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From R&D to operational assistance

Fuel flexibility in coal power plants with co-firing

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Electrabel

BELGIUM HAS GREEN CERTIFICATE SYSTEMS

- 3 systems (one per region)
- Compatibility is technically feasible but excluded by law except OK between Brussels and Wallonia
- Growing target calculated on the base of yearly electricity sales for each supplier
- Penalty between 75 and 125 €/certificate
  or 7,5 to 12,5 €c/kWh
  but only a part of the benefit according to energy balance
- Regulatory body in each region
- Market of green certificates : market value < penalty
- Today : stable market value

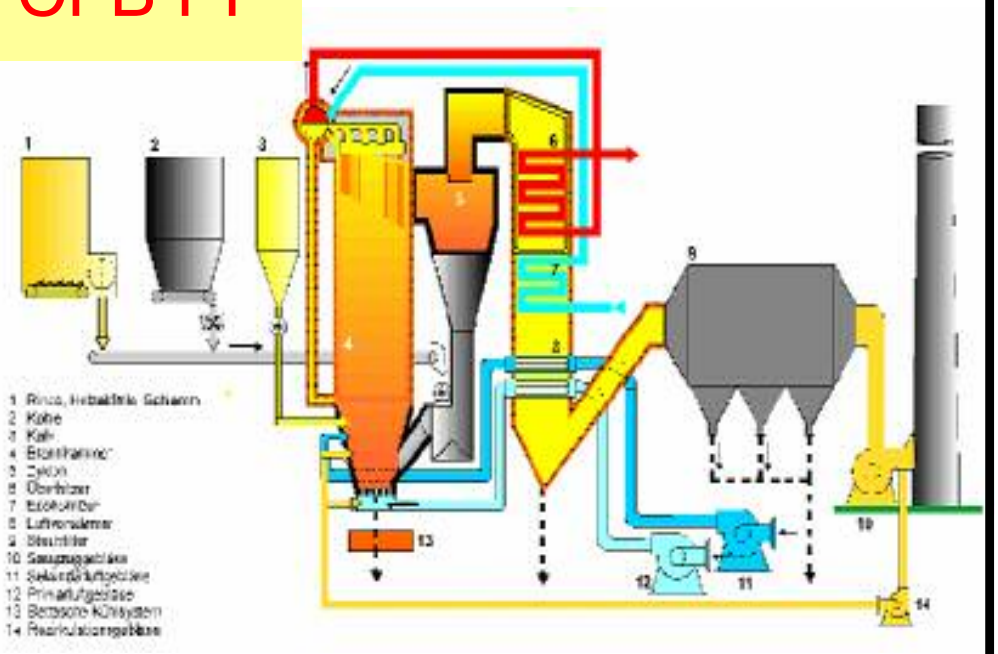
BIOMASS TECHNOLOGIES

- Modern coal power plants can accommodate biomass
  ex. Avedore PF (Dk), Buggenum ICCG (NL)
- Firing biomass in dedicated plants equipped
  with grate boilers or Fluidised Beds
  (depending upon capacity 20..35 MW)
  with feedstock = cheap local biomass

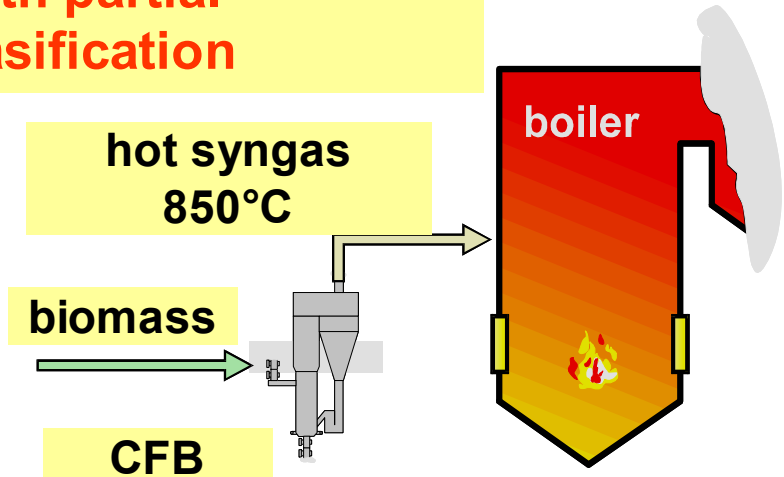
  INVESTMENT AT LEAST 3 X MORE EXPENSIVE
- Co-gasification of biomass (like Ruien) :
  (capacity depending upon dryness of feedstock)
  feedstock = cheap local biomass or waste
- Retrofit of existing coal power plant (like Awirs 4) :
  feedstock = expensive imported biomass
- Mixing bio-fuels with coal (with co-milling or separate injection)
  nearly no investment
  (cheap) waste or more expensive biomass

