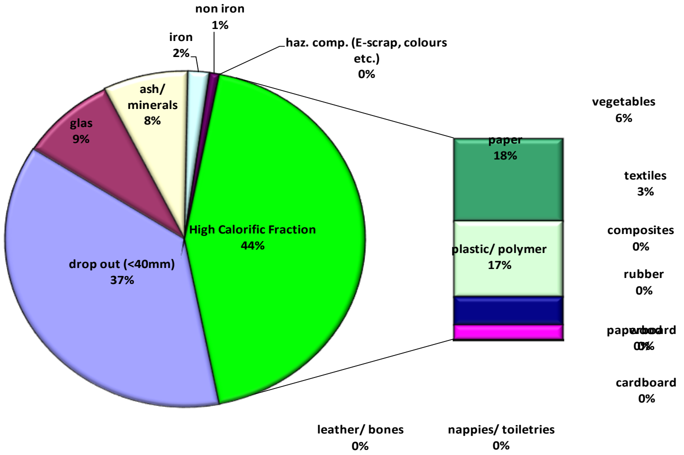
Pre-treating of commercial and industrial waste (C+IW) to high grade SRF (main burner) requires less investment due to the pre-selected and cherry-picked waste.

Waste Assessment: Composition

Assessing the waste composition by manuell classification

In order to design a suitable pre-treatment process for mixed waste, the proportion of recyclables, recyclable materials, combustible materials and impurities must first be determined.

