Quality-assured fuels as part of an integrated waste management concept

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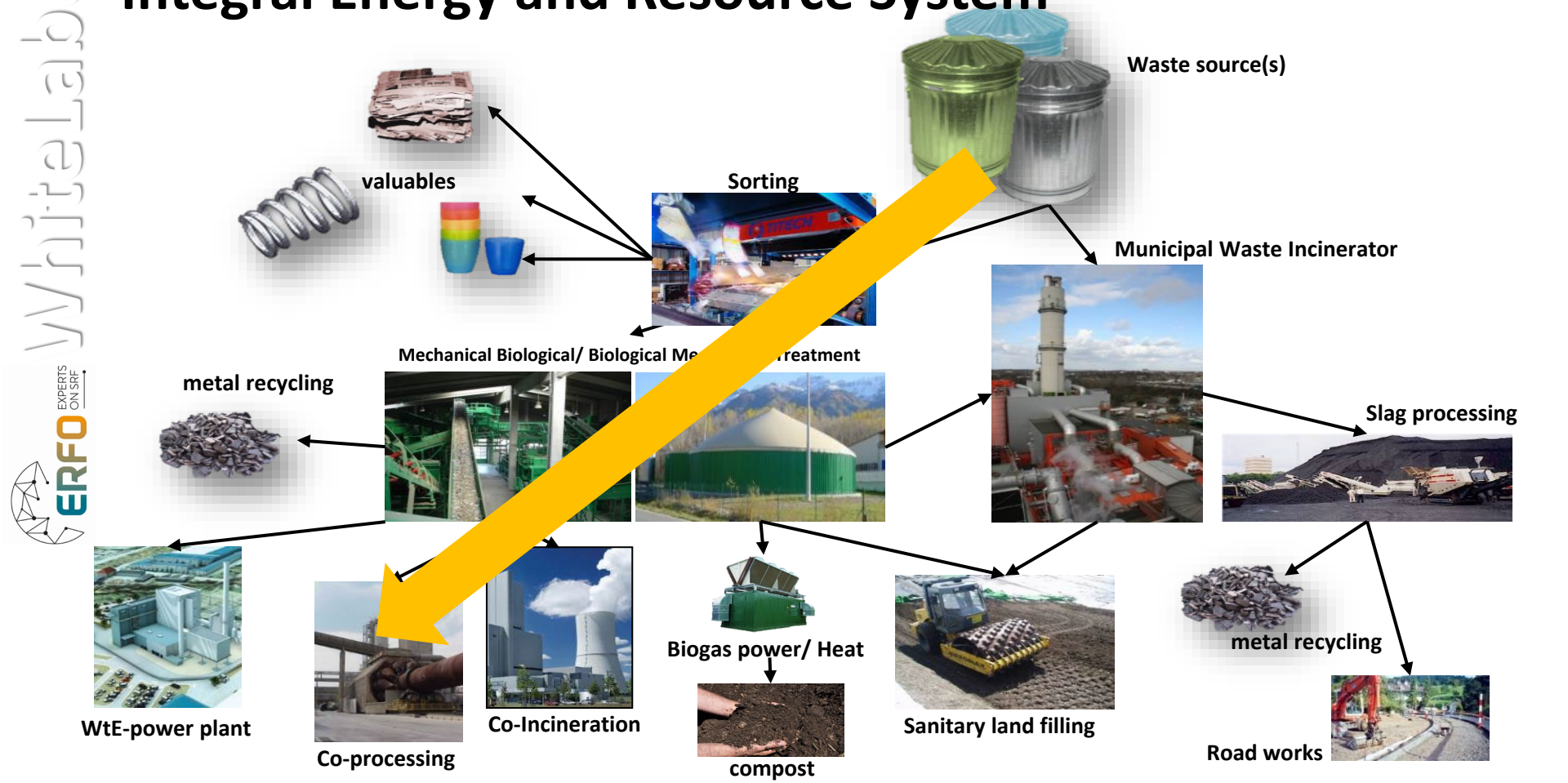
Integral Energy and Resource System



From waste to quality assigned fuels

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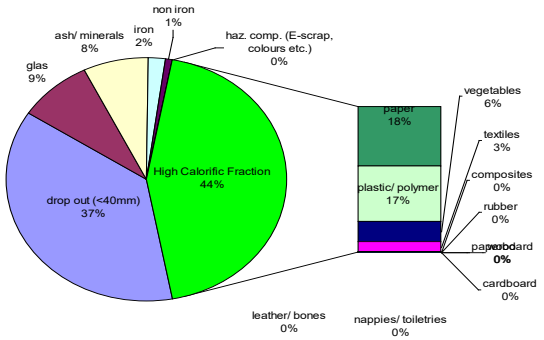
Competence Activities References About Us

How to proceed?