BIOMASS TECHNOLOGIES

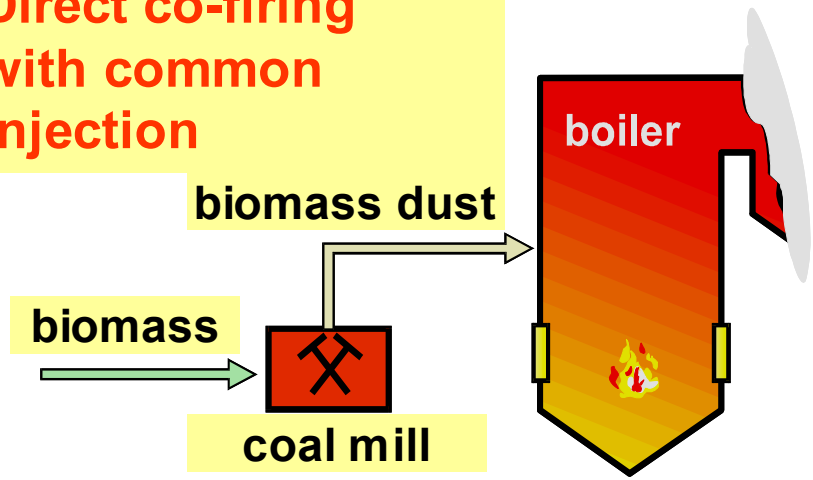
CFB PP



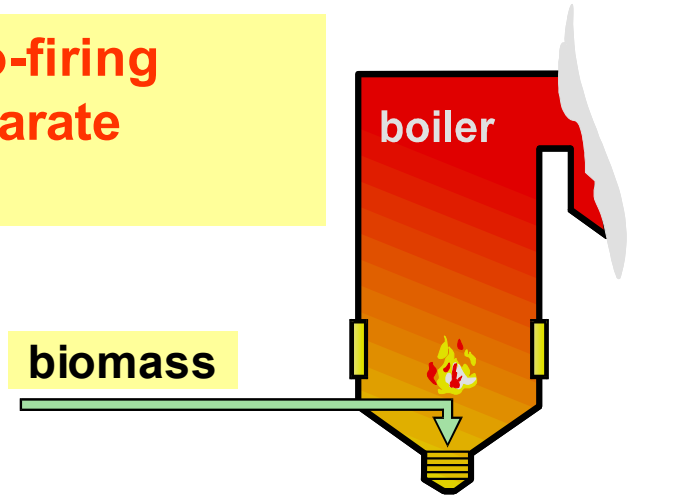
Indirect co-firing with partial gasification



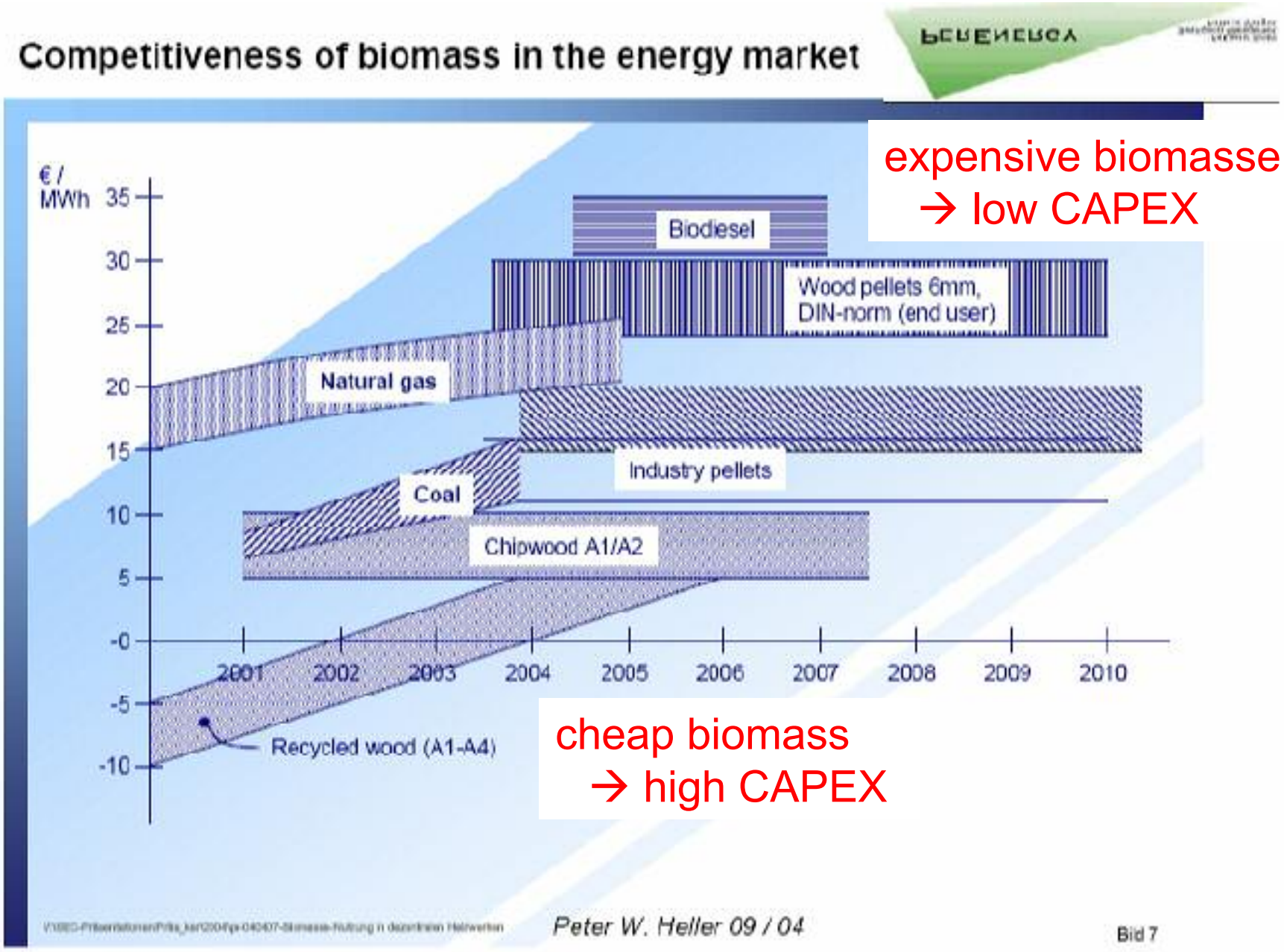
Direct co-firing with common injection



Direct co-firing with separate injection



BIOMASS COST



expensive biomasse
→ low CAPEX

cheap biomass
→ high CAPEX

Which kind of biomass ?
How is it used ?