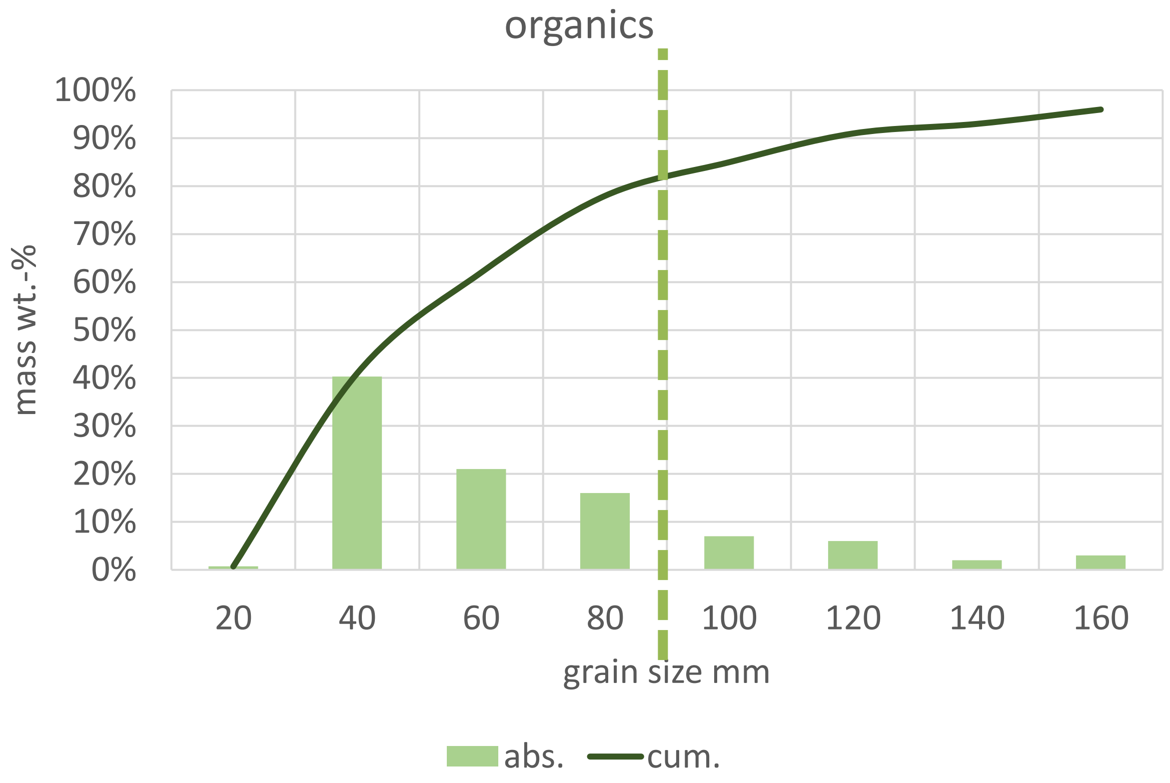
Determination of the fuel potentials



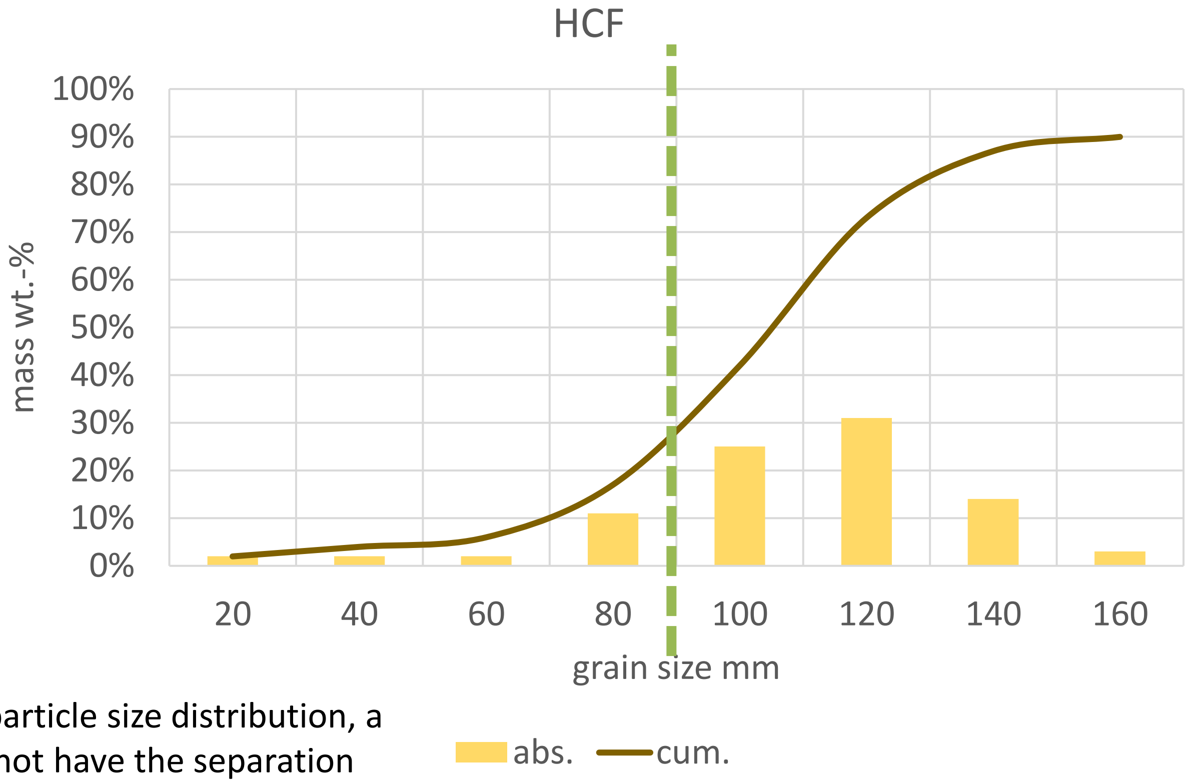
Waste Composition **High Calorific Fraction**

credit: WLTP

Results of screening analysis: Organcis



Results of screening analysis: HCF



Because of the flat particle size distribution, a compost screen cannot have the separation effect that is required here.

The minimum requirements

1. Basic determination

1.1 Definition
1.2 Economical frame
1.3 Waste assessment
1.4 Technical process assessment
1.5 Permission
1.6 Designing the pre-treating process

2. Conditioning

2.1 Source & Composition
2.2 Treating haz./non-hazardous waste
2.3 Equipment
2.4 Quality assurance
2.5 AF and CO_2
2.6 Logistics

3. Materials Handling

3.1 AFR Systems
3.2 Truck unloading
3.3 Conveying and screening
3.4 AF storage
3.5 Weighing and feeding
3.6 Pneumatic conveying
3.7 ATEX directive

4. Co-processing

4.1 Kiln process
4.2 Feeding points
4.3 Co-processing
4.4 Awareness of Impacts
4.5 Faulty operation

Outlook on the chemical properties of the AFs

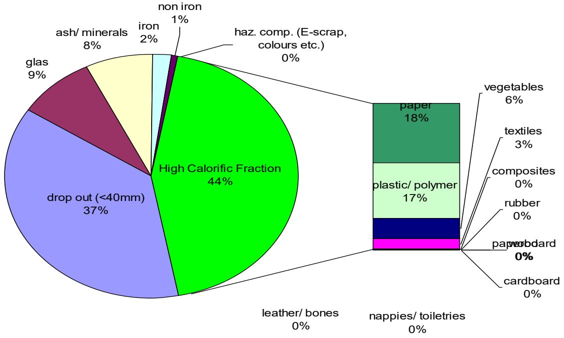
To avoid surprises during use, the waste assessment must also identify the chemically supporting as well as the interfering elements. These are:

- Moisture by organics and untreated biomass,
- Silicium, i.e. "lime eater" by glass,
- Alkalines by glass and food,
- Volatile heavy metals such as Hg, Cd, Tl etc.
- Sulfate, e.g. introduced by mortar from construction waste, and
- Chlorine by food salt and PVC…

