



From innovation to operational assistance

Biomass Co-firing in Electrabel
Power Plants: the Belgian context

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ELECTRABEL BIOMASS COMPETENCE CENTRE

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Electrabel 

GENERATION
BeLux



(Co-)firing biomass in Belgium

1. Green certificates in Belgium
2. Electrabel strategy & bio-fuels
3. Electrabel projects
4. Resulting green power forecast

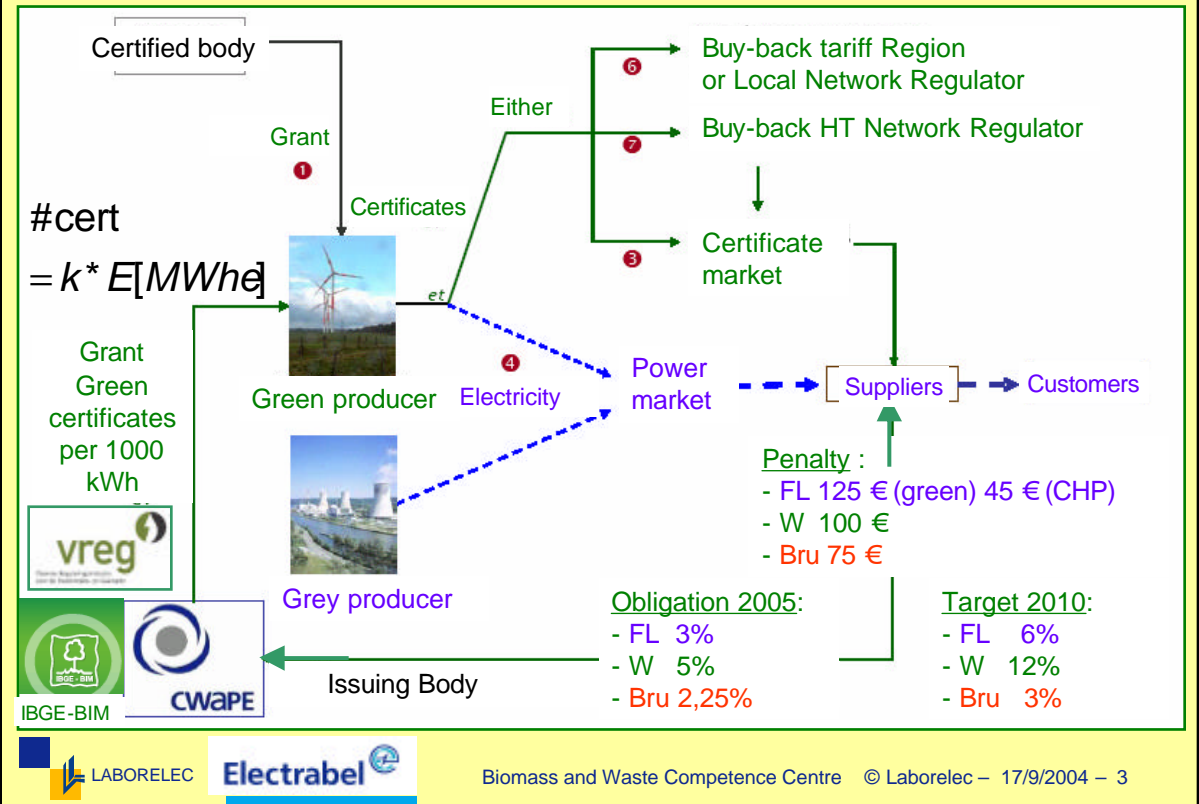


**Biomass & Waste
Competence Centre**

The technical Competence Center
in green energy processes and emerging technologies.

From innovation to operational assistance.

