FRANCE'S BIGGEST BIOMASS CHP PLANT

M. INSA – EDF R&D

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Joint workshop in Skive, Denmark

DALKIA IN A FEW FIGURES (before transfer and now)

- **42,980** employees in **27** countries / now **20,000** employees
- Revenue: **€8.38 billion / now €4.00 billion**
- **163,000** energy facilities managed worldwide / now **90,000**
- **112** TWh energy managed capacity / now **50TWh**
- **7.2 Mt** of avoided CO_2 / now **3.6 million Mt**

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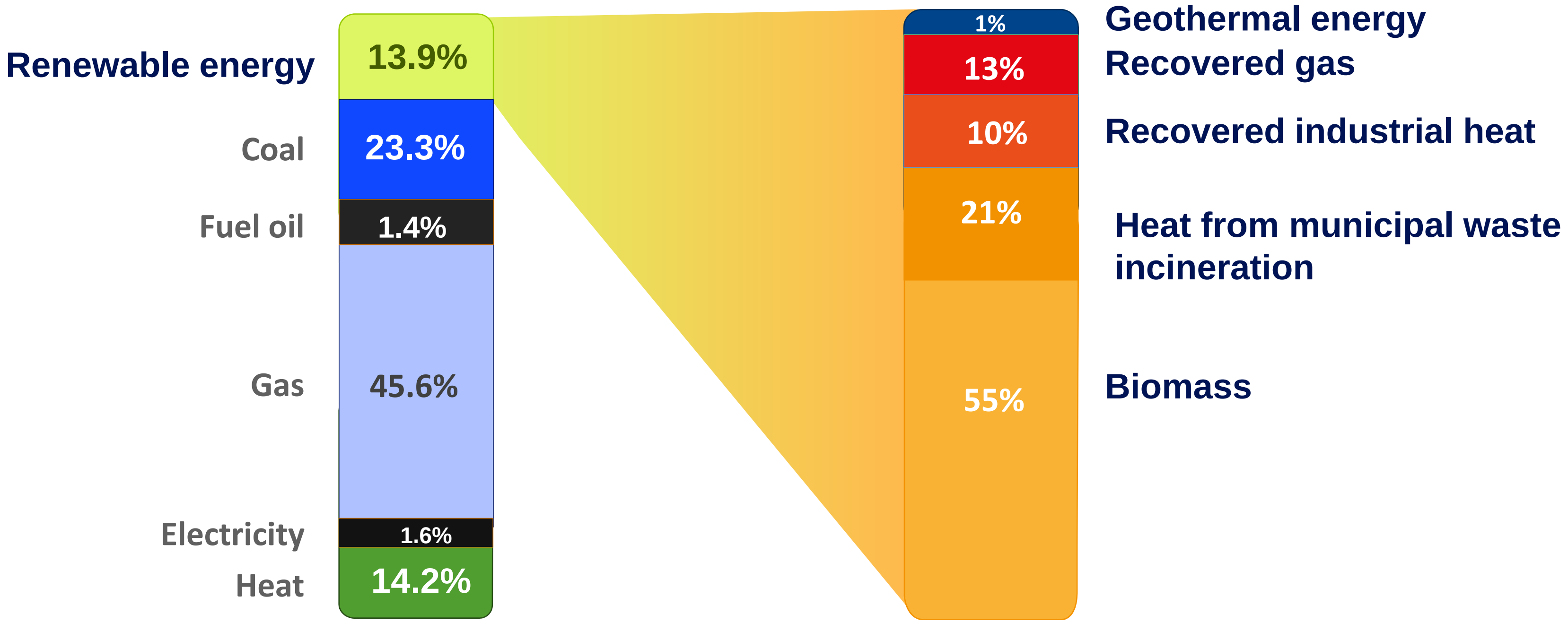
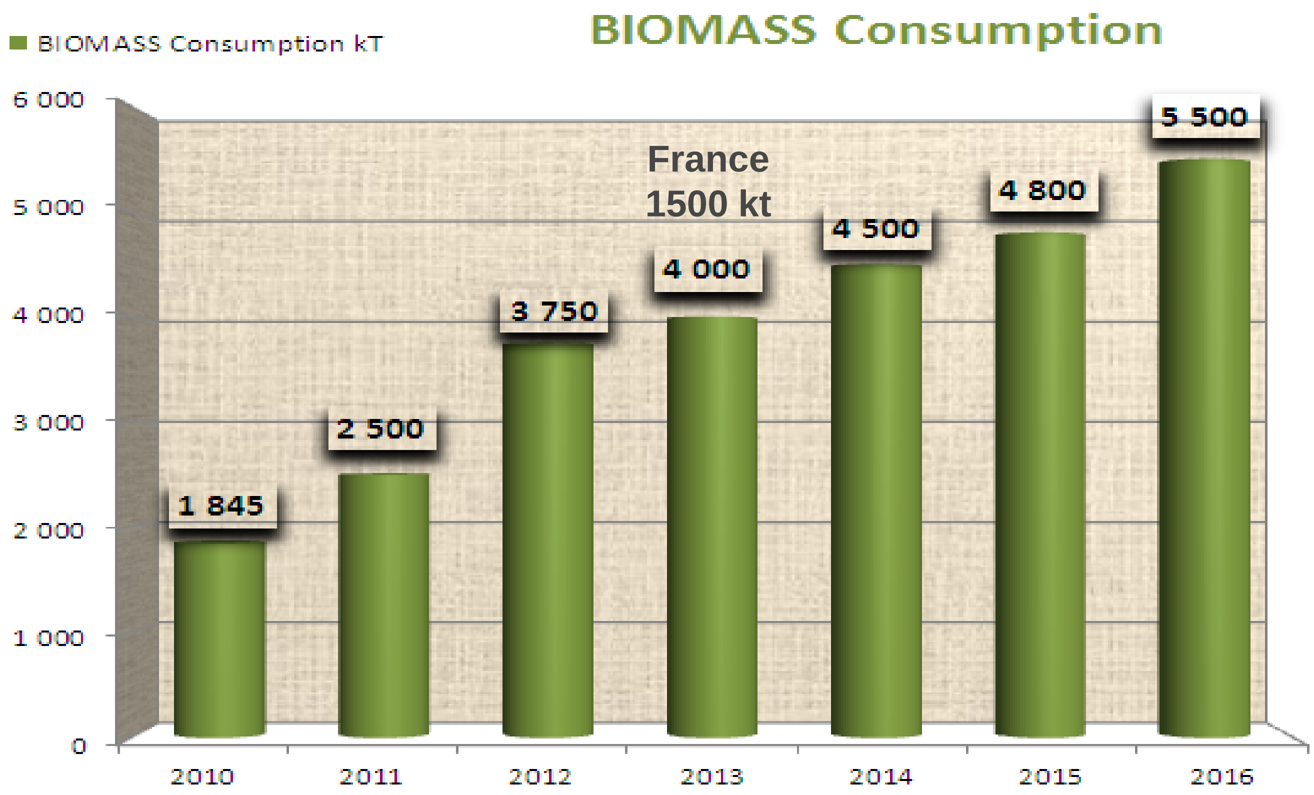
BREAKDOWN OF FUELS USED BY DALKIA