Waste Assessment: Composition & thermal potential

Waste Component	Share	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

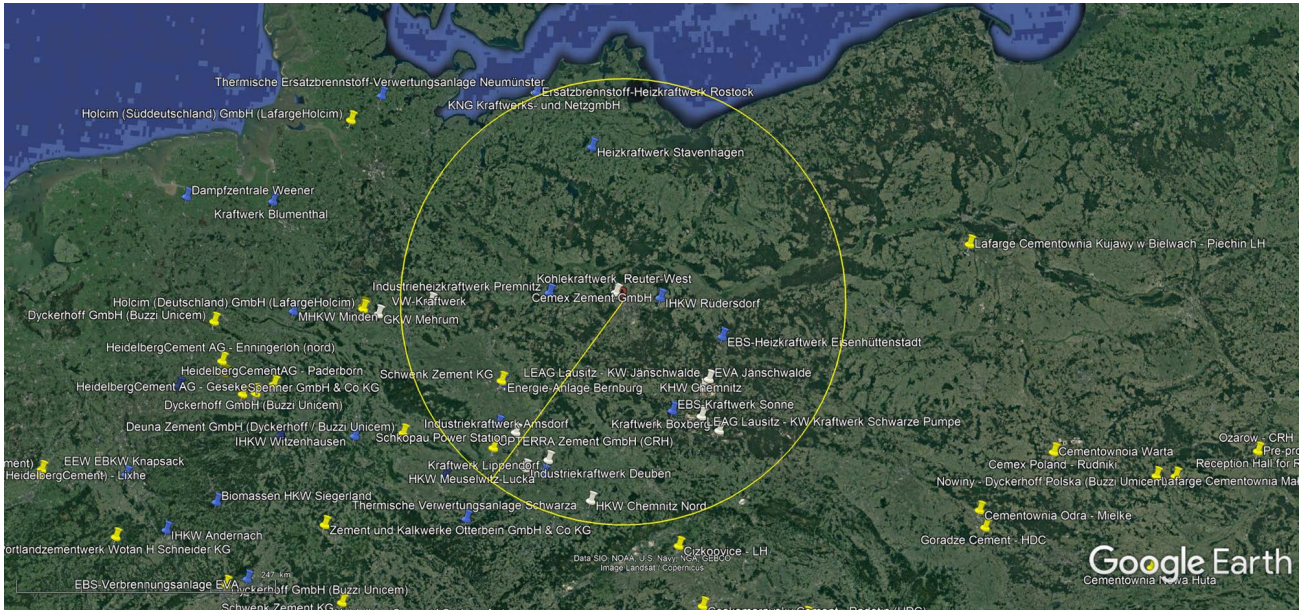


Determination of potential/ processing strategy

Waste composition wt.-%	untreated waste	Input after bio dry + sort.	HCF	bio fraction undersize <80mm	calciner fuel (RDF)	heavy fraction (to MWI or landfill)	main burner fuel (SRF)
organic	31,0%	23,9%	7,6%	38,4%	6,4%	9,3%	2,8%
paper, cardboard, journals	11,0%	11,1%	18,9%	4,2%	22,3%	13,8%	33,5%
long living wrappings	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Pet-wrappings	1,0%	1,0%	1,8%	0,3%	2,5%	0,9%	4,2%
exp. polystyrene	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
smooth plastics	12,0%	12,1%	20,6%	4,6%	27,8%	10,1%	53,6%
hard plastics	3,0%	3,0%	5,1%	1,1%	6,1%	3,8%	0,7%
iron	1,2%	1,2%	1,3%	1,1%	0,4%	2,5%	0,0%
glass	2,0%	2,4%	0,8%	3,8%	0,3%	1,5%	0,0%
soil + stones	2,0%	2,4%	0,5%	4,0%	0,4%	0,6%	0,0%
wood	1,0%	1,2%	2,0%	0,4%	0,7%	3,9%	0,1%
textiles	4,0%	4,7%	9,1%	0,9%	3,1%	17,7%	3,3%
divers	1,0%	1,2%	1,3%	1,1%	1,1%	1,5%	1,1%
alumina	0,8%	0,8%	0,9%	0,8%	0,7%	1,0%	0,2%
rubber + leather	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
toiletries	10,0%	11,9%	5,0%	17,9%	6,8%	2,5%	0,1%
residuals	20,0%	23,7%	25,2%	22,4%	21,3%	30,8%	0,5%
Total:	100,0%	100,7%	100,0%	101,2%	100,0%	100,0%	100,0%
tonnage per year:	**110.000**	**93.220**	**43.899**	**49.321**	**25.939**	**17.960**	**12.122**
calorific value MJ/kg DM	*8,5*	*8,9*	*12,7*	*5,5*	*14,4*	*10,1*	*21,2*
net cv MJ/kg incl. moisture:	20,0%	**7,1**	**10,1**		**11,5**		**17,0**

Access and competition

Example: Berlin and 200 km radius



- Integrated cement plant
- WtE-power plant
- Coal fired power plant

Technical assessment

Credit: WLTP

The technical assessment shall serve you to determine the right properties:

1) Type of kiln and needs for adopting the processes
2) Energy demand and materials handling
3) Limitations according the raw material and fuel(s)
4) Limitation according to air pollution control (permission)

Technical assessment

Whether the consistency of the waste is liquid, pasty or solid the final user defines the requirement and specification of the **A**lternative **F**uel and **R**aw materials (**AFR**), and consequently defines the requested equipment in the pre-treatment process.

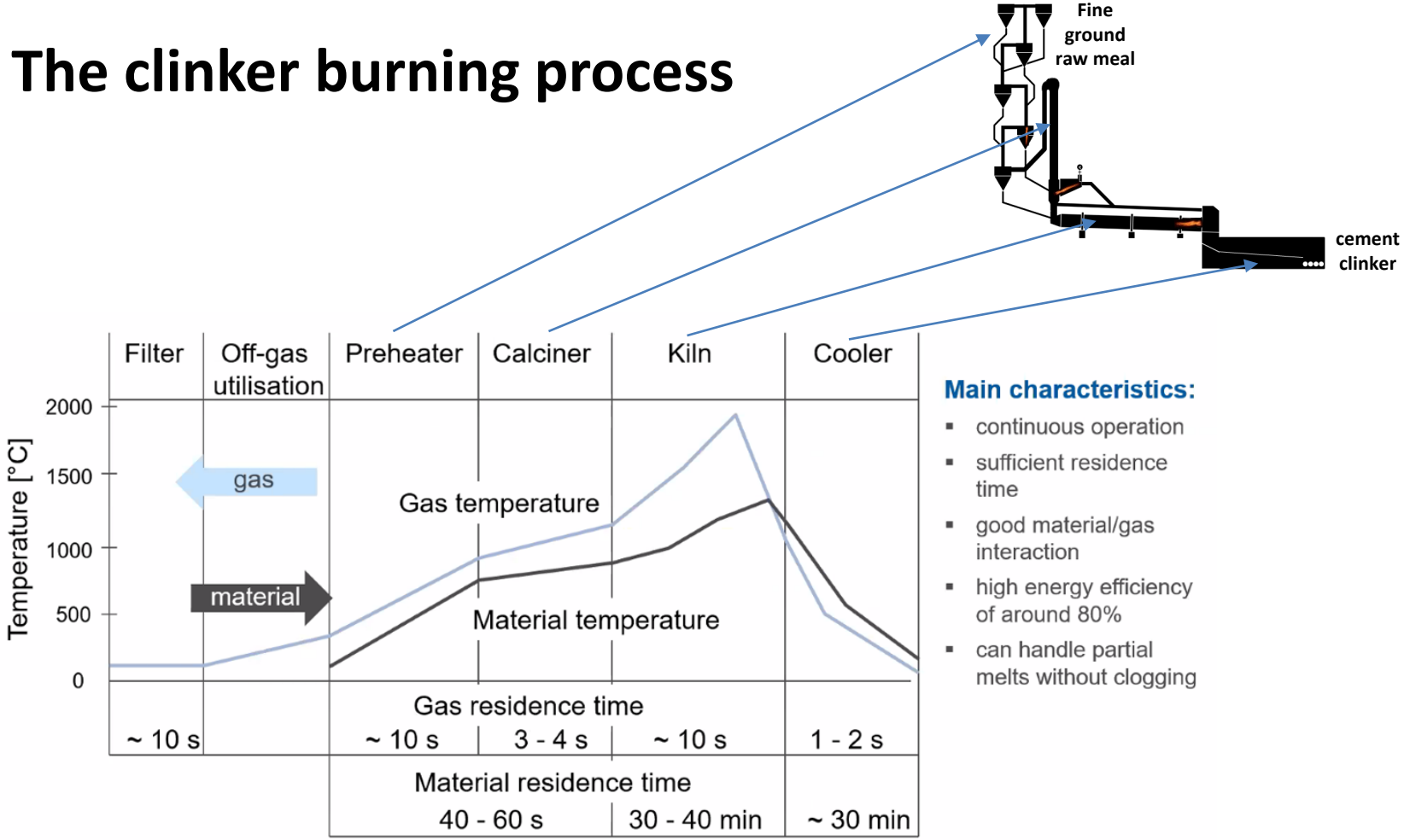
Consequently, untreated waste cannot be used as a fuel!

However, when using AFs we have to respect the requirements of the

- **thermal production process,**
- **product quality,**
- **air pollution control.**

The clinker forming pyro process is not a disposal process!