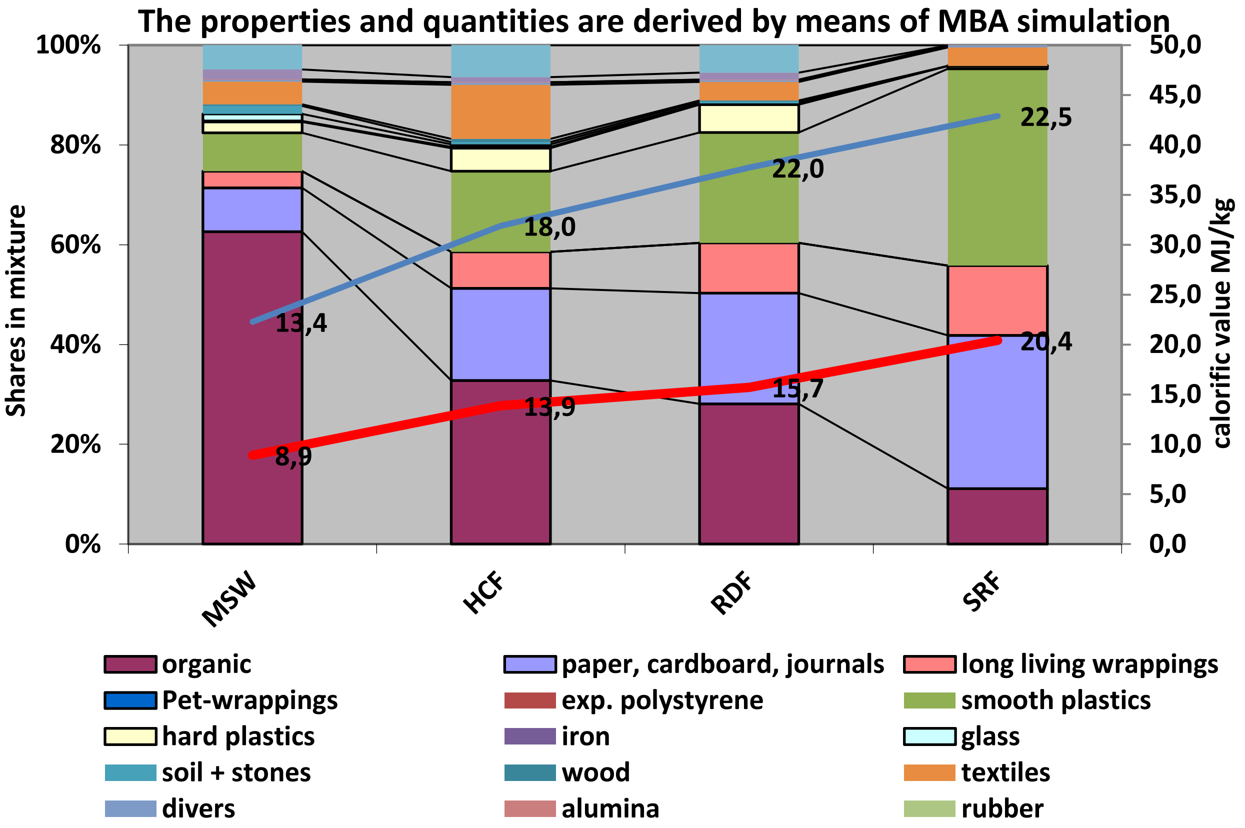
Waste Assessment: Composition + thermal potential

Waste Component	Share	MBT Modelling	Untreated waste	resulting fuel mix
composites				
rubber				
plastic/ polymer	16,5%			51%
wood				
textiles	3,2%			12%
paper	18,0%			35%
paperboard				
cardboard				
nappies/ toiletries				
leather/ bones				
vegetables	6,1%			1%
glas	8,6%			
iron	1,9%			
non iron	0,9%			
haz. comp. (E-scrap, colours etc.)				
ash/ minerals	7,6%			
drop out (<40mm)	37,1%			
		Hu (kJ/kg):	7.974	22.177

Credit: WLTP and TerraMelhor



MBT Modelling/ outlook to quantity and quality

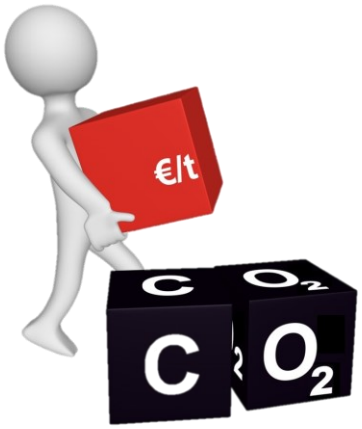


Credits: WLTP (Bangalore 2016)