BIOMASS DATA



- 530 operating biomass plants worldwide in 16 countries *(2014)*
- 3,000 MWth heat capacity installed – 437 MWe electricity power installed
- 80 projects under development

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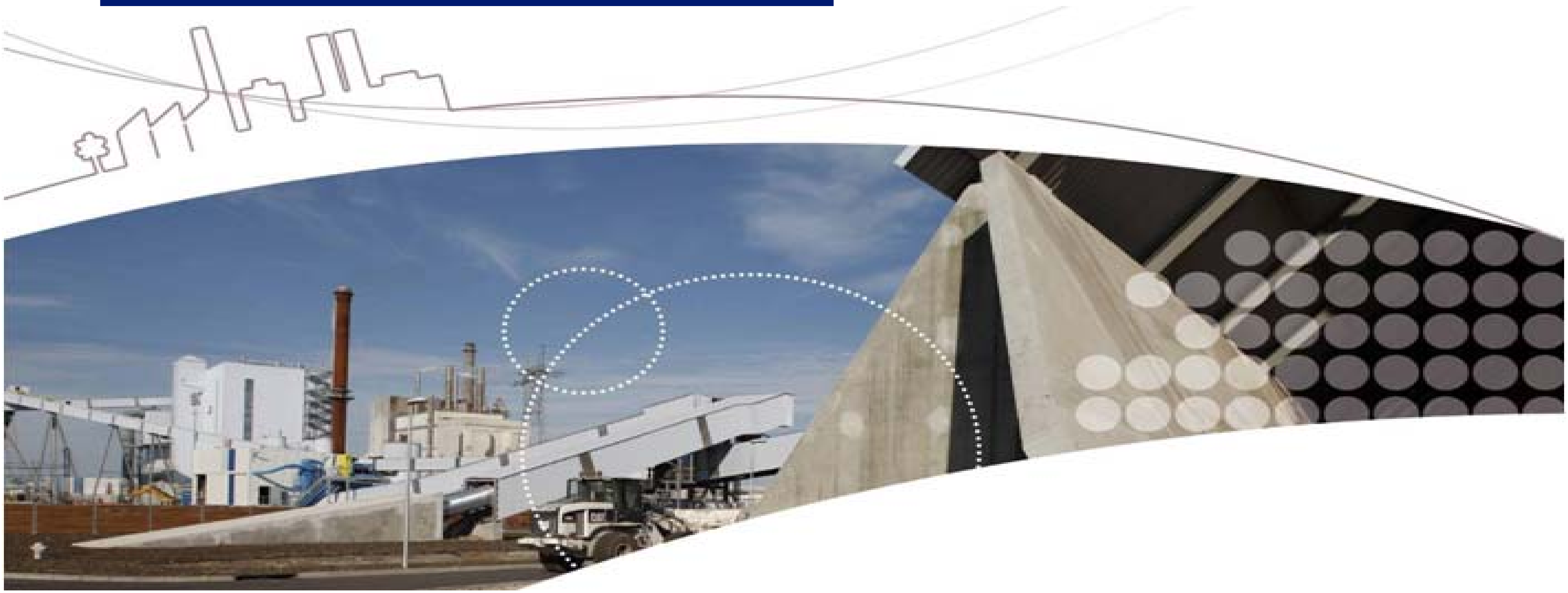

CONTEXT

Dalkia & Smurfit Kappa had implemented the biggest biomass CHP plant in France

- A call for renewable CHP projects was launched in 2006 by the state in order to reach 20% of renewable energy by 2020.
- Dalkia won this project, designed and constructed the CHP on Smurfit pulp and paper plant.
- Dalkia keeps the contract with Smurfit and the state to operate and maintain the CHP for 20 years, producing heat (steam) for the pulp & paper process and power.

Smurfit Kappa
Cellulose du Pin

140 MW (LHV)

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FIRST / A PARTNERSHIP

Smurfit Kappa
Cellulose du Pin

- First paper company in the production and trade of paper – cardboard packaging
- 349 production sites
- Have its own biomass supply susbsidiary

➢ **Facture plant produces 475 000 t per year of paper and wanted to use steam from renewables**

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- High experience on biomass energy
- A unique expertise in developing, constructing, operating and managing high energy performance facilities
- Creating energy savings

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TARGETS FOR THE TWO PARTNERS

Smurfit Kappa Cellulose du Pin requirements

- Replace steam and electricity production facilities and avoid capital expenditure
- Reduce energy bills
- Increase production capacity
- Consolidate their environmental approach and convey a green image