The clinker burning process

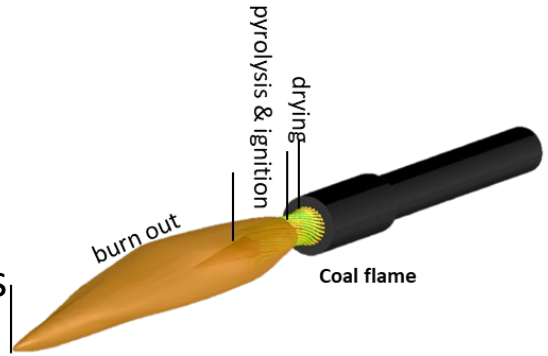


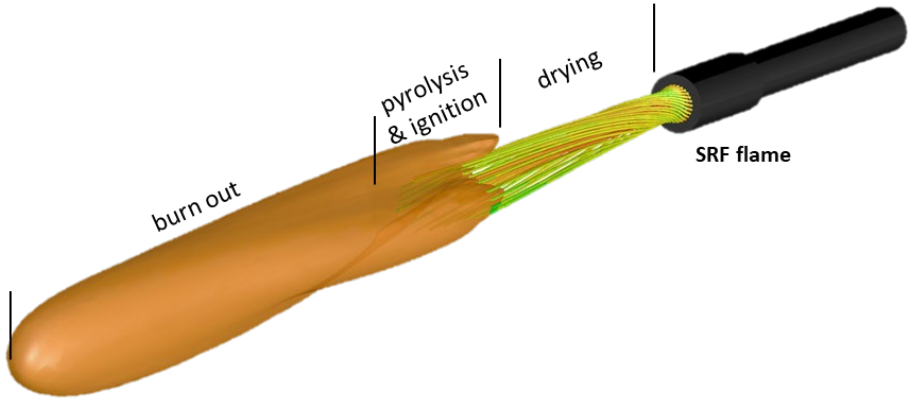
Main characteristics:

- continuous operation
- sufficient residence time
- good material/gas interaction
- high energy efficiency of around 80%
- can handle partial melts without clogging

Technical Assessment

The conditioning quality determines the length (time for drying and ignition), length (dwell time) and position (amount and type of particles) of the SRF-flame and thus the temperature profile in the rotary kiln.

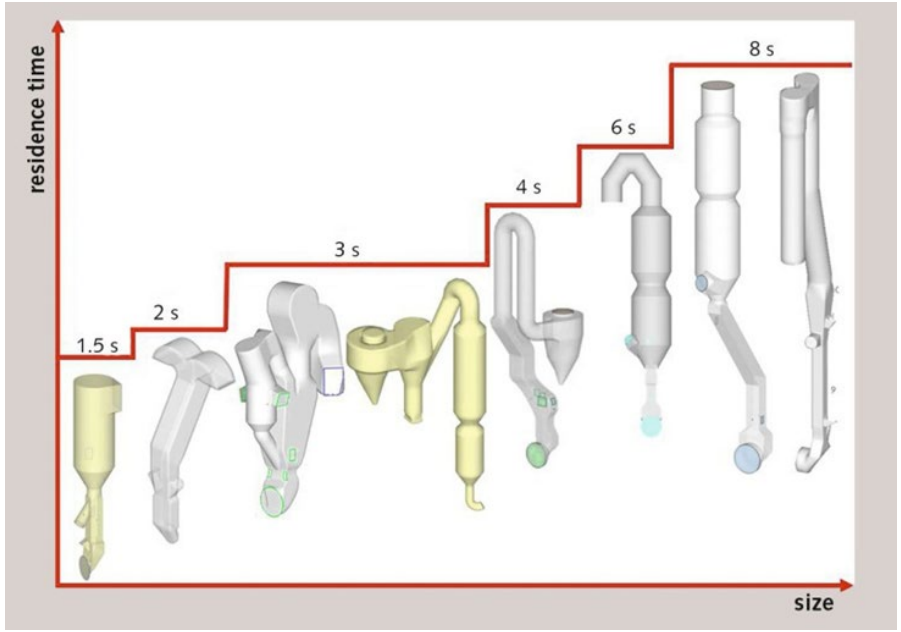




Burning carbon and hydrogen based fuels (coal, lignite, oil/ solvents, SRF or H_2) results in radiant heat for the clinkerization process.

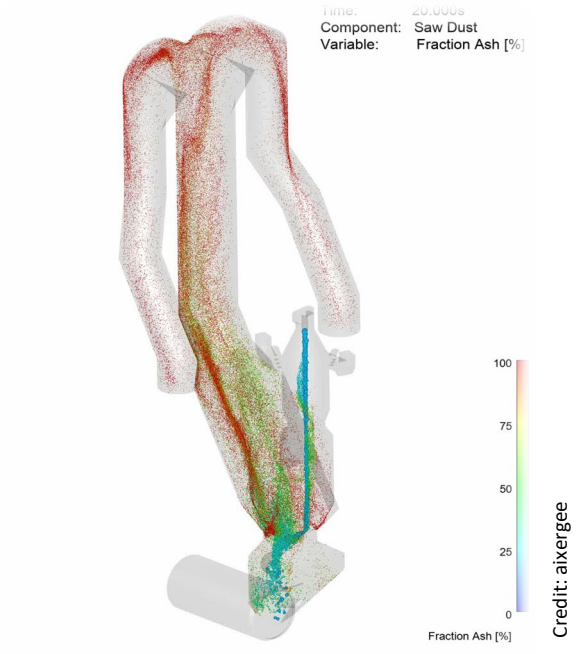
Source: PROCESS // Optimization - ZKG 02 2012

Technical Assessment



Credit: KHD

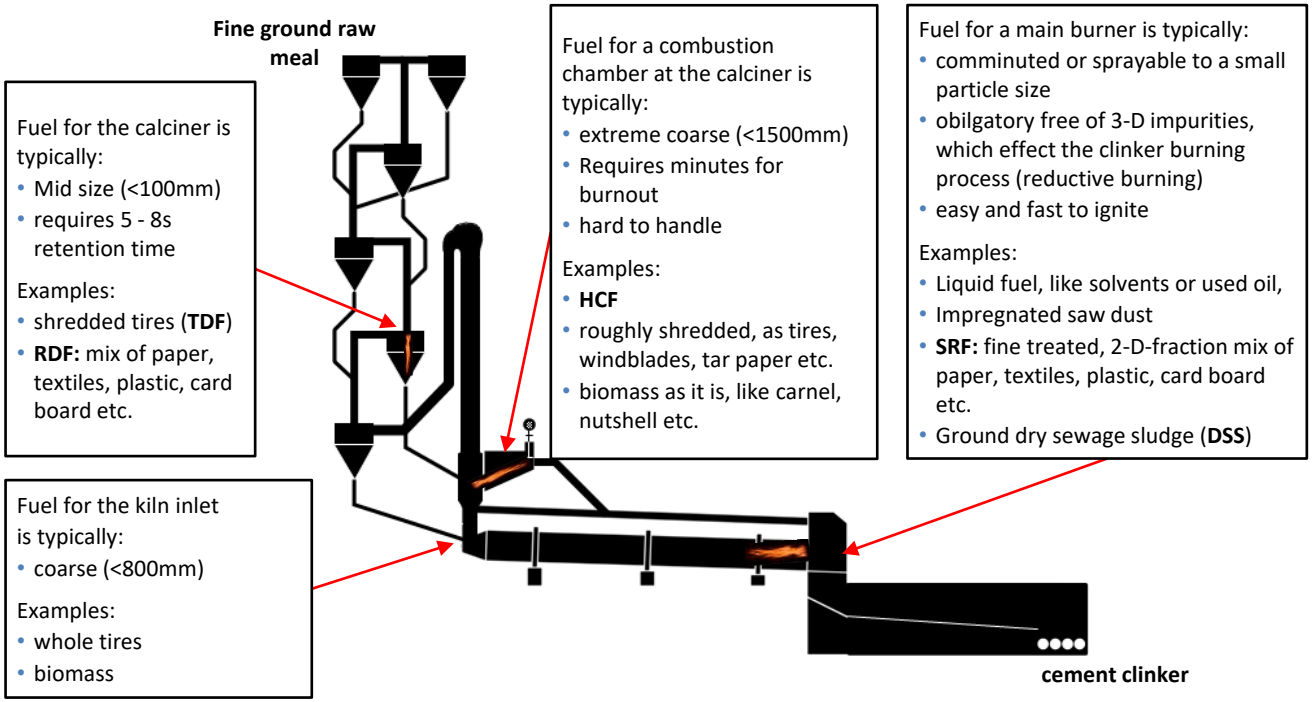
The residence time, oxygen distribution and the point of feeding defines the grain size of RDF for designing the pre-processing right.