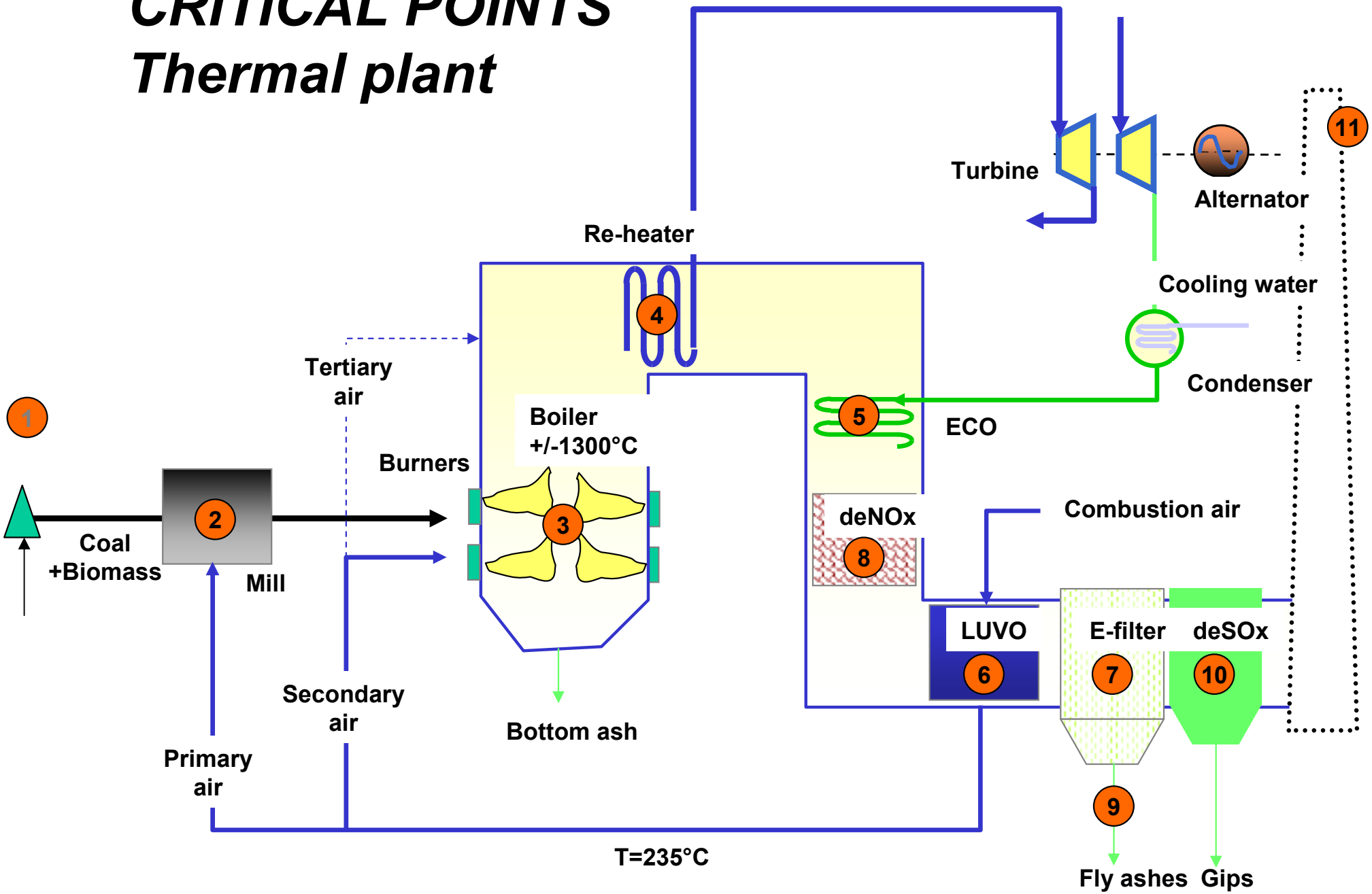
Reference:

With an electrical efficiency of 36 %,
1 ton hardcoal generates approx. 2,5 MWh

(Co-)firing bio-fuels today :

- sewage sludge : mixed with coal 1 kg ➔ ~ 1,0 kWh
- olive cake : mixed with coal 1 kg ➔ ~ 1,3 kWh
- coffee ground : mixed with coal 1 kg ➔ ~ 1,6 kWh
- wood dust : injected after mills 1 kg ➔ ~ 1,8 kWh
- wood chips : syngas injected 1 kg ➔ ~ 0,8…1,5 kWh
- wood “pellets” : hammer mills 1 kg ➔ ~ 1,8 kWh

CRITICAL POINTS
Thermal plant

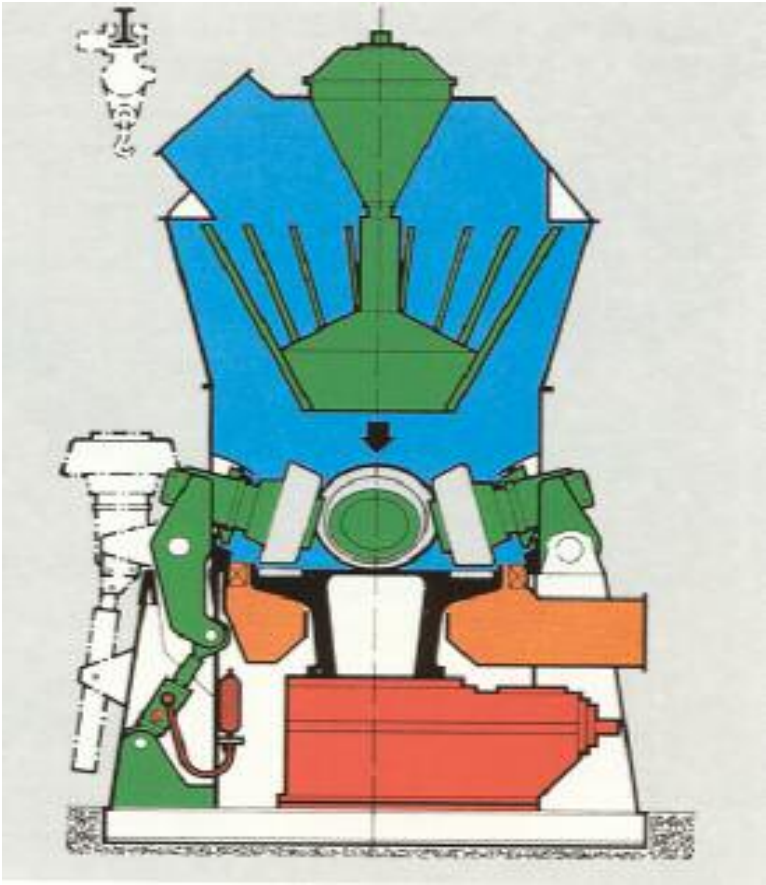


Critical points of co-firing biomass with coal

1.	Storage	Health, fire, …
2.	Milling	Mechanical problems, fire, explosions (volatiles)
3.	Furnace	Slagging, corrosion (reducing atmosphere !)
4.	Super-heater	Fouling, HT-corrosion (Cl, K)
5.	Economizer	$CaSO_4$ deposits
6.	High-dust $DeNO_x$	Catalyst deactivation (K, P, As, Ca)
7.	Air heater	Blockage, LT-corrosion, …
8.	ESP	Efficiency (S)
9.	By-products	Valorization ash in cement & concrete (Ca, P)
10.	DeSOx	Waste water, gypsum quality
11.	Stack: emissions	Legal aspect: permits

