Hands-on experience in biomass co-firing
A power company's perspective

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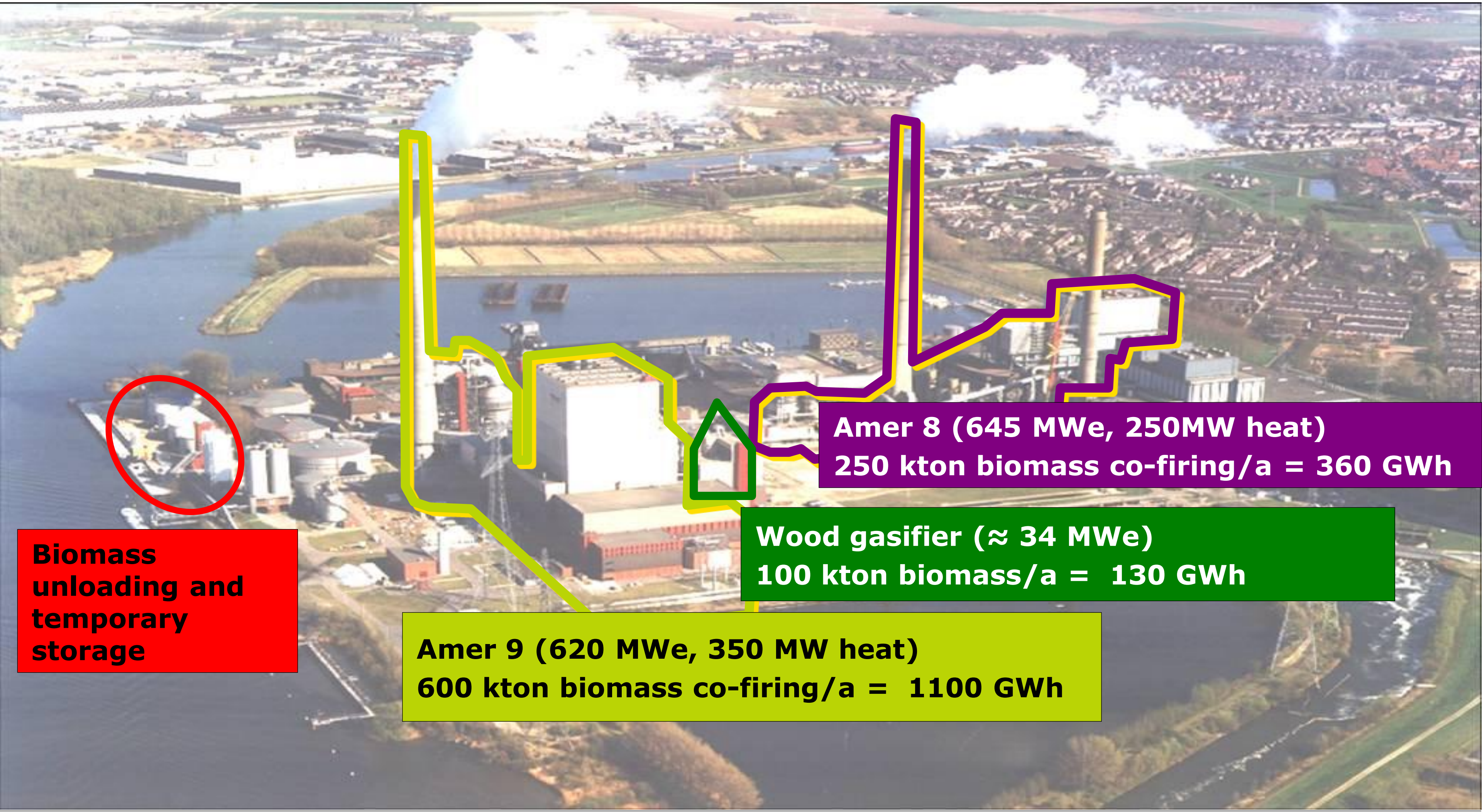
RWE Essent’s biomass activities

Cuijk stand alone biomass combustion plant (25 MWe)

(has been sold – now operated by a new company)

Amer wood gasifier
(34 MWe eq.)