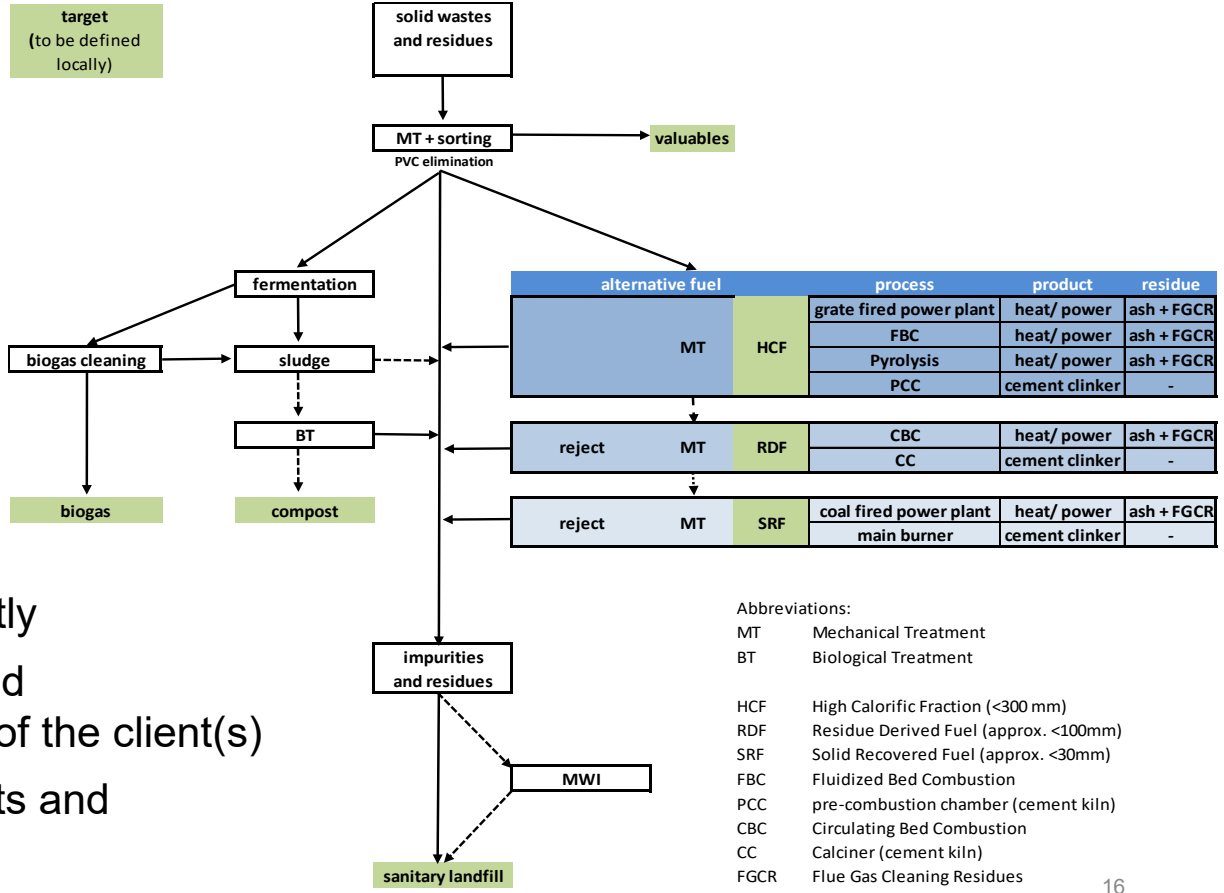
Credit: aixergee

Vice versa a CFD simulation can guide to the best point of feeding for the pyro process.

Co-processing Alterative Fuels (AFs)



Designing the integrale system



- ✓ Define the target(s) correctly
- ✓ Set the plant to the required characteristics and needs of the client(s)
- ✓ Consider all long-term costs and revenues in the design

Abbreviations:

MT	Mechanical Treatment
BT	Biological Treatment
HCF	High Calorific Fraction (<300 mm)
RDF	Residue Derived Fuel (approx. <100mm)
SRF	Solid Recovered Fuel (approx. <30mm)
FBC	Fluidized Bed Combustion
PCC	pre-combustion chamber (cement kiln)
CBC	Circulating Bed Combustion
CC	Calciner (cement kiln)
FGCR	Flue Gas Cleaning Residues
MWI	Municipal Waste Incinerator

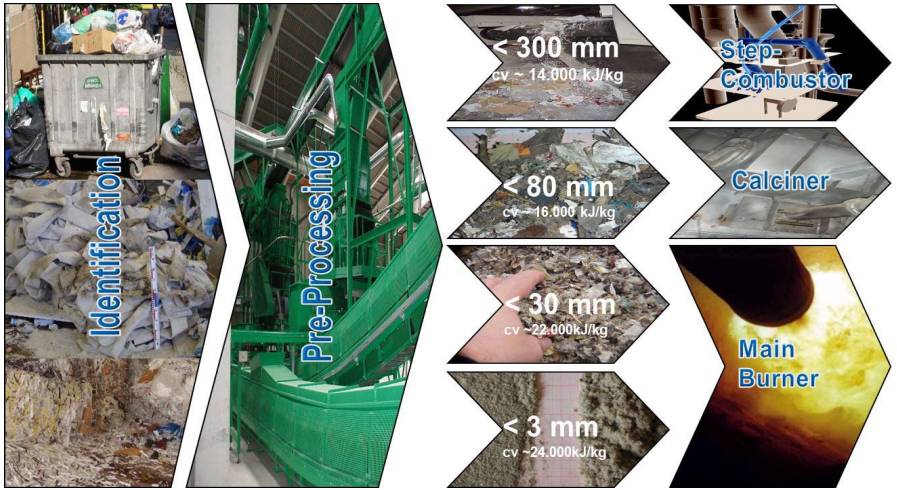
Important note:

