Recycling of biomass ashes in The Netherlands

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General

- Biomass: sustainable source for power production (transition)
- Import biomass: mainly for co-combustion
- Inland biomass: small and medium scale power and heat production
- Small country, densly populated (403 inhabitants /km2)
- Ash management important issue!

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General: ash management

- Removal must be assured;
- compliance with the current regulations.
- Sustainability utilizations
- maximum financial benefits, or minimum costs.
- acceptance by society and must
- compliance with power brand (green power, grey power).

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Power generation from biomass

- Co-combustion: in coal fired power plants
- 5 medium scale biomass fired power plants
- 20-50 Mwe
- Poultry litter (1)
- Demolition wood (3)
- Combination of biomass fuels (1)

- 2 sewage sludge and 2 paper sludge

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Power generation from biomass

- Fertilizer: poultry litter ash
- Phosphor production: sewage sludge ash
- asphalt filler: sewage sludge ash
- Mining / backfilling: sewage sludge ash
- Soil stabilization: paper sludge ash (Topcrete®)
- Binder prefab concrete: paper sludge ash

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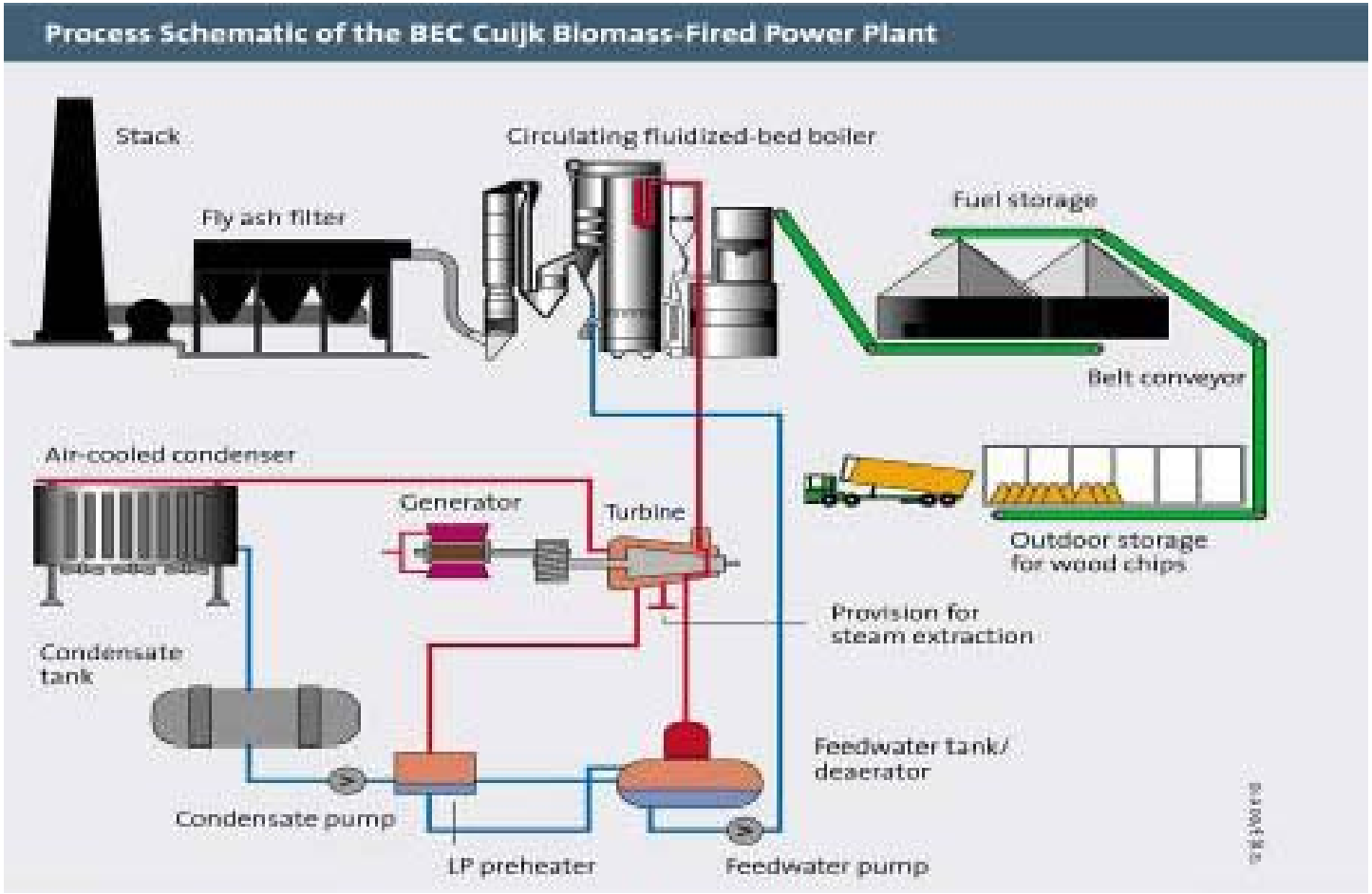
Bio Energy plant Cuijk (BEP Cuijk)