Amer co-firing: Amer 8: 75 MWe (250 kton/a)
Amer 9: 160 MWe biomass (600 kton/a)



Aerial view of biomass ship unloading facilities (Amer power station)

Pneumatic ship unloader

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Dutch governmental support systems for biomass cofiring

- First phase (until 2003) : tax credits on produced kWh's

- Second phase :
  - 10 years subsidy contracts (per project)
  - Subsidy on sustainably produced kWh's

- Since 2015 :
  - Tendering system (auction) for all sustainability options
  - Cheapest options first (total kWh price)
  - Link between subsidy level and market price of electricity

Fuels

> Wood pellets

> Citrus pellets

> Palm kernel chips

> Olive residu

> Coffee husks, peanut shell pellets, …

> Torrefied wood pellets

> Bentonite saturated with bio oil

Amer co-firing history

2005 - Amer 9

2nd coal layer => biomass (36m%)

2004 - Amer 9

Serious corrosion

Many types of biomass were tested

Biomass	Slagging / fouling
Olive kernel	Very strong
Cacao husks	Very strong
Citrus pulp	Strong
Palm kernel husks	Strong
Wheat semolina (Grieß)	Strong
Soya hulls	Strong
White wood	Low

2003 - Amer 9

1st coal layer => biomass (18m%)

2000 - Amer 9 (and Amer 8)

Up to 5m% co-firing (mixed with coal)

2000

Wood gasifier Amer 9
Capacity: 33 MW
Fuel type: waste wood

2003

1st biomass mill Amer 9 and unloading facilities
Capacity: 83 MW, pellets

Hammer mills BS-12
Capacity: 100 MW

2004

Hammer mills Amer 8
Capacity: 96 MW, pellets

Logistical system Amer 8/9
Type: silo's, conveyors

2005

2nd biomass mill Amer 9
Capacity: 83 MW, pellets

Bio-oil Claus A (test 2002)
Capacity: 92 MW, bio-oil

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Technical aspects of biomass co-firing with coal

- Biomass is hard to grind: coarser particles after grinding
- More mass flow needed for the same energy output
- Net efficiency almost the same
- Plant output can stay the same (if spare mill capacity can be used)
- Emissions (NOx, SOx, dust) get slightly lower
- Ash quality can remain high (certified up to 50 % biomass)
- With white wood pellets: lower wear, no fouling

Technical challenges we had to overcome: some examples

- > Fuel quality: dust, fineness, durability of pellets
- > Fuel logistics: risk of self ignition, risk of fire and explosion
- > Milling biomass
- > Pneumatic conveying of (grinded) biomass
- > Unconverted biomass in bottom ash
- > Sparks in convective boiler parts
- > Rapid furnace wall corrosion
- > Overheating of superheater surfaces (→ load limitation)