If a pre-processing is planned, both results are required from

a) **technical assessment**

b) **thermal potential of the waste**

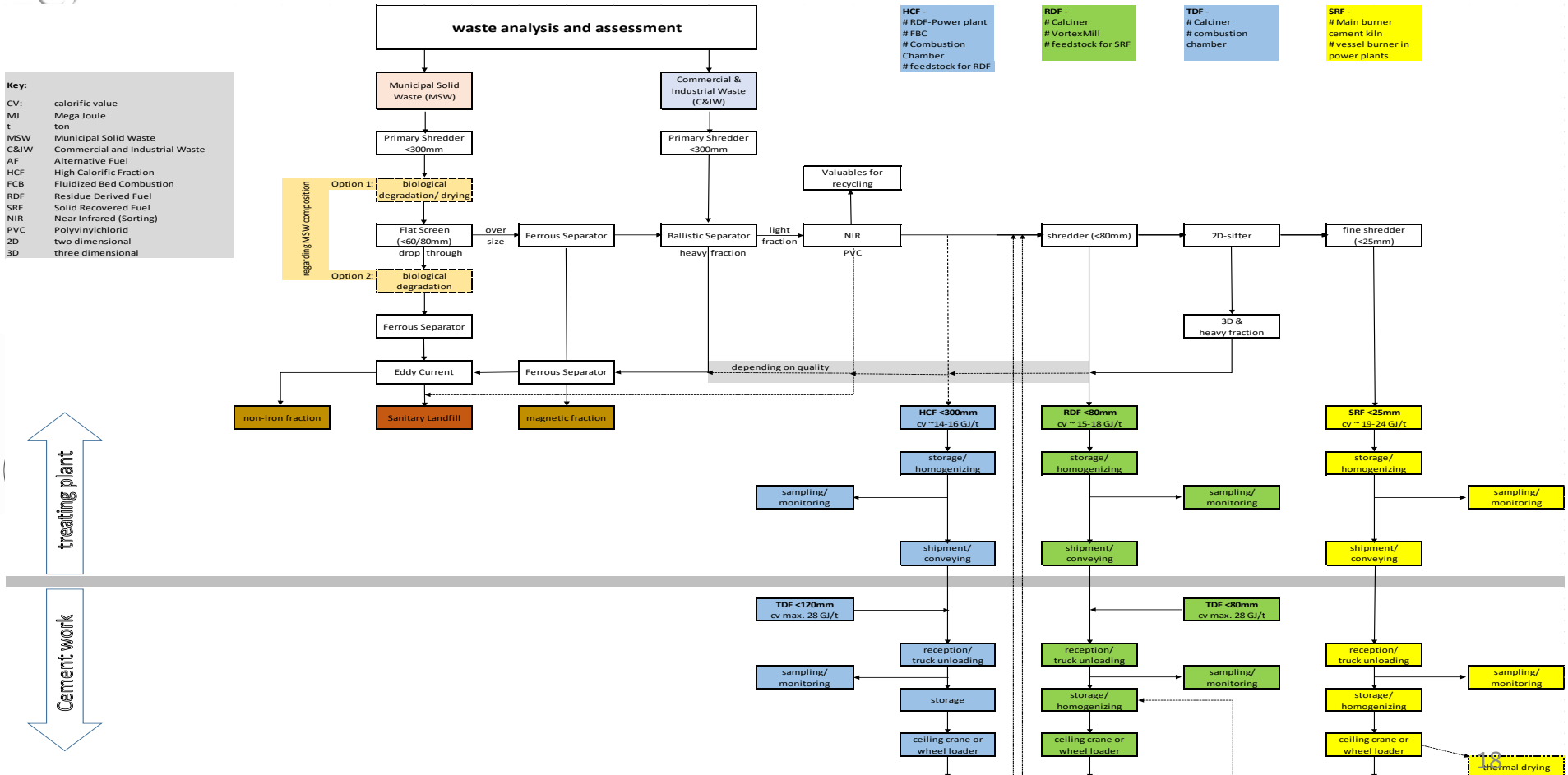
The waste potential and the performance of the kiln determine the required design of the pre-treatment plant and thus the necessary investment.



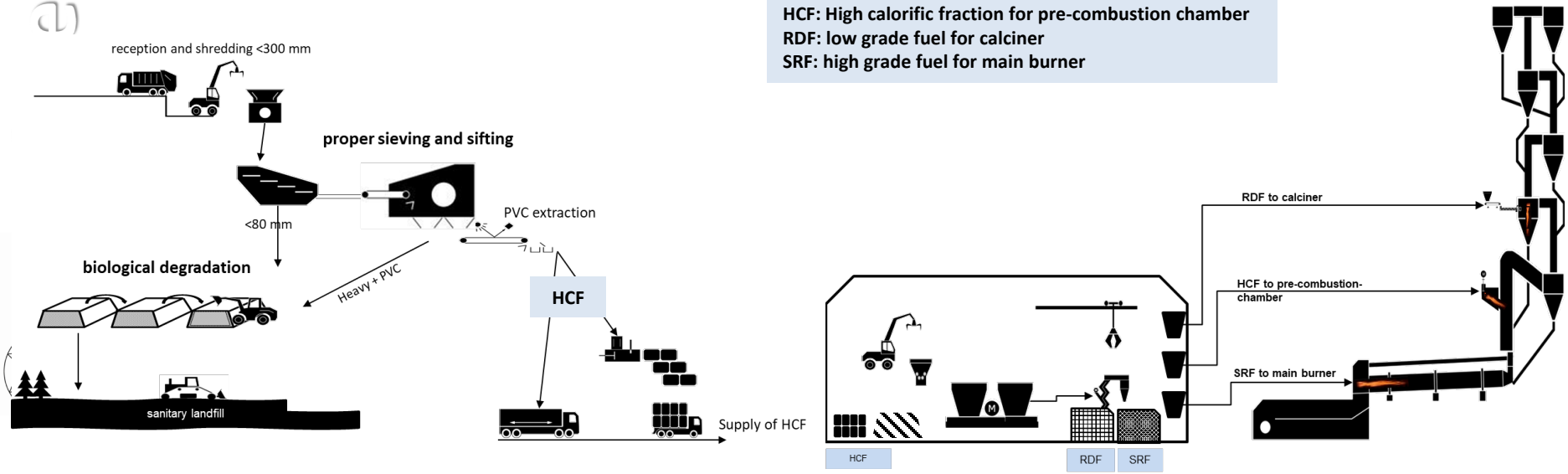
However, if the conditioning plant reaches its limits, the rotary **kiln must be adapted**.

It should be noted that **only a sensible and favourable - not a cheap -** solution will lead to a sustainable and long-term security of supply for the kiln operation with a high thermal substitution rate (TSR).