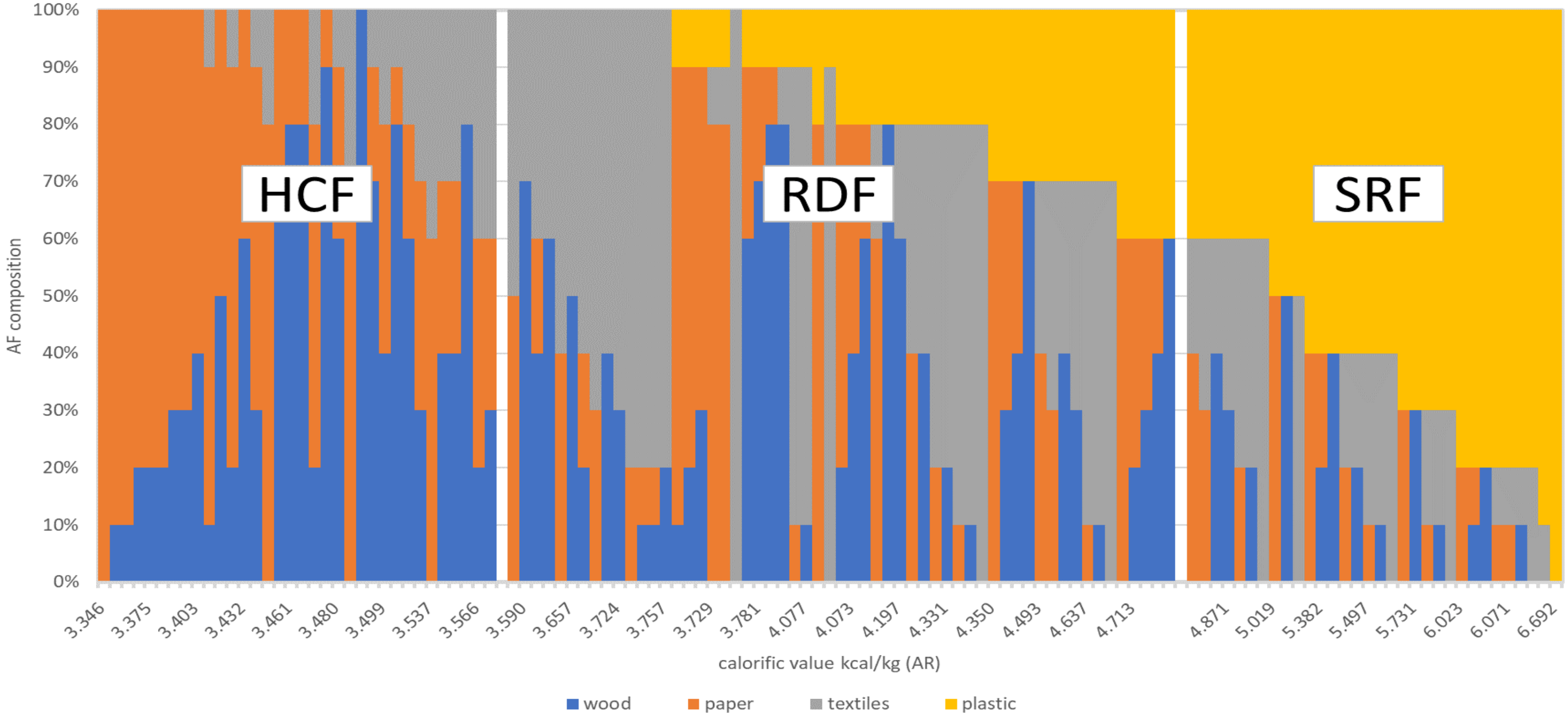
WhiteLabel

MBT Modelling based on representative data of a waste assessment

Composition of Fraction	unvalidated MSW composition	MSW after biodrying	HCF (< 300mm)	RDF (< 100mm)
		MBT simulation		
organic	43,6%	24,8%	10,2%	8,4%
paper, cardboard, journals	9,1%	12,1%	19,9%	23,1%
long living wrappings	0,7%	0,9%	1,5%	2,0%
Pet-wrappings	0,8%	1,1%	1,9%	2,5%
exp. polystyrene	0,5%	0,7%	1,0%	1,3%
smooth plastics	10,6%	14,1%	23,2%	30,7%
hard plastics	1,9%	2,5%	4,1%	4,8%
iron	5,6%	7,5%	7,7%	2,5%
glass	2,4%	3,2%	1,0%	0,3%
soil + stones	1,7%	2,3%	0,5%	0,4%
wood	0,7%	0,9%	1,5%	0,5%
textiles	0,2%	0,3%	0,5%	0,2%
divers	0,2%	0,3%	0,3%	0,2%
aluminum	2,8%	3,7%	3,8%	3,2%
rubber	0,5%	0,7%	0,7%	0,3%
toiletries	4,0%	5,3%	2,2%	2,9%
Residuals	14,8%	19,8%	20,2%	16,8%
gross calorific value MJ/kg	*7,9*	*8,9*	*12,5*	*15,2*