BEP Cuijk: combustion experiments: fuels

Code	Fuel combination	Additive
HP	92 % Wood + 8 % paper sludge	No
HZ	84 % Wood + 16 % sieve overflow compost	No
HG	87 % Wood + 13 % sieve overflow organic waste	No
HB	93 % Wood + 7 % grass from roadsides	Yes
HBZ	88 % Wood + 12 % grass from roadsides	No

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BEP Cuijk: combustion experiments: fuels

Parameter		paper sludge	sieve overflow compost	sieve overflow organic waste	wood
C	% m/m	32.3		33.4	
H	% m/m	3.44	5.30	3.97	6.19
N	% m/m	0.20		1.44	
S	% m/m	0.10		0.22	
O	% m/m	17.90		18.40	
moisture content	% m/m	48.1	52.4	38.8	44.6
ash content	% m/m	46.1	21.5	42.6	3.1
LHV (wet) AR	MJ/kg	3.98	6.10	5.77	9.16

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BEP Cuijk: combustion experiments: fly ash

	Virgin wood			Combustion experiments 2010				
	Av.	min	Max	HP3	HZ4	HG3	HB3	HBZ3
Al_2O_3	4.6	2.75	6.52	7.19	4.92	5.01	4.63	3.24
CaO	25.7	12.45	39.00	42.9	22.1	21.1	16.1	20.0
Cl	0.6	0.06	1.17	0.33	-	-	-	-
Fe_2O_3	2.9	1.97	3.92	1.62	2.55	2.39	2.17	1.47
K_2O	8.2	4.46	11.98	4.37	6.27	6.14	5.46	5.98
MgO	3.6	1.77	5.34	2.48	2.46	2.28	1.88	2.33
Na_2O	0.6	0.42	0.84	0.05	0.78	0.89	0.61	0.75
P_2O_5	3.4	1.80	5.06	0.20	2.90	3.50	2.63	3.70
SiO_2	45.8	23.84	67.68	40.19	52.7	52.8	60.8	57.5
SO_3	4.2	0.37	7.95	2.79	0.5	0.2	1.0	0.9
TiO_2	0.3	0.22	0.45	-	-	-	-	-
LOI	9.4	1.32	17.42	0.00	4.8	5.6	4.7	4.2

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BEP Cuijk: combustion experiments: fly ash

	HP3	HZ4	HG3	HB3	HBZ3
Quartz	12.7	28.2	18.8	42.8	12.3
Ca2SiO4 alfa	9.5	1.9	6.5	2.3	10.4
Rutile	1.0	<1	<1	<1	<1
Ca3Al2O6	7.6	1.8	4.4	1.0	7.5
Calcite	8.1	4.7	8.9	5.1	11.2
Portlandite	<1		<1	<1	<1
Free lime	12.4	4.2	9.8	4.1	12.1
Periklase	<1	<1	<1	<1	<1
Gehlenite	4.0	1.5	3.1	1.4	3.6
Ca2SiO4 beta	5.2	1.2	3.2		4.5
Mayenite	1.1		<1		1.4
Sylvite		1.7	<1	<1	
Anhydrite		<1	<1	<1	
Feldspar		4.2	1.3	2.0	
Cristoballite		<1			
Gypsum		<1			
Hallite			<1		
Not identified	37	47	40	38	35
Total	100.0	100.0	100.0	100.0	100.0