Designing the pre-process right

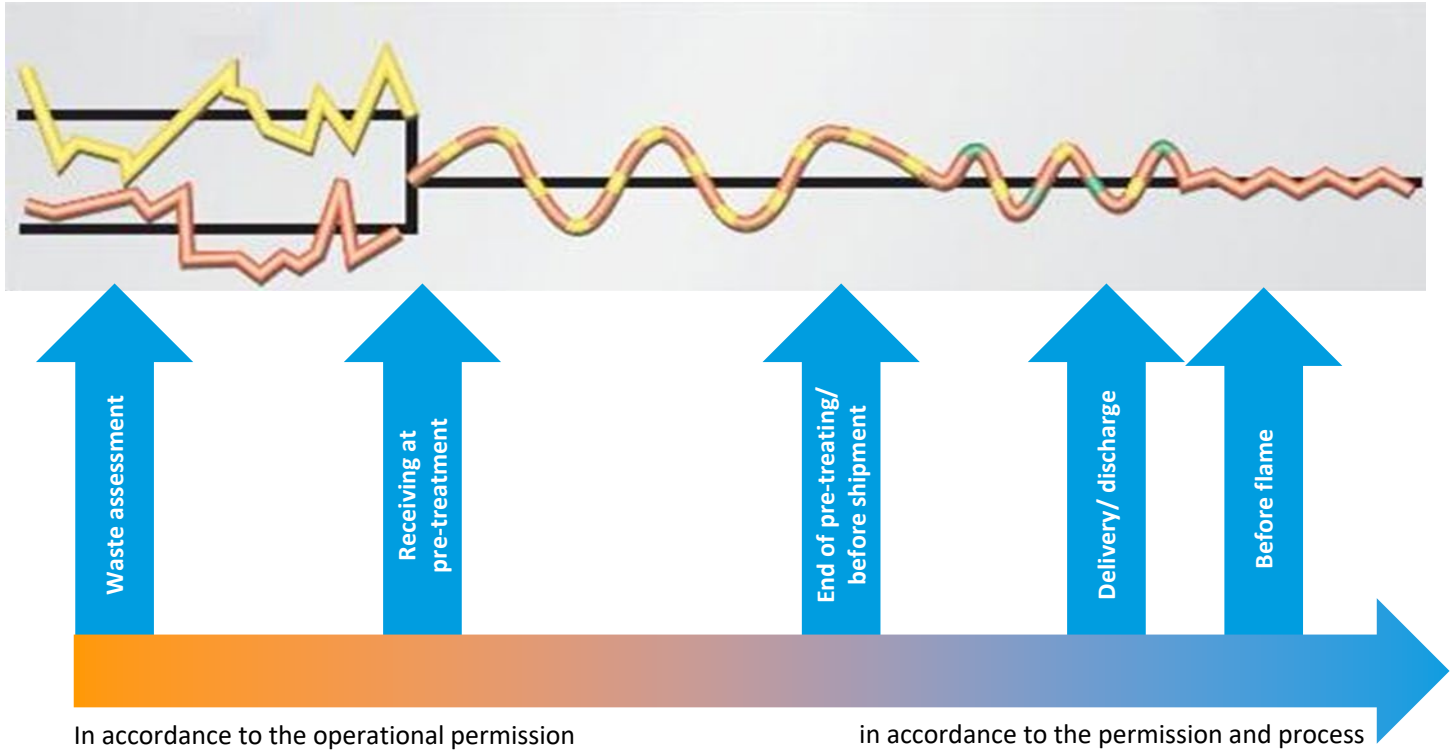


Proposed solution for integrating the clinker burning process into a sustainable waste management system

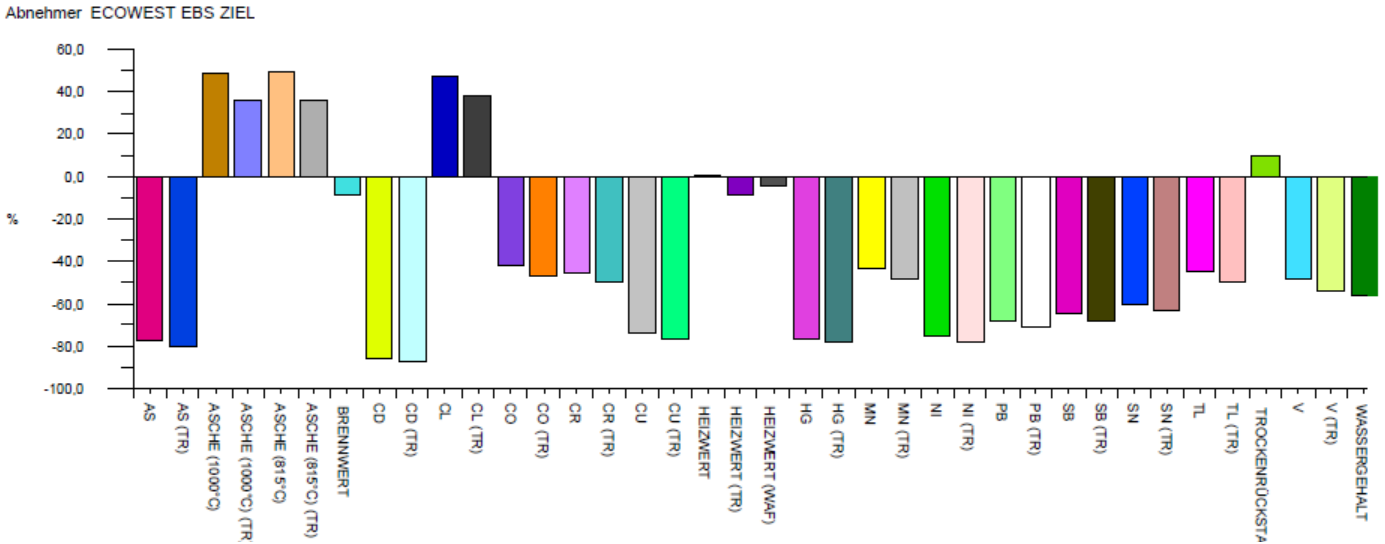


Parallel to the pre- and co-processing processes, it is mandatory to monitor the AF qualities in terms of process, product and emissions.

Quality targets



Monitoring the individual access parameters



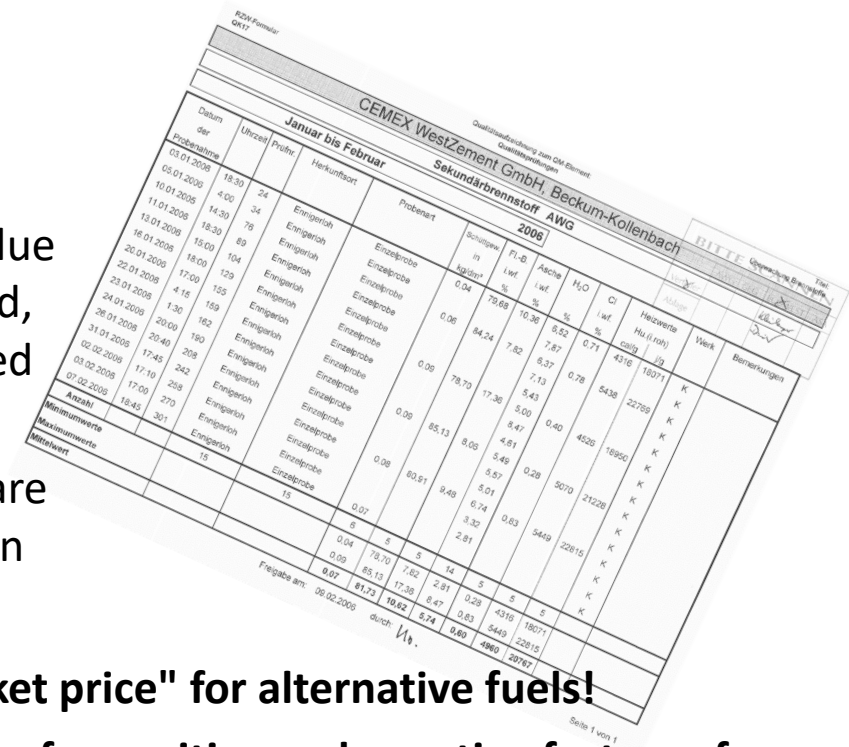
Objective	Remark	Counter measure
ash content (on 815°C resp. 1000°C)	above 10%	install a more suitable screening system
chlorine	above 0,5%	install NIR
Lower/ gross cv	Safety distance too small	Corresponds to the moisture content, meaning homogenization or to dry…