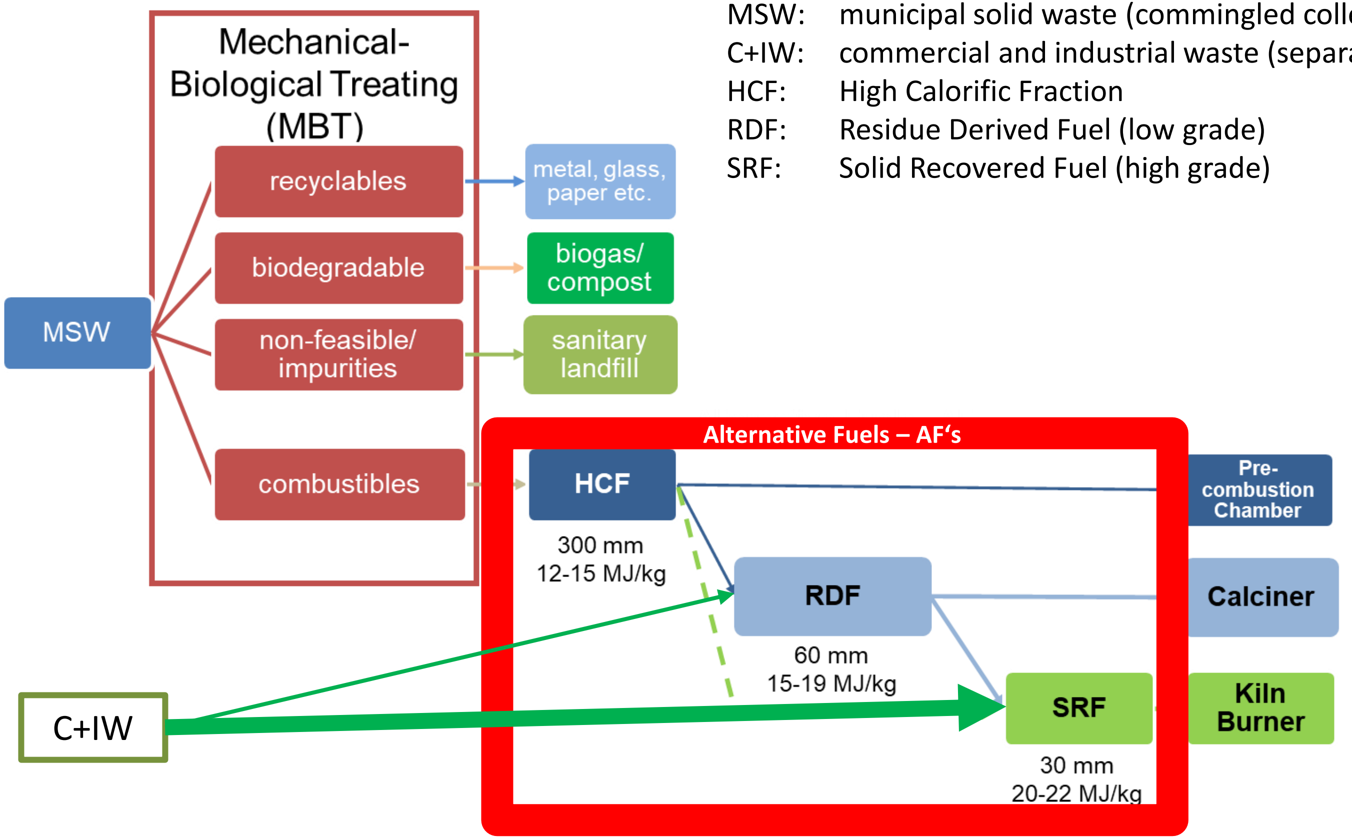


Derivation of the cv and their CO_2-neutral portion



Regarding the source and purpose the composition of blend AF can vary between 0% (polymer) in SRF and 100% (biomass) of CO_2-neutral compounds in HCF.

Waste Assessment and sensefull design



MSW: municipal solid waste (commingled collected)
C+IW: commercial and industrial waste (separate collection)
HCF: High Calorific Fraction
RDF: Residue Derived Fuel (low grade)
SRF: Solid Recovered Fuel (high grade)

Waste Assessment and sensefull design

The pre-treatment of mixed municipal solid waste requires excellent separation and purification equipment to obtain the required fuel properties.