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BEP Cuijk: combustion experiments: fly ash

- Health and safety issues
- Assesment of metals, PAH, dioxins, PCBs, furans, respirable quartz
- Conclusion: nuisance dust

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BEP Cuijk: potential applications: filler in asphalt

Parameter	Water solubility	D_{10}	D_{50}	D_{90}	Passing 125 µm	Passing 63 µm	Soundness NEN-EN 450-1
Unit	% m/m	µm	µm	µm	%	%	Mm
Requirement	≤10	-	-	-	85-100	70-100	≤ 10
Coal fly ash	±5	±2	±18	±42	>95	-	<5
HG3	17	4	35	120	91	75	-
HP3	3	4	35	120	96	51	13
HZ4	11	7	60	>250	71	53	-
HB3	10	7	60	>250	56	36	-
HBZ3	-	10	35	140	90	76	21

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BEP Cuijk: potential applications: filler in concrete

Parameter	Water solubility	D_{10}	D_{50}	D_{90}	Passing 125 µm	Passing 63 µm	Soundness NEN-EN 450-1
Unit	% m/m	µm	µm	µm	%	%	Mm
Requirement	≤10	-	-	-	85-100	70-100	≤ 10
Coal fly ash	±5	±2	±18	±42	>95	-	<5
HG3	17	4	35	120	91	75	-
HP3	3	4	35	120	96	51	13
HZ4	11	7	60	>250	71	53	-
HB3	10	7	60	>250	56	36	-
HBZ3	-	10	35	140	90	76	21

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BEP Cuijk: potential applications: infrastructural works

- Embankments, fillings
- Large quantities have to be available
- Leaching behavior (Decree Soil Quality)
- Limits for use without restrictions exceeded for Ba, Cl, Cr, Mo, SO4
- Use with restriction: OK
- Competion with secondary materials like MSWI bottom ash>negative price

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BEP Cuijk: potential applications: sludge stabilization

- Stabilzation of industrial sludge
- Tests are running

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BEP Cuijk: potential applications: soil improvement/fertilizer (1)

- No regulations for forestry
- Waste spreading
- Study of effects of harvesting om Dutch forestry

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BEP Cuijk: potential applications: soil improvement/fertilizer (2)

- Waste in agriculture: Law on fertilzer
- Proven agricultural capacility
- Minimum content of MgO, CaO, SO3 or Na2O
- CaO at least 25% m/m > HP3

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BEP Cuijk: potential applications: soil improvement/fertilizer (3)

	limit	total	on CaO
As	30	9.6	37
Cd	2.5	10	38
Cr	150	60	232
Cu	150	233	896
Hg	1.5	0.09	0.35
Ni	60	29	113
Pb	200	75	288
Zn	600	715	2750

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BEP Cuijk: potential applications: soil improvement/fertilizer (4)

- Too much heavy metals

- Another way: raw material production of fertilizers
- PK fertilizer
- Basic interest Dutch fertilizer industry

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BEP Cuijk: potential applications: mineral barrier for disposal sites

- Hydrostab®
- Soluble alkali silicates
- Mix sewage sludge, fly ashes
- Some free lime
- Applied volumes depends on projects
- Winterstop
- Sales assurance?

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Evaluation and conclusions (1)

- Many potential applications for ashes can be found
- Practice is stubborn
- Biomass ash: small volumes and variation in quality

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Evaluation and conclusions (2)

- Present applications biomass ashes based on:
  - Physical properties (volume, fineness)
  - Nutrient concentration
  - Lime content

Present application BEP Cuijk:

- Asphalt filler,
- sludge stabilization

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Evaluation and conclusions (3)

- New applications will be investigated:
  - Fertilizer: less metals, higher CaO content
  - Raw material fertilizer: more K2O, P2O5
  - Concrete production: filler; soundess
  - Production of sand-lime bricks

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Evaluation and conclusions (4)

- New applications have to reduce costs ash management
- improve sustainable use

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