Belgian certificate systems



Buy-back tariff certificates (€/certificate)

SOURCE	BEL	FL	W
off-shore wind	90	NA	NA
on-shore wind	50	80	65
hydro	50	95	65
solar	150	450	65
biomass	20	80	65

Main legal issues

- ✓ **Permit and linked constraints**
(MER, étude d'incidence)
 - status of biomass source (fuel, waste)
- ✓ **Emissions :**
waste incineration or LCP or in between ?
- ✓ **Green character :**
 - + how many green certificates ?
 - CO2 approach Wallonia
 - energy approach in Flanders : production & transportation is subtracted

Biomassa is CO₂-neutral (NO GHG)

For bio-waste **ladder van Lansink** is applied in FL



crops



Biomassa is **renewable**

GHG emission of the plant

=

GHG captured by crops



Bio-waste is **renewable**

GHG emission v/d centrale

=

GHG generated by
spontaneous fermentation

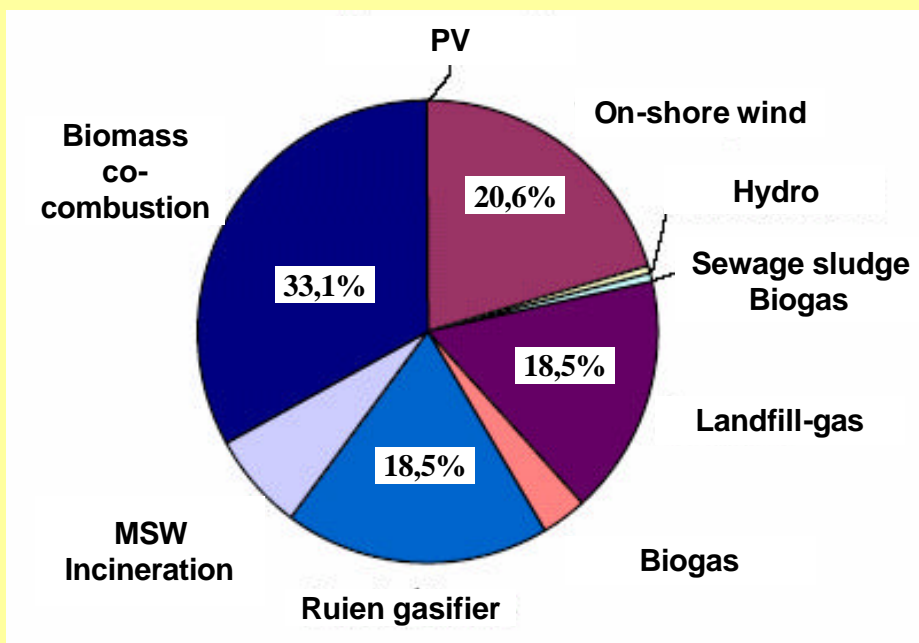
Definition of renewables

BEL	<p>Based upon sustainable development Sustainable development <i>“All non-fossile non-nuclear energy source that meets the needs of the present without compromising the ability of future generations to meet their own needs.”</i> PV, Wind, Geothermal, Biogas, Biomass accepted</p>
FL	<p>Tide&Wave, Hydro < 10 MWe, Biomass according to a)-d) a) vegetable products from agriculture and forestry; b) litter and manure; c) sorted organic-biological waste; d) unsorted organic-biological waste (MSW) with min. 35 % energy recuperated</p>
W	<p>CHP and Hydro < 20 MWe included</p>
Bru	<p>Hydro < 10 MWe Biomass = organic waste from agriculture and forestry</p>

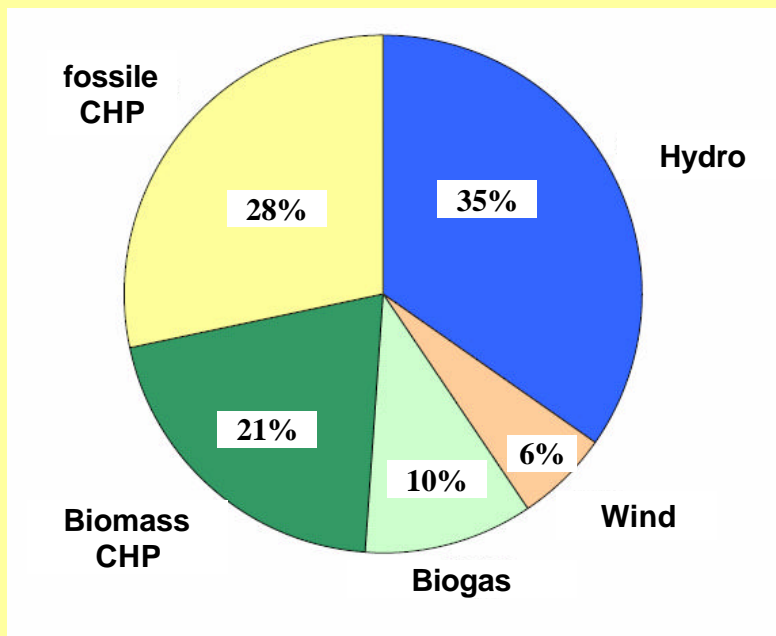
B Green certificates : obligation & realisation