Use of coal roller mills for biomass

- Wear is caused by minerals which are both coarse and hard
- Power consumption is influenced by:
  - Particle size before grinding
  - Particle size needed after grinding
  - Type of coal or value of HGI
  - Moisture content
- With fibrous biomass risk of
  - agglomeration
  - vibrations and mechanical trouble
  - fires

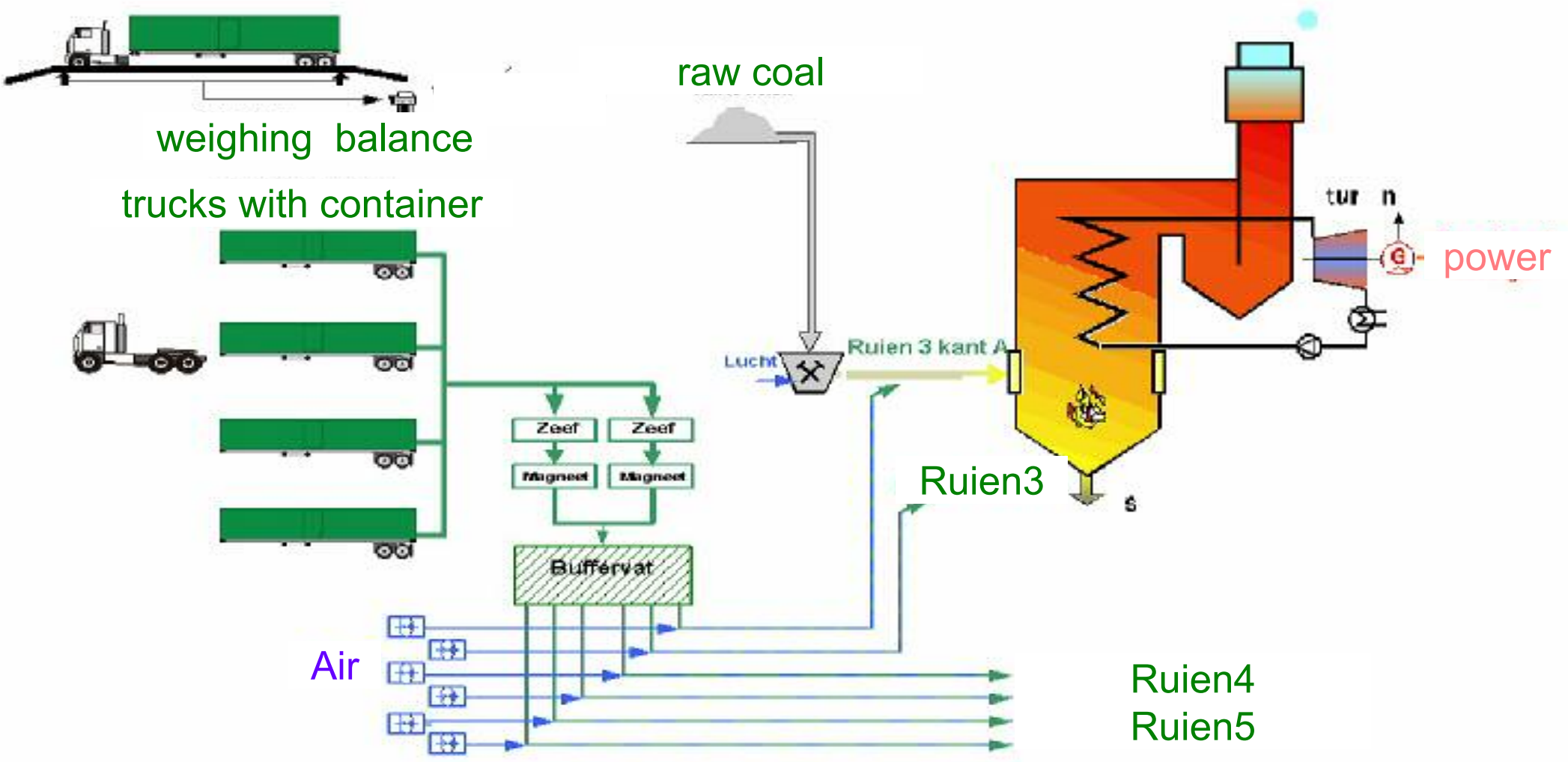


RECENT DEVELOPMENTS

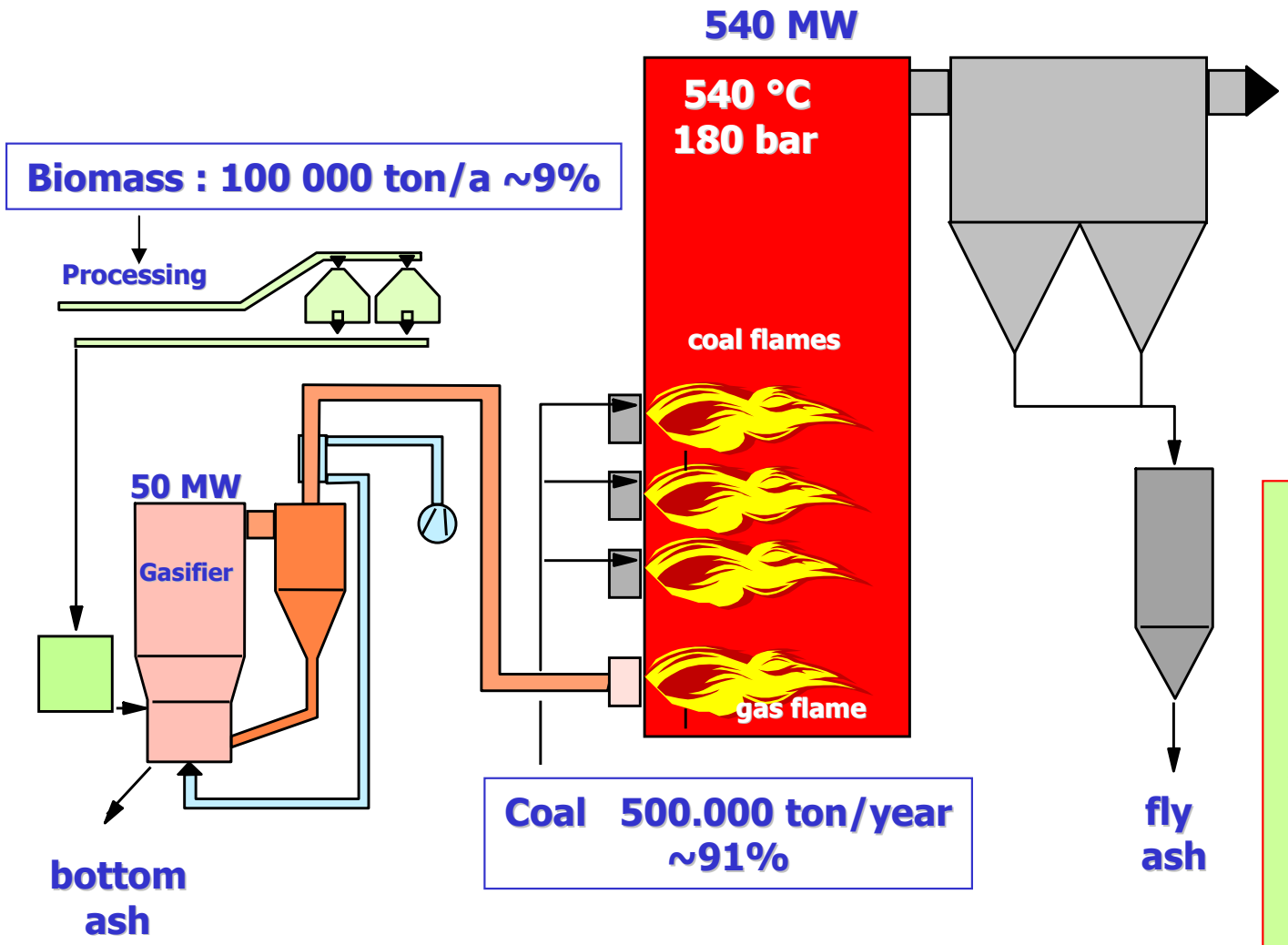
- 2005 :
  - Wood dust : Langerlo : + ~ 20 MW O.K.
  - Firing « wood pellets » :
    - Rodenhuize : co-combustion : ~ 65 MW test run
    - *Awirs (Liège) : 100% pellets : ~ 70 MW ~O.K.*
  - Olive cake :
    - + Mill efficiency enhancements : total + ~ 5 MW
  - Coffee Grounds : Mol
- 2007 :
  - Wood chips milling : Ruien : ~15 MW

Ruien Power Station

WOOD DUST IN RUIEN



WOOD CHIPS CFB GASIFIER RUIEN



- ✓ 120.000 mt/year wood chips
- ✓ 17 – 28 MWe
- ✓ 30-50% d.m. moisture

Concept of biomass co-firing in Ruien PP

Aanvoer kolen + olijfpulp

Kolenpark

Biomassa mengen met kolen en verwerking via kolenmolens.

- ✓ 40.000 mt/year olive cake
- ✓ 8 MWe

- ✓ 40.000 mt/year wood dust
- ✓ 10 MWe

Houtstofaanvoer

Inblazen biomassa-stof in de poederkoolleiding.

Vergasser

- ✓ 120.000 mt/year wood chips
- ✓ 30% moisture
- ✓ 22 MWe

Vergassing van biomassa en co-verbranding syngas via separate brander.