Verschil tussen gemiddelde wanddiktemeting 2003 en gemiddelde meting 2006

	niveau [+m]	B	D	F	H	J	L	N	P	R	T	V	X	Z	GEM
	47	0,2	0,1	-0,3	0,1	-0,4	-0,4	-0,3	-0,2	-0,5	-0,7	-0,5	-0,3		**-0,3**
BOLK	46	0,3	-0,3	-0,1	-0,4		-0,4	-0,3	0,1	-0,6	-0,9	-0,5	-0,2		**-0,3**
	45	-0,7	0,0	-0,3	-0,2	-0,1	-0,1	-0,3	-0,2	-0,8	0,2	-0,4	-0,6	-0,7	**-0,3**
	44	-0,2	-0,2	0,0	-0,3	-0,4	-0,4	-0,1	-0,2	-0,4	-0,6	-0,9	-0,3	-0,6	**-0,4**
	43	0,2	-0,2	-0,1	-0,2	-0,3		0,3	-0,7	-0,2	-0,2	-0,7	-0,6	-0,5	**-0,3**
10	42	-0,7	-0,5	-0,6	-0,5	-0,3	-0,5	-0,2	-0,6	-0,1	-0,3	-1,1	-0,4	-0,1	**-0,5**
	41	-0,6	0,2	-0,2	-0,5	-0,8	-0,2	0,1	-0,2	-0,5	-0,4	-0,8	-0,3	-0,5	**-0,4**
	40	-0,3	-0,4	-0,8	-0,1	-0,8	-1,1	-1,2	-1,0	-0,2	-0,3	-0,8	-0,5	-1,1	**-0,7**
	39	-0,6	-0,6	-1,1	0,0	-0,7	-0,9	-0,4	-0,5	-0,4	-0,5	-0,4	-0,4	-0,3	**-0,5**
20	38	-0,6	-1,2	-0,3	-0,6	-0,6	-0,4	-0,5	-0,5	-0,3	-0,3	-0,8	-0,7	-0,4	**-0,5**
	37	-0,7	-0,3	-0,6	-0,3	-0,4	-0,6	-0,6	-0,3	-0,3	-0,5	-0,3	-0,3	-0,6	**-0,4**
30	36	-0,1	-0,6	-0,4	-0,7	-0,5	-0,3	-0,4	-0,3	-0,2	-0,4	-0,3	-0,3	0,0	**-0,3**
	35	-0,2	0,0	-0,1	-0,1	-0,5	-0,5	-0,5	-0,4	-0,2	-0,7	-0,4	-0,3	-0,3	**-0,3**
	34	-0,1	-0,4	-0,4	-0,5	-0,2	-0,3	-0,3	-0,4	-1,0	-0,6	-0,4	-0,6		**-0,4**
40	33	-0,6	-0,7	-0,5	-0,5	-0,4	-0,7	-0,3	-0,3	-0,3	-0,2	-0,6	0,0		**-0,4**
	32	-0,1	-0,4	-0,1	0,0	-0,5	-0,7	-0,1	-0,3	-0,2	-0,5	-0,1	-0,5		**-0,3**
	31	-0,8	-0,2	-0,7	-0,7	-0,5	-0,3	-0,9	-0,5	-0,2	0,0	-0,1	-0,8		**-0,5**
50	30	-0,5	-0,8	-0,6	0,0	-0,7	0,0	-0,2	-1,3	-0,3	0,3	-0,3	-0,5		**-0,4**
	29	-0,4	-0,9	-0,3	0,2	-0,3	0,6	-0,5	-0,3	-0,8	-0,4	-0,2			**-0,3**
60	28	-0,2	-0,3	-0,5	0,0	0,1	-0,6	-0,1	0,0	-0,4	-0,1	-0,5			**-0,2**
	27	0,0	-0,2	-0,5	-0,4	-0,6		-0,7	-0,4	0,1	-0,1	-0,5			**-0,3**
	26	-0,1	-0,2	-0,4	-0,1	0,0	-0,6	-0,6	0,1	-1,2	-0,8	-0,9			**-0,4**
	25	0,0	-0,4	-0,4	-0,2	-0,3	-0,2	-0,6							**-0,3**
	24	-0,4	-0,2	-0,4	-0,5	-0,2	-0,4								**-0,4**
	GEM	**-0,3**	**-0,4**	**-0,4**	**-0,3**	**-0,4**	**-0,4**	**-0,4**	**-0,4**	**-0,4**	**-0,4**	**-0,5**	**-0,4**	**-0,5**	**-0,39**

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Co-firing is more attractive than stand alone biomass units

CO-FIRING	DEDICATED STAND ALONE BIOMASS UNITS
> High conversion efficiency(> 40 %)	> Lower effiency (about 30%)
> Low emissions	> Mostly higher emissions
> Relatively attractive economics	> Very high generation cost
> Biomass from the world market	> 'Local' biomass applicable
> Pulverized fuel technology; milling of biomass necessary	> Mostly grate firing or fluidised bed: no milling required

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Technical developments
in the past 15 years

- First phase: biomass mixed with coal → bad grinding
- Separate milling of biomass and coal: either in hammer mills or converted coal mills
- Converted coal mills: suitable only for biomass; mass flow limitation → reduced energy output of the mill
- Recent developments: flexible converted mills: on-line switching from biomass to coal. Increased mass flow → energy output same as with coal
- Recent development: pneumatic pellet transport to the mills

Safety in biomass handling needs special attention

- Dust from dry biomass can form ignitable layers and explosive dust clouds
- (Fresh wood chips have no dust problems)
- Self heating in stored biomass can happen, especially when moisture comes in → temperature monitoring necessary
- Transport systems must be kept clean. Closed transport systems are attractive. Otherwise, continuous cleaning necessary
- Explosion detection and suppression systems at transfer points and in mills
- Best practices have been developed to secure biomass systems

Future outlook

- A fully sustainable energy system requires about 50 % of storable energy
- Biomass is stored, concentrated solar energy
- So, biomass will get more and more important in global energy supply
- Co-firing biomass with coal is an attractive (intermediate) step
- Biomass share in co-firing can be increased. Ultimately, coal plants can be converted to 100 % biomass
- Today, high percentages of co-firing and even 100 % conversion is proven technology (Netherlands, UK, Denmark, Belgium)
- so: **BIOMASS HAS A GREAT FUTURE**

Thank you

- Dr. Wim Willeboer

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