FL : 50 TWh	2002	2003	2004	2005	2006	2007	2008	2009	2010
Obligation	0,50%	1,20%	2%	2,50%	3%	3,75%	4,50%	5,25%	6%
Certificates x 1000	250	600	1.000	1.250	1.500	1.875	2.250	2.625	3.000
Certificates real	150	292	544						
Penalty	€ 75,00	€ 100,00	€ 125,00	€ 125,00	€ 125,00	€ 125,00	€ 125,00	€ 125,00	€ 125,00
Market value	€ 79,04	€ 92,62	€ 110,93						
W		2003	2004	2005	2006	2007	2008	2009	2010
GWh		23.369	23.628	23.891	24.156	24.424	24.696	24.970	25.247
Obligation		3%	4%	5%	6%	7%	?	?	12%
Certificates x 1000		701	945	1.195	1.449	1.710	?	?	3.030
Certificates real		752	872	975		1.600			
Penalty		€ 75,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00
Market value		€ 84,38	€ 91,74						
Bru : 5 TWh	EXCHANGEABLE		2004	2005	2006				
Obligation			2%	2,25%	2,50%				
Penalty			€ 75,00	€ 75,00	€ 75,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00

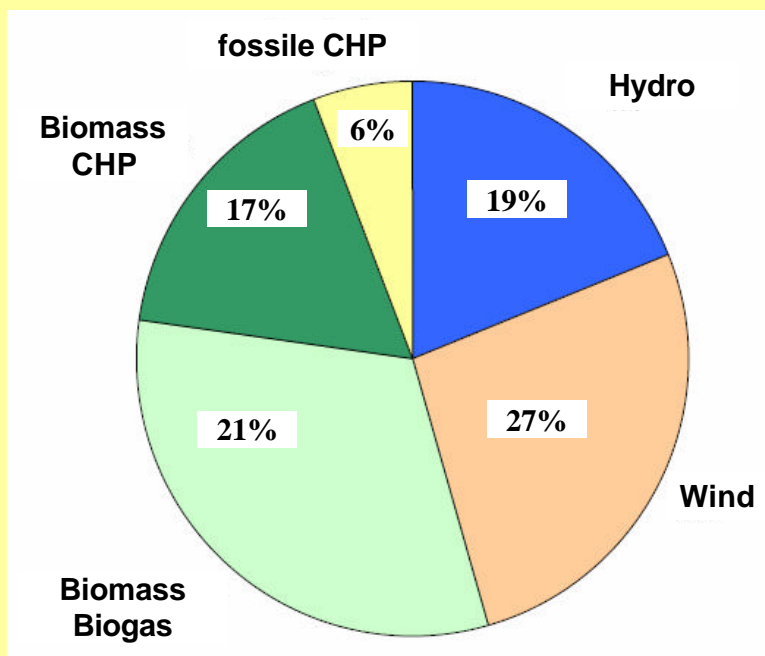
Green certificates generation : Flanders 2002-2005