The minimum requirements

1. Basic determination → **2. Conditioning** → **3. Materials Handling** → **4. Co-processing**

1. Basic determination

1.1 Definition
1.2 Economical frame
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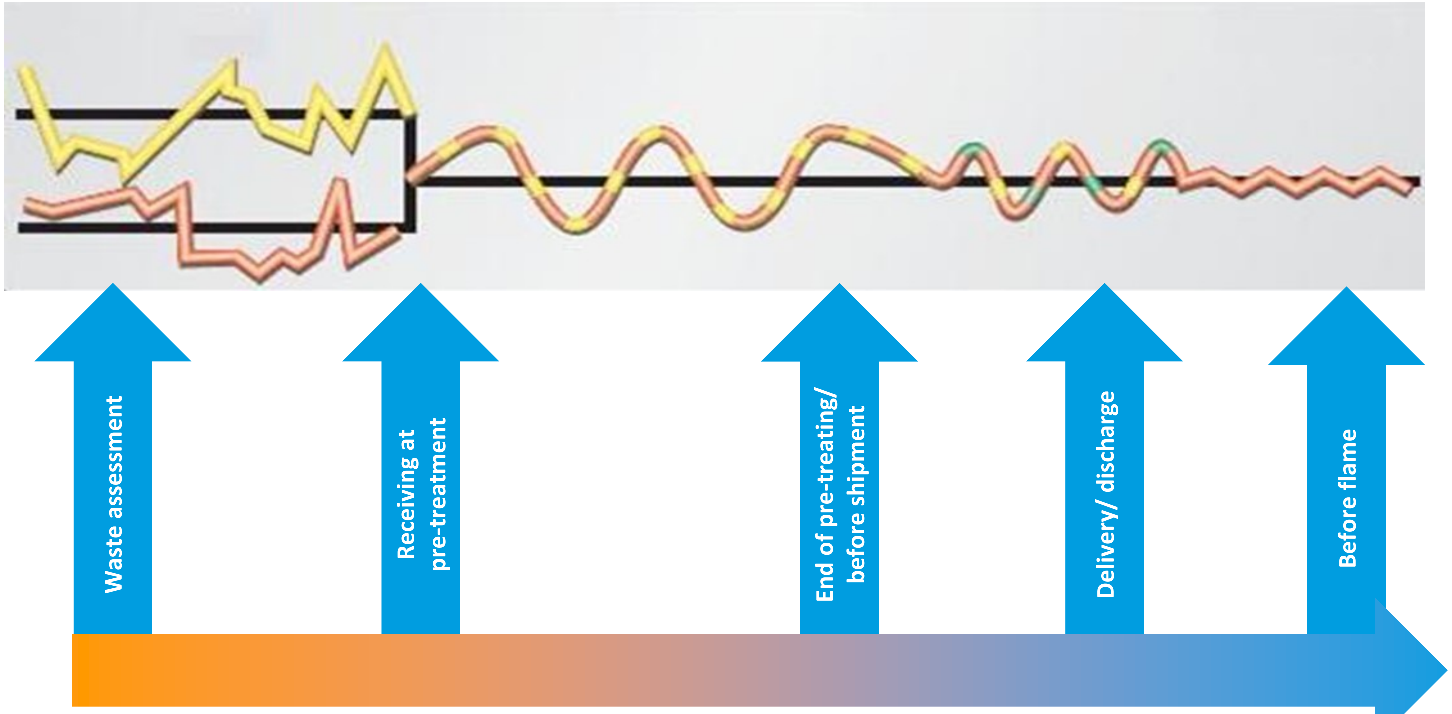
4.1 Kiln process
4.2 Feeding points
4.3 Co-processing
4.4 Awareness of Impacts
4.5 Faulty operation