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.


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) MJ/kg	Werk	Bemerkungen
03.01.2006	18:30	24	Ennigerloh	Einzelprobe	0,04	79,68	10,36	9,53	0,71	4316	18071	K	
05.01.2006	4:00	34	Ennigerloh	Einzelprobe				7,87				K	
10.01.2006	14:30	76	Ennigerloh	Einzelprobe	0,06	84,24	7,82	8,37	0,78	5438	22769	K	
11.01.2006	18:30	89	Ennigerloh	Einzelprobe				7,13				K	
15.01.2006	15:00	104	Ennigerloh	Einzelprobe	0,05	78,73	17,36	5,43	0,40	4526	18956	K	
16.01.2006	15:00	129	Ennigerloh	Einzelprobe				5,00				K	
20.01.2006	18:00	155	Ennigerloh	Einzelprobe	0,05	85,13	8,05	8,47	0,28	5070	21228	K	
22.01.2006	17:00	169	Ennigerloh	Einzelprobe				4,81				K	
23.01.2006	4:15	162	Ennigerloh	Einzelprobe	0,06	80,91	9,49	5,49	0,83	5449	22815	K	
24.01.2006	1:30	190	Ennigerloh	Einzelprobe				5,57				K	
26.01.2006	20:00	208	Ennigerloh	Einzelprobe	0,08			5,01				K	
31.01.2006	20:40	242	Ennigerloh	Einzelprobe				6,74				K	
02.02.2006	17:45	258	Ennigerloh	Einzelprobe	0,07			3,32				K	
03.02.2006	17:10	273	Ennigerloh	Einzelprobe				2,81				K	
07.02.2006	17:00	301	Ennigerloh	Einzelprobe								K	
Anzahl	18:45		15		6	5	5	14	5	5	5		
Minimumwerte					0,04	78,10	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	10,52	5,74	0,60	4960	20767		

Freigabe am: 06.02.2006 durch: Mb.

Seite 1 von 1

This is the answer to why there is no "market price" for alternative fuels!

Each client has its individual set of tolerance for positive and negative factors of influence, based on the previous technical assessment regarding process, product and the 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 €	2,00 €
			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).

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 €	2,00 €
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			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):				**20,00 €**

Pricing based on a bonus/malus agreement

Example 1:		Median value/ month	in accordance to committed norms	
	calorific value MJ/kg	17,32	=(17,32 MJ/kg – 16 MJ/kg)*2€	2,64 €/t
	chlorine	1,14%	…and so on/ see above	-7,20 €/t
	moisture	30,0%	-"-	-15,00 €/t
	biomass content	31,8%	-"-	8,60 €/t
			Purchase price:	**-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:	**31,00 €/t**

Now you can bill on monthly base

- ✓ Verification of the agreed parameters
- ✓ agreed on comprehensible norms and 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/ behaviour

- penalty per amount of fossil ingredients

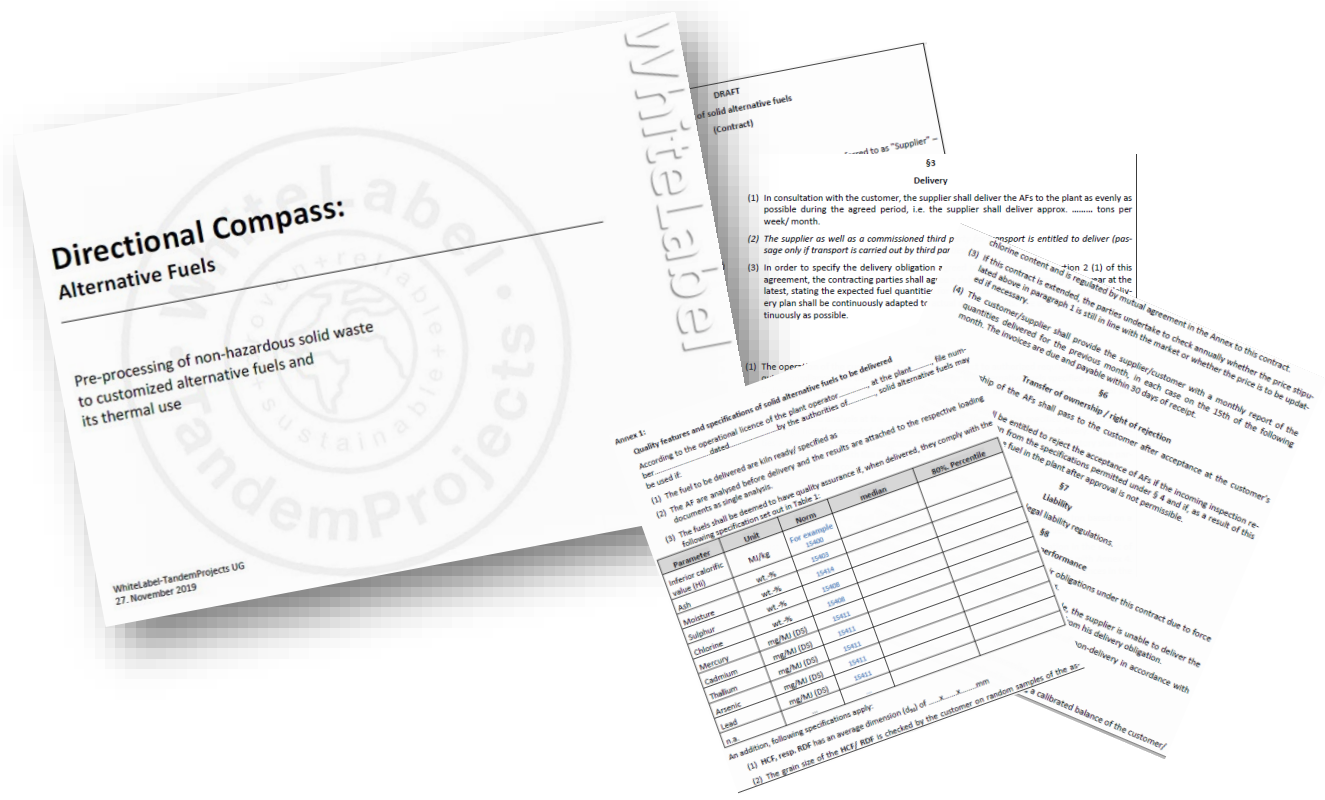
- penalty per harming impurities such as water, Cl etc.