Green certificates generation : Wallonia 2004



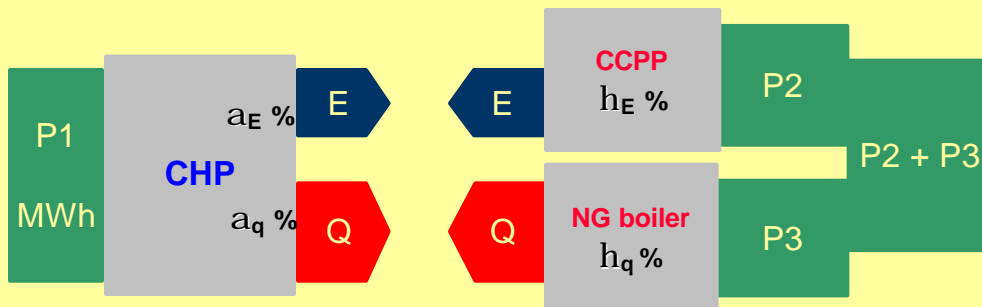
Green certificates generation : Wallonia 2007



CHP certificates Flanders :primary power P

- ✓ Quality CHP > **5 %**
- ✓ Penalty = **45 €**

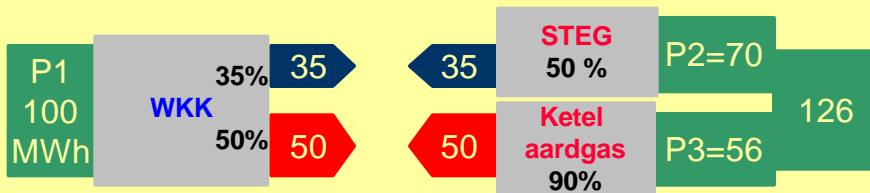
$$\text{Qual} = \frac{P_2 + P_3 - P_1}{P_2 + P_3} = \left[1 - \frac{1}{\frac{a_q}{h_q} + \frac{a_e}{h_e}} \right] \times 100\%$$



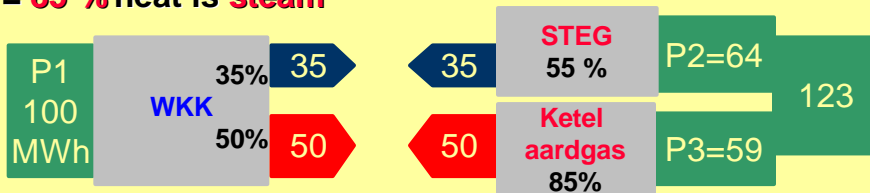
$$\# \text{cert} = P_2 + P_3 - P_1 = k * E = \left[\frac{1}{h_e} + \frac{a_q}{a_e \cdot h_q} - \frac{1}{a_e} \right] \times E$$

Reference efficiencies FL

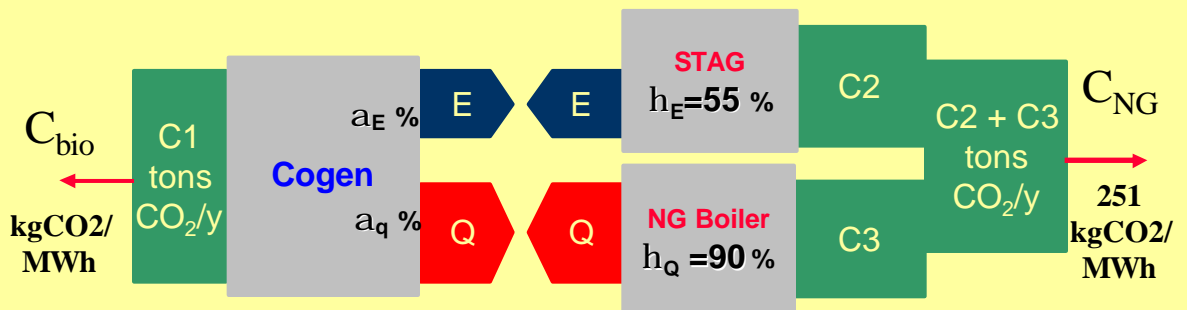
- ✓ $h_E = 35\%$ biomass
- ✓ $h_E = 50\%$ network tension ≤ 15 kV
- ✓ $h_q = 90\%$ heat is warm water