Brute kolen

Kolenmolen

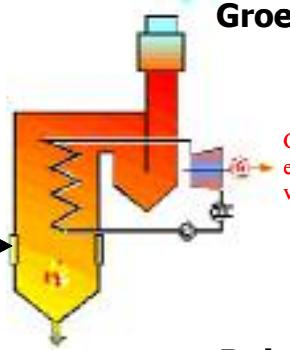
Brute kolen

Kolenmolen

Brute kolen

Kolenmolen

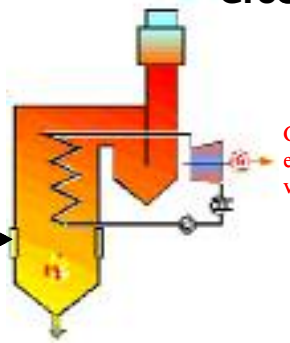
Ruien Groep 3



Geproduceerd elektrisch vermogen

- ✓ coal
- ✓ 130 MWe

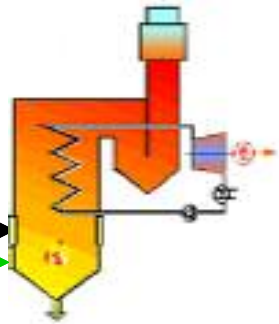
Ruien Groep 4



Geproduceerd elektrisch vermogen

- ✓ coal
- ✓ 130 MWe

Ruien Groep 5

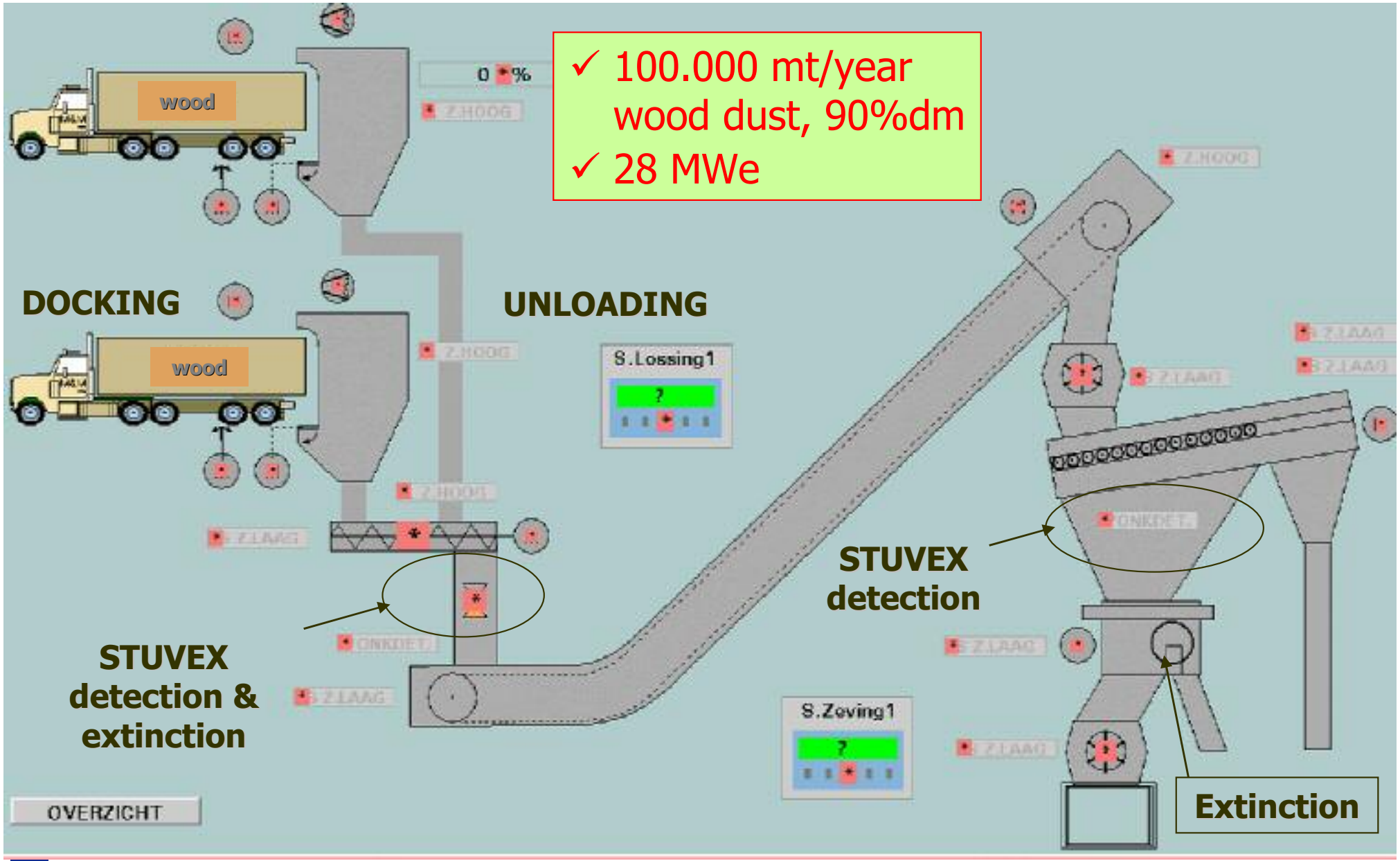


Geproduceerd elektrisch vermogen

- ✓ coal
- ✓ 200 MWe

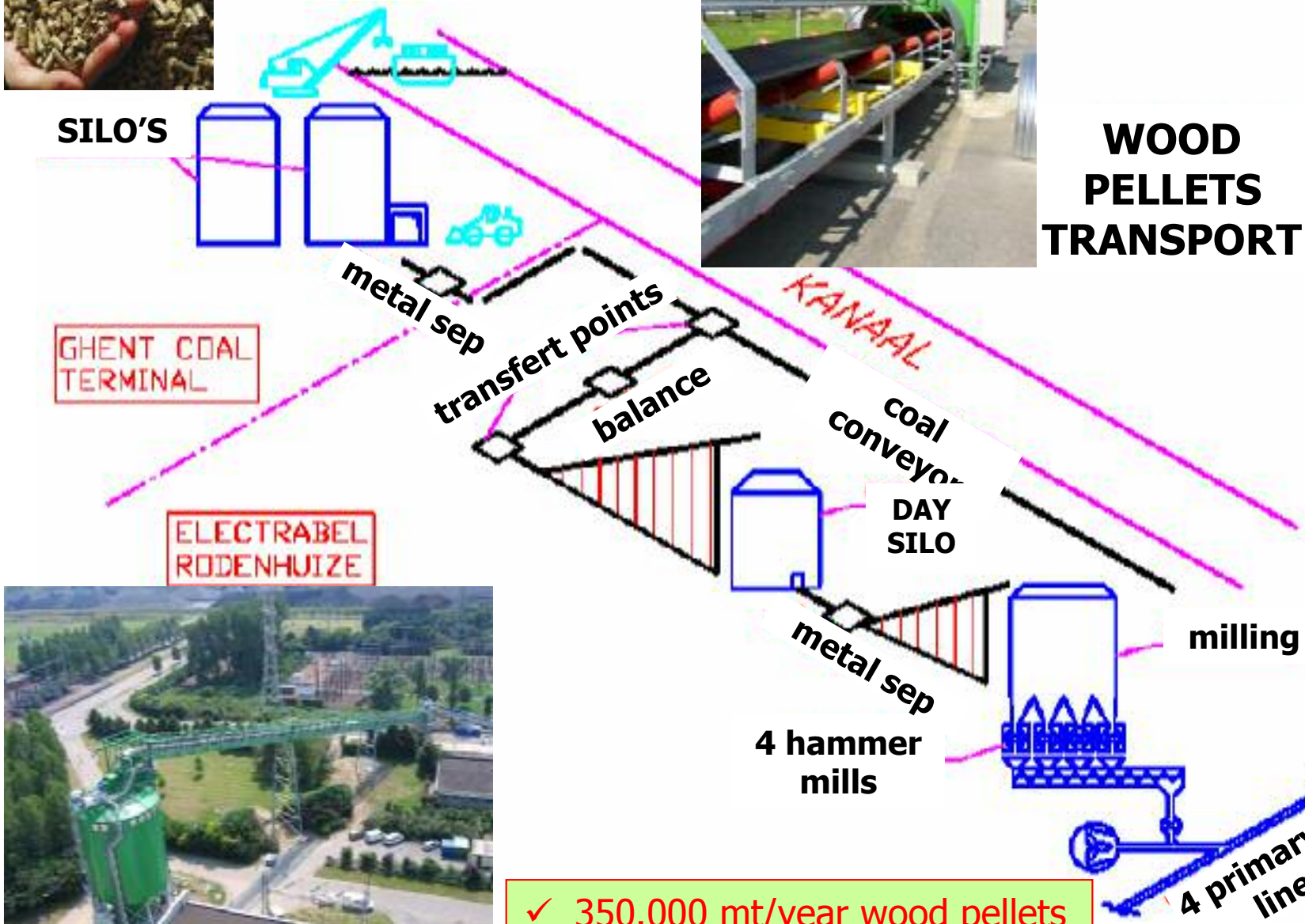