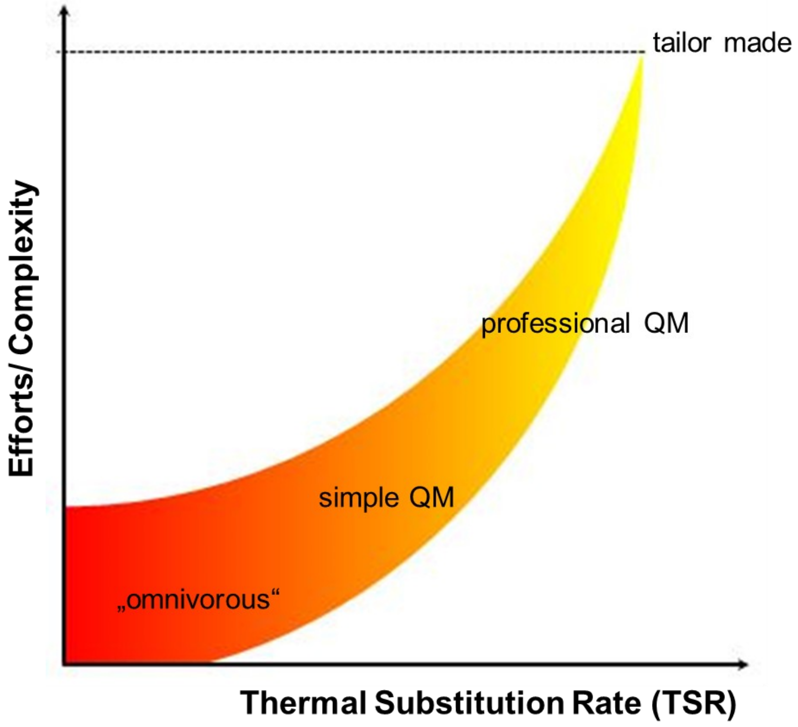
Quality targets



In accordance to the operational permission

in accordance to the permission and process

Quality targets



High quality

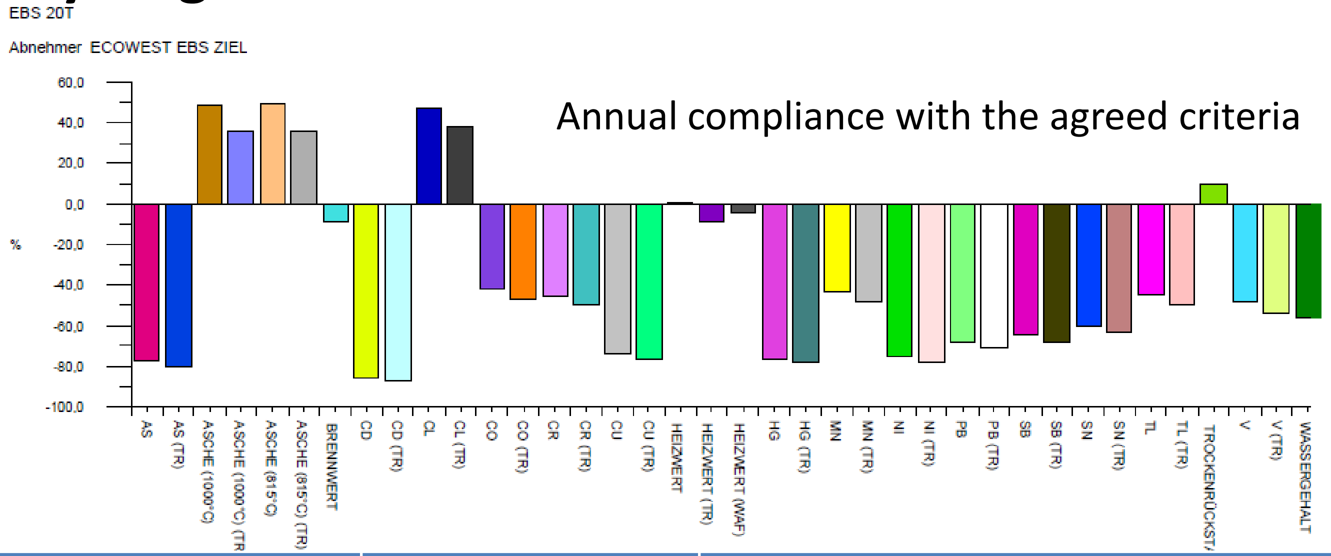
- Small and equal grain size
- No 3D particles in SRF
- Water content of about 12%
- Constant ash chemistry (cf. ternary diagram)
- Low in impurities
- Low content of Cl, S, Na, K, Mg and/ or heavy metals

Low quality

- Coarse grain size/ heavy fuel particles (3D)
- inhomogeneous
- High or different water content
- Different ash chemistry
- Impurities of metal, glass, stones
- High content of Cl, S, Na, K, Mg and/ or heavy metals

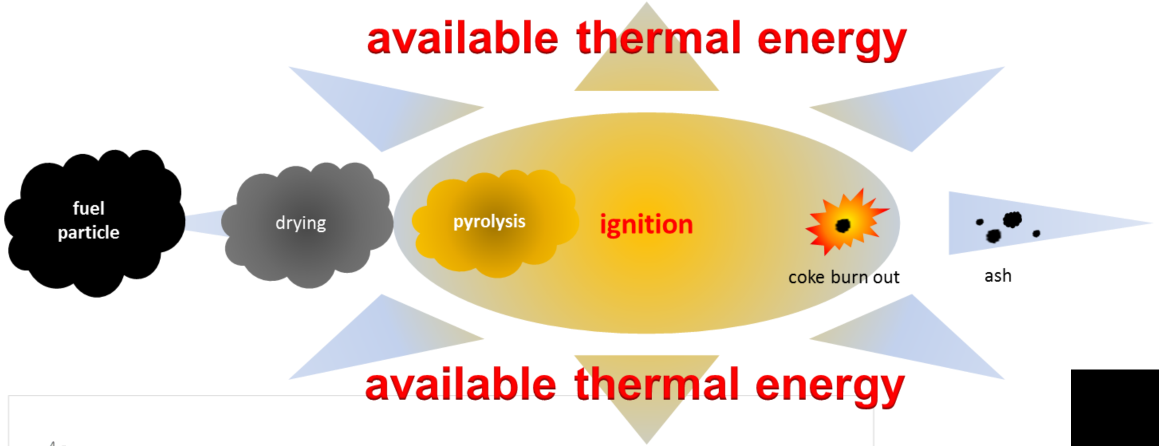
The higher the TSR rate, the more precisely the fuel must match the process.