- ✓ $h_E = 55\%$ network tension > 15 kV.
- ✓ $h_q = 85\%$ heat is steam



Green certificates in Wallonia : GHG C [CO₂eq]



$$k = \frac{C_2 + C_3 - C_1}{C_2}, E \text{ MWhe}, Q \text{ MWhth},$$

$$\# \text{ cert} = k * E = E + \frac{h_e}{h_q} * Q - \frac{C_{bio}/a_e}{C_{NG}/h_e} * E$$

k vs Elec Power installed

- ✓ > 20 MWe : Q=0
- ✓ >5 MWe <20 MWe
 $k_{max} = 1$
- ✓ < 5 MWe :
 $k_{max} = 2$

Specific rate of fossile GHG generation in kg CO₂eq/MWh primary energy (CWaPE)

❖ NON FOSSILE

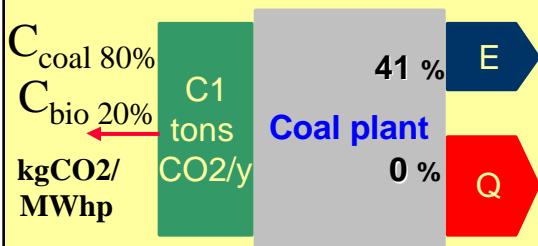
❖ wind/solar/hydraulics	0
❖ organic biodegradable matters	0
❖ milling	4
❖ transport on max. 100 km	5
❖ drying	10
❖ corn crops	22
❖ wood	23
❖ cultivated wood (short rotation coppices)	45
❖ colesseed oil	65
❖ bio-diesel	80

❖ FOSSILE

❖ natural gas	251
❖ gasoil	306
❖ light fuel oil	310
❖ heavy fuel oil	320
❖ coal	385



CASE 1: Co-combustion coal + bio-fuel



CO2 emission rates (CWAPE).

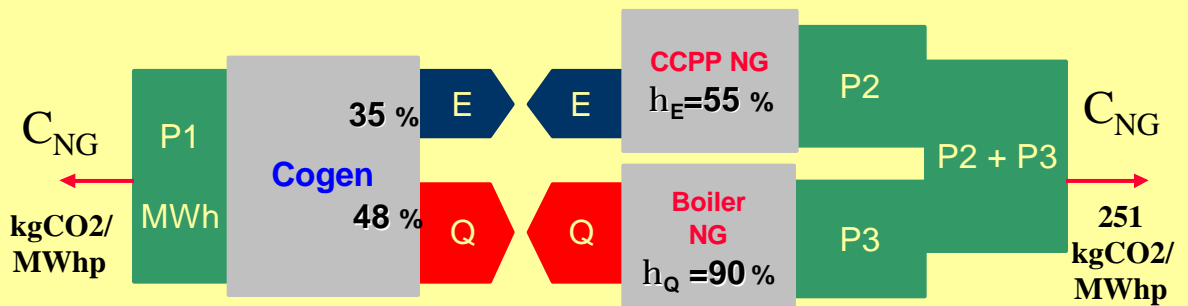
- ✓ $C_{NG} = 251 \text{ kgCO}_2/\text{MW hp}$,
- ✓ $C_{coal} = 385 \text{ kgCO}_2/\text{MW hp}$,
- ✓ $C_{bio} = 23 \text{ kgCO}_2/\text{MW hp}$,

Mass ratio	Bio-Energy	k
10%	6%	-0,95
20%	12%	-0,82
30%	19%	-0,69
40%	27%	-0,53
50%	36%	-0,37
60%	45%	-0,18
70%	56%	0,03
80%	69%	0,28
90%	83%	0,55
95%	91%	0,71
100%	100%	0,88

$$k = 1 - \frac{55\%}{a_e} * \left(\frac{C_{bio} * 12\% + C_{coal} * 88\%}{C_{gaz}} \right)$$

$$= \left[1 - \frac{55\%}{41\%} \frac{(23 * 12\% + 385 * 88\%)}{251} \right]$$

CASE 2: NG cogeneration 1 MWe



$$k = 1 + \frac{h_E}{a_E} * \left(\frac{a_Q}{h_Q} - \frac{C_{NG}}{C_{NG}} \right) = 1 - \frac{55}{35} * \left(1 - \frac{48}{90} \right) = 1 - 0,73 = 0,27$$

$$NGC = k * E (MWh / y) = 0,27 * 3500 \text{ hours} / y$$

$$= 933 \text{ certificates} / \text{installed MWe} / y$$

Electrabel STRATEGY

Which kind of Biomass ?