Ruien bio-power plant today

WOOD DUST IN LANGERLO



WOOD PELLETS RODENHUIZE

WOOD PELLETS TRANSPORT



- ✓ 350.000 mt/year wood pellets
- ✓ 80 MWe

DESIGN RODENHUIZE 4

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WOOD PELLETS IN AWIRS-4

wood pellets

hammer mills

boiler

electricity

unloading

Counter

pellet silo's

wood dust silo

natural gas

fan

Counter

EF

flue gas

steam

network

boiler

electricity generator

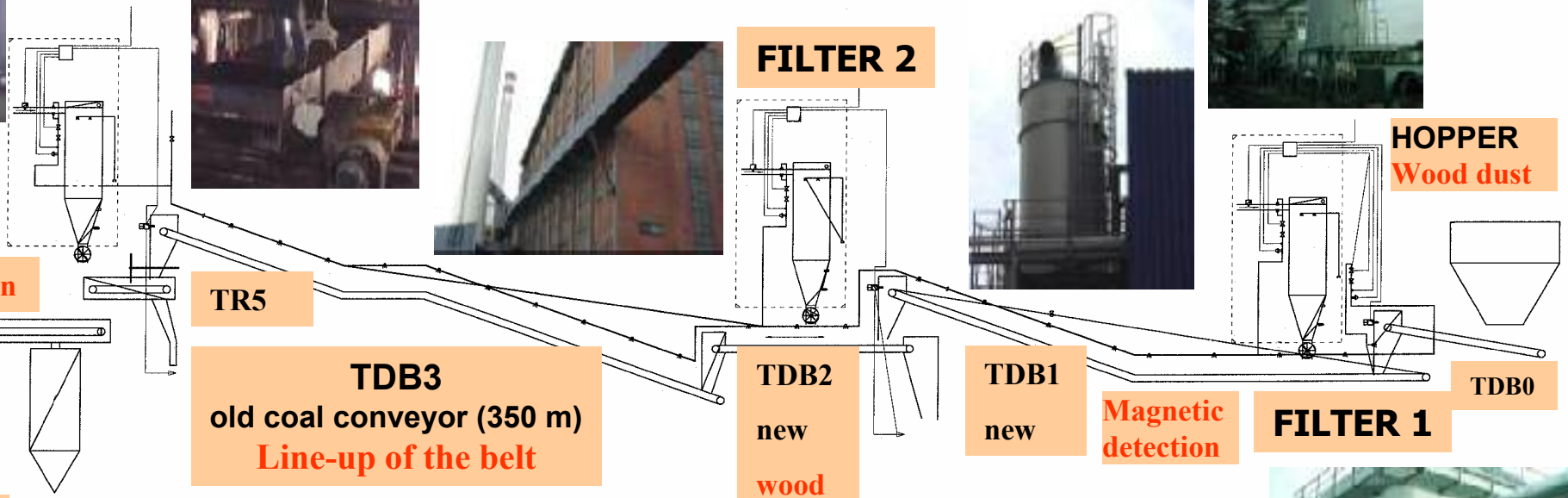
- ✓ 350.000 mt/year wood pellets
- ✓ 80 MWe