_____

gate fee to/ revenue from cement plant

You will find a template of a draft of a delivery contract in the Annex of our Directional Compass p. 74 – 83

https://wltp.eu/assets/uploads/2016/07/20200305-WLTP-Handbook-2.4-1.pdf



Hvala na pozornosti!

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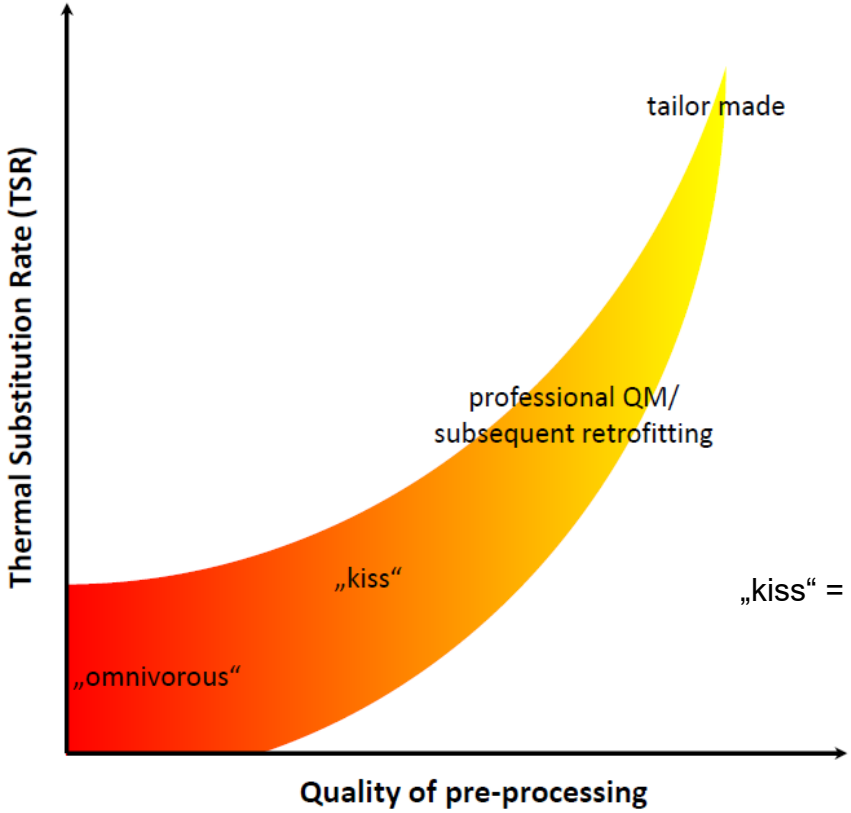
Monitoring the Quality



„kiss“ = „keep it smart and simple“

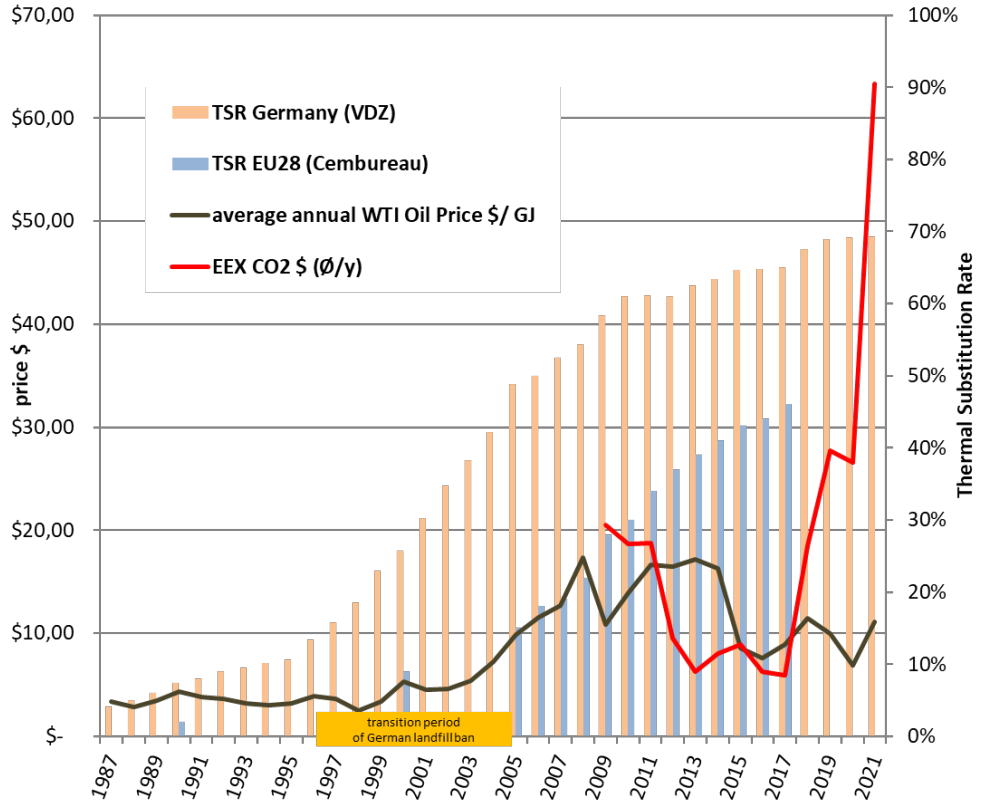
Economical Framework

4) 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.

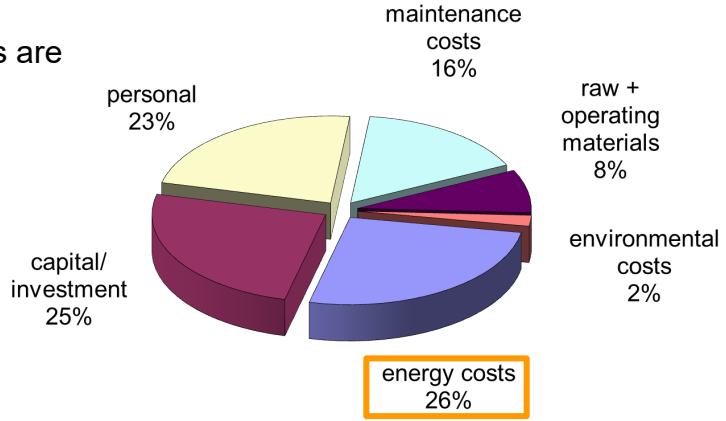
H_u WTI Oil: 41,9 GJ/t
1t = 7,33 barrels



Economical Framework

5) Primary energy costs

Roughly 26% of the cement making 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 a cheaper energy source, and switched to lignite, which also marks the specification of proper SRF today.

Later, fluid or solid, pre-treated hazardous waste derived fuels and non-hazardous waste derived fuels are used for co-processing. Now, the financial optimization process has reached the whole process chain regarding its high competitive situation on the waste market as well as on the cement market.

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

The benefit of AFR is by saving primary energy costs and today to substitute alternative fuels against those with a better gate fee.