Reminder :

With a power plant efficiency of 36 %, 1 kg hard coal or dry wood generates about 2,5 kWh

Today's Basket :

- Olive Cake : 1 kg → ~ 1,3 kWh
- Wood Dust : 1 kg → ~ 1,8 kWh
- Wood Chips : 1 kg → ~ 0,8 ... 1,5 kWh
- "Pellets" (clean wood) : 1 kg → ~ 1,8 kWh
- Sewage Sludge : 1 kg → ~ 1,0 kWh.
- Coffee grounds : 1 kg → ~ 1,6 kWh

BIO-FUELS selected by ELECTRABEL

Co-combustion of biomass in the existing
ELECTRABEL coal plants

Today :

- ❖ Ruien : wood dust – ~ 10 MW
- ❖ Ruien : clean wood chips : gasifier - ~ 17 MW
- ❖ Langerlo, Rodenhuize, Ruien : olive cake : Σ ~ 12 MW
- ❖ Langerlo : sewage sludge - ~ 4 MW

■ **In Flanders :**

« **Biomass** » means co-combustion with hard coal !

Biomass sourcing



- **Wood dust**, wood chips, sewage sludge : Belgium
- **Olive cake** : Spain, Tunisia, Middle-East
- **Wood pellets** : Canada, South Africa, Baltic States, South America
- **Coffee grounds** : Switzerland, Germany, Spain

Resulting green power in 2004

Biomass source	Quantity t/a	Power plant	Average MW	Avoided coal t/a	Avoided CO ₂ t/a
syngas	104 700	Ruien	17	47 100	111 000
wood dust	40 100	Ruien	10	28 800	68 000
olive cake	64 000	LLO/Ruien/RDH	12	34 600	81 500
sewage sludge	28 000	LLO	4	11 200	26 500
Total	304 500	with coal	43	121 700	287 000

ELECTRABEL Biomass Projects

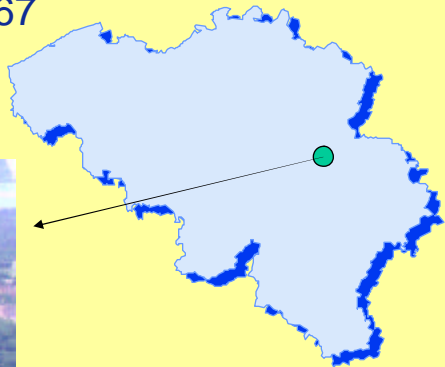
■ 2005 :

- ❖ Wood dust : Langerlo : + ~ 20 MW
- ❖ « Wood Pellets » :
 - Rodenhuize : co-combustion : ~ 60 MW
 - Awirs (Liège) : *conversion in progress* : ~ 80 MW
- ❖ Olive cake :
 - Mol : + ~ 5 MW
 - Mill efficiency enhancements other plants :
+ ~ 5 à 10 MW
- ❖ Coffee Grounds : Langerlo, Rodenhuize, Mol

■ CO2 Allocation Plan : *still coal in Flanders ???*

AWIRS 4 project

- Oil–gas unit commissioned in 1967
- Converted in 1982 to coal – gas
- Power level :125 MW