AWIRS4-DESIGN

FILTER 3

FILTER 2

HOPPER
Wood dust



R2 selection

TR5

TDB3
old coal conveyor (350 m)
Line-up of the belt

TDB2
new
wood dust

TDB1
new

Magnetic detection

FILTER 1

TDB0

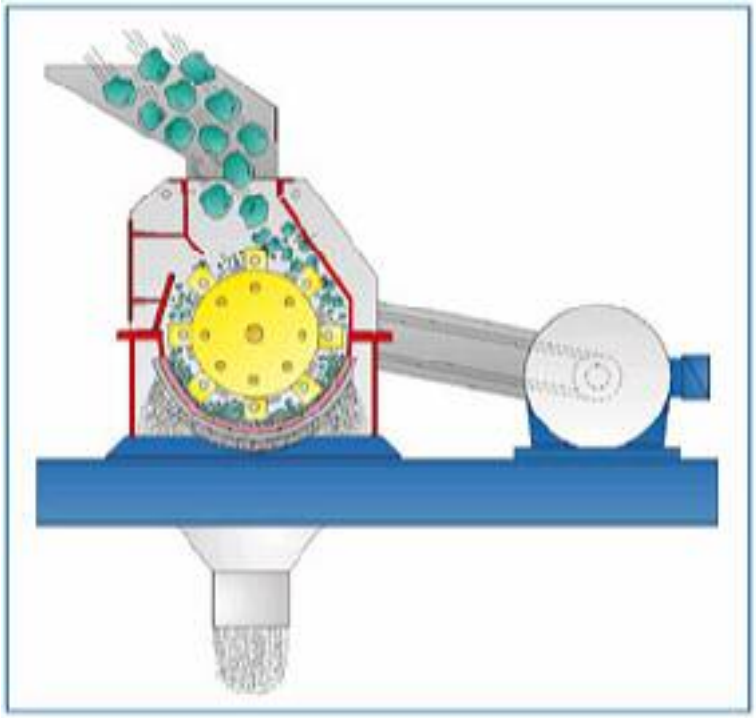
CENTREX 2

CENTREX 1

all conveyors fully covered

TECHNICAL ISSUES HAMMER MILLS

- Plugging of the sieves (holes of 2.5 mm)
- Wood dust bridging
- Hammer wearing
- Capacity linked to pellet quality
- Abrasion steel elements



Awirs 4

- 2 BVO mills
- 25 ton/h each
- 90% part. < 1.0 mm
- 1 mill ➔ 8 burners
- feed all burners

Rodenhuize 4

- 4 Sprout - Matador mills
- 10 ton/h each
- 99% part. < 1.5 mm
- 1 mill ➔ 2 burners
- feed middle burner row

Liquid bio-oils

Additional alternative liquid biofuels available :

- Palm oil
  - greatest potential available (Malaysia = 25 mil.ton/a)
  - not always produced on a sustainable base
  - cost 300 – 600 €/t
- Oils of coco, rapeseed, soya, sunflower
  - more expensive
- Recycled fry oil
  - cost 300 €/ton
  - potential limited
  - waste stream

INSTALLED CAPACITY WITH BIOMASS

2004 : 60 MW

- Ruien : wood dust ~ 8 MW
- Ruien : gasification of clean wood chips ~ 17 MW
- Langerlo, Rodenhuize, Ruien : olive cake ~ 31 MW
- Langerlo : sewage sludge ~ 4 MW

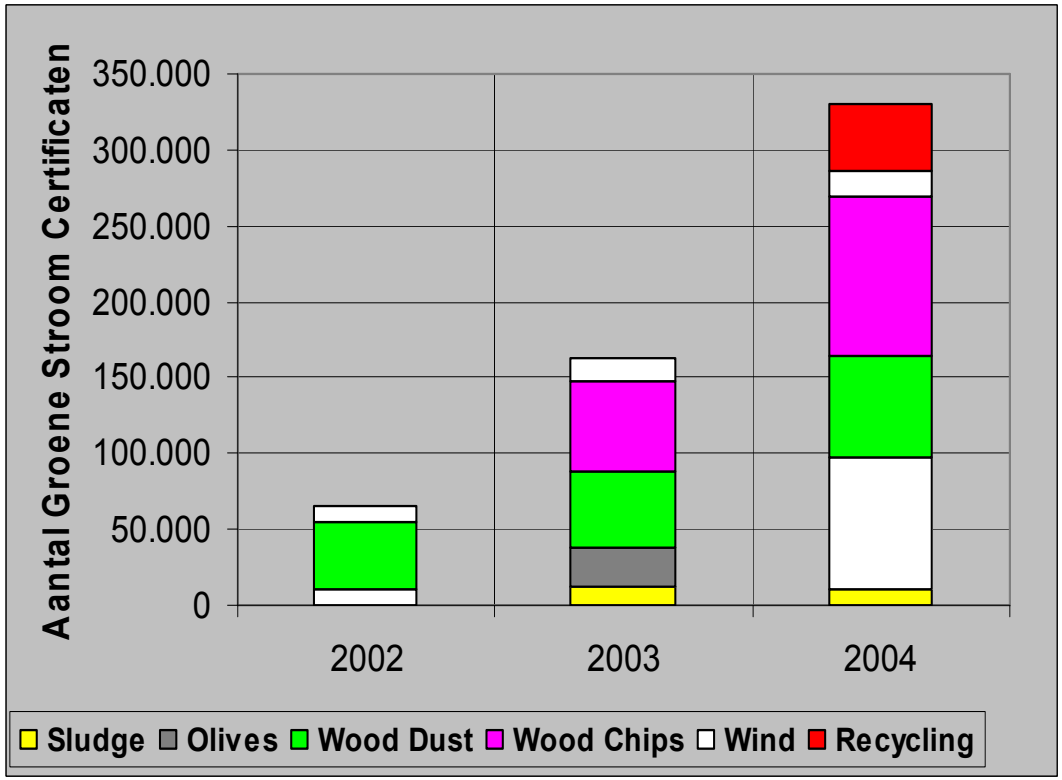
2005 : 246 MW

- Ruien wood dust ~ 10 MW
- Ruien : gasification of clean wood chips ~ 20 MW
- Langerlo : wood dust ~ 28 MW
- Langerlo, Rodenhuize, Ruien : olive cake ~ 34 MW
- Langerlo : sewage sludge ~ 4 MW
- Mol : coffee ground ~ 2 MW
- Awirs wood pellets ~ 80 MW
- Rodenhuize wood pellets ~ 66 MW

2007 : 261 MW

- Ruien wood pulverisation (Biostof) ~ 15 MW

EVOLUTION GREEN POWER ELECTRABEL



Biomass source	ton/a	Power plant	Capacity MW	GREEN Certificates	Avoided ton/y CO_2
2005	*402 000*	*biomass*	*246*	*610 000*	*611 000*
2006	*782 200*	*biomass*	*246*	*1 007 300*	*1 258 700*

MAIN DIFFICULTIES

- L : Logistics and organization (volume !)
- A : Administrative : stability of regulations ?
  - Operation license
  - Emissions regulations
  - Green Certification
- S : Supply : market growing, prices rise
- T : Technical : specific technical adaptations

➔ *Long delays = loss of opportunities…*

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- You get access to more than 40 years of experience
- You get rapid service with reliable solutions
- You increase the profitability of your installations
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The technical Competence Center
in energy processes and energy use.
From R&D to operational assistance.