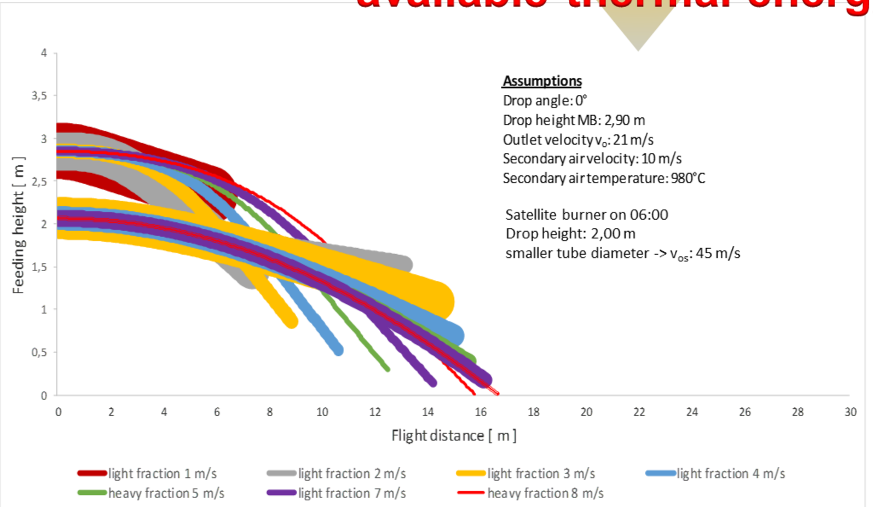
Quality targets

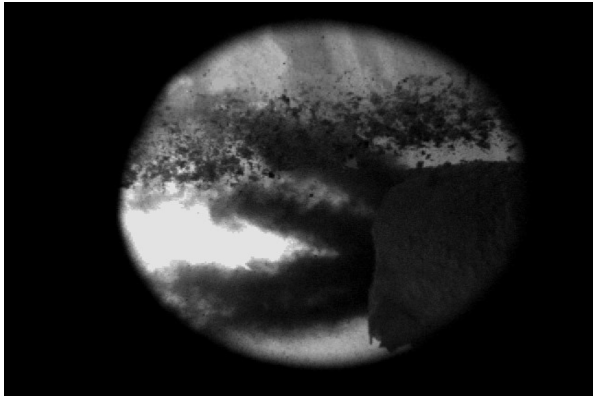


Objective	remark	Counter measure
ash content (on 815 resp. 1000°C)	Higher than 10%	effective screening, sifting and monitoring
chlorine	above 0,5%	install NIR
Lower/ gross cv	„safety distance“ to threshold too small	Corresponds to the moisture and ash content, which results in optimization of pre-processing (screening, drying, blending etc.)

Adjustment of SRF quality and burner parameters







Practical significance

Control SRF conditioning quality:

For approaching a sufficient and high TSR the conditioner should agree on a practicable specification with its customer.

This, he can use for acquisition of suitable C+IW for its SRF according to the kiln's need, or…

Practical significance

credit: JOEST

...the **conditioner** may install a suitable classifier with a wind speed range from 5 to 15 m/s of decent.

If a **cement** plant is supplied by different suppliers, this unit can also be used as a "police filter" in a storage facility at the cement plant **(two stuff streams)**.

credit: A TEC

An alternative can be crushing if all the resulting particles subsequently take on suitable flight properties
(one stuff stream).

Next Step of Adaptation for exhausting TSR on Calciner

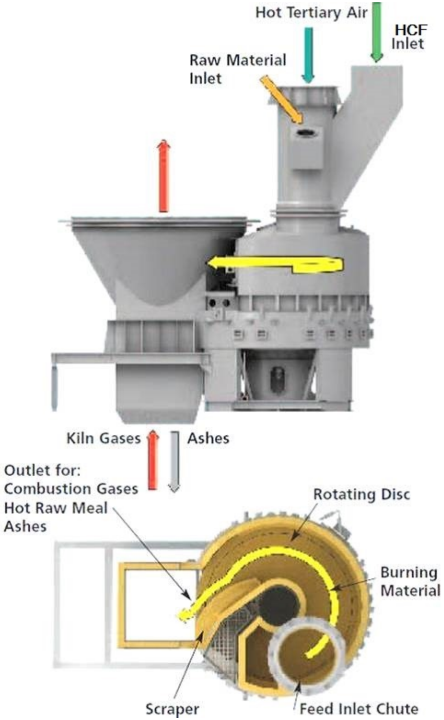
A TEC

TKIS

Co-processing RDF in the Calciner means extension of residence time or modifying the RDF-conditioning

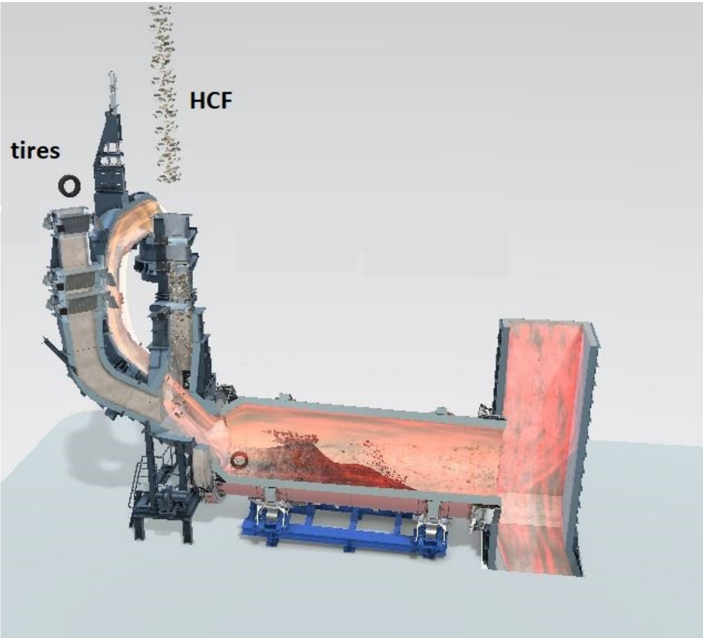
Next Step of Adaptation for exhausting TSR on Calciner

PREPOL Step Combustor (tkIS)



HOTDISC (FLSmidth)

Pyrorotor (KHD)



Coarse HCF <300mm for co-processing at the calciner

Conclusion

If pre-processing is planned both results are required of

a) the waste assessment, and

b) the technical assessment.

Thus, the waste potential and the performance of the kiln determine, on the one hand, the need for adaptation of the kiln and, on the other hand, the required design of the processing plant and thus the necessary total investment.

It should be noted that only a favorable solution (not a cheap one) leads to a safe supply and a safe kiln operation at high TSR.

And:

Co-processing is a part of the solution!

Obrigado por ouvir!

www.wltp.eu

Alguma observação ou pergunta?