Awirs 4 wood pellets Project major constraints

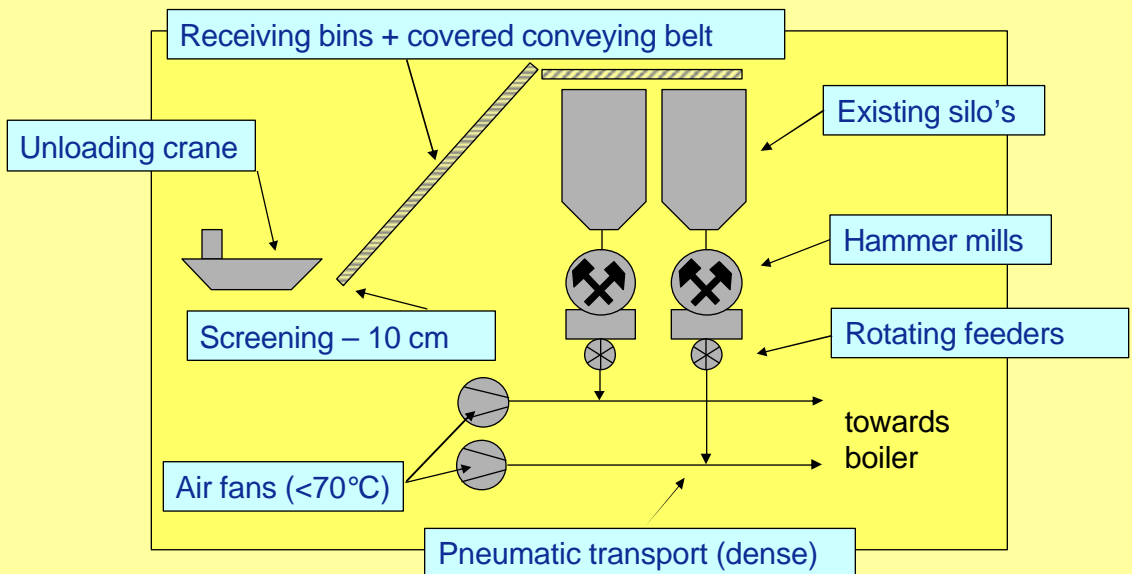


- Existing old 120 MW pulverised coal power plant
- Short delay : 7 months for realisation
- Full substitution of coal : « World Premiere »
- Must be fully reversible to coal in 3 weeks time
- Safety issue: fire and explosion with wood dust
- Delivery wood pellet : just-in-time 1200 tons/day
- Steam : 510°C instead of 545°C
- Power level : 80 MW instead of 120 MW with coal

Awirs 4 wood pellets : facts and figures

plant	34%	efficiency
	80,3	MWe
wood pellets	17	GJ/ton
	4,7	MWHP/ton
	1,6	MWhe/ton
	350.097	tons/year
	50	tons/h
	105	\$/ton
	4,9	€/GJ
	52,32	€/MWhe
generation	7000	hours
	562.100	MWh
green certificates	0,70	tau(CO2) min.
	393.470	certificates/y

Awirs 4 wood pellets : technical concept



Conveyors (some new some old) are newly equipped with **metal and spark detection and CO detection** (manual stop and manual water spreading with sprinklers)

Forecast green power in 2005



Biomass source	Quantity t/a	Power plant	Average MW	Avoided coal t/a	Avoided CO ₂ t/a
syngas	120 000	Ruien	19	54 000	127 300
wood dust	70 000	Ruien	18	50 400	118 800
olive cake	100 000	LLO/Ruien /RDH/Mol	19	54 000	127 300
sewage sludge	30000	LLO	4	12 000	28 300
wood pellets	275 000	Awirs /RDH	47	187 000	440 700
coffee ground	15 000	LLO/Mol	4	7 200	17 000
Total	610 000	with coal	111	121 700	732 000

Forecast green power in 2006



Biomass source	Quantity t/a	Power plant	Average MW	Avoided coal t/a	Avoided CO ₂ t/a
2004	304 500	with coal	43	121 700	287 000
2005	610 000	with coal	111	121 700	732 000
2006	1 120 000	with coal	202	652 400	1 537 000

Conclusions

Following issues are essential

- Stable, clear regulations, not too complex
 - ✓ bio-fuel status
 - ✓ emission limits
 - ✓ permit
- Clear responsibility definitions at Authority level
- Revised policy on quota and licenses
- Tradable European certificate system to avoid distortion of competition
- Social support/acceptance for renewable energy

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QUESTIONS ?