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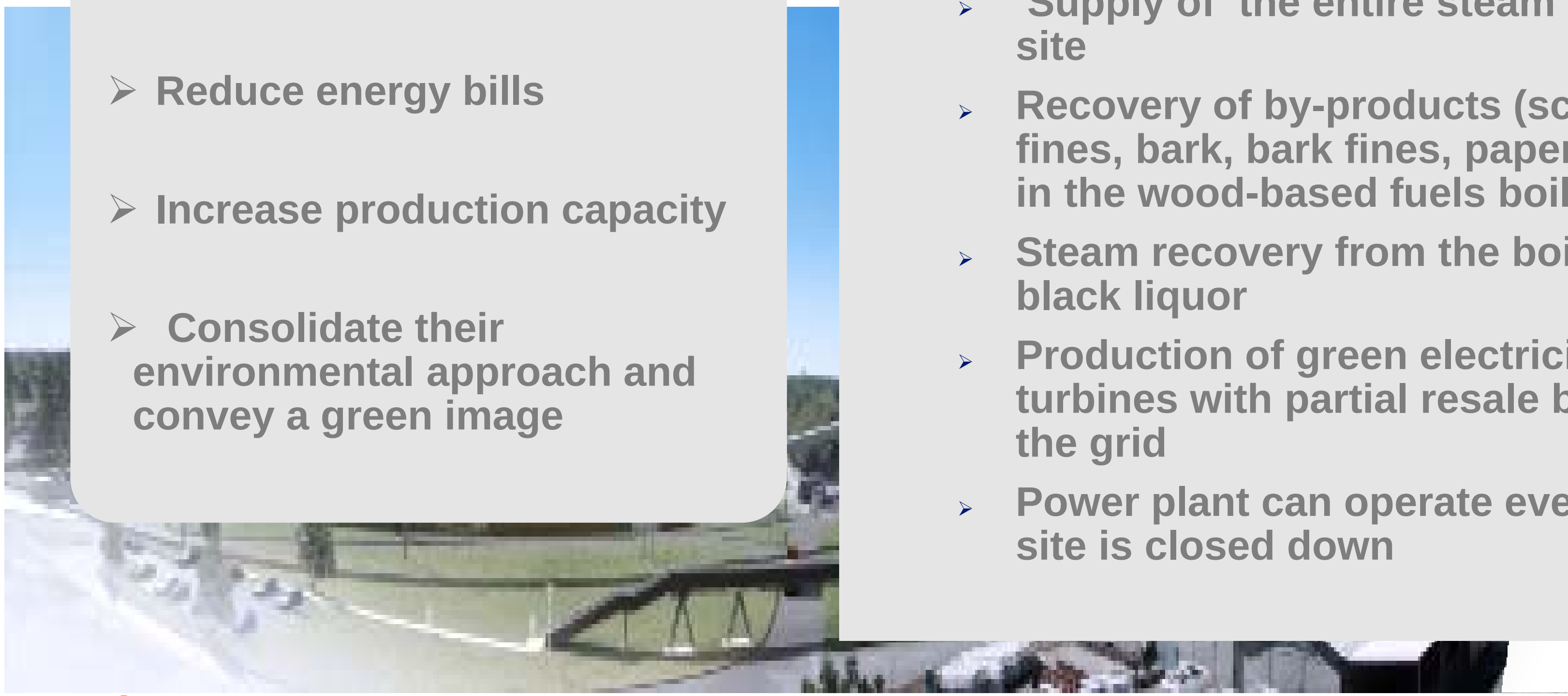
- New wood-based fuels boiler, 2 new turbines, 1 natural gas standby boiler
- Supply of the entire steam for the site
- Recovery of by-products (screening fines, bark, bark fines, paper sludge) in the wood-based fuels boiler
- Steam recovery from the boiler black liquor
- Production of green electricity from turbines with partial resale back to the grid
- Power plant can operate even if the site is closed down



Main issues : Creating energy savings & respect of environment

- **Social Issues**
  - 90 new direct jobs created in Aquitaine
  - Creation of a local biomass supply chain

- **Environmental Issues**
  - Use of the energy production on site
  - Promotion of local biomass fuels
  - Contribution for the forest management

- **Economical Issues**
  - Use of forest residues (no competition with others industries)
  - An investment with direct impacts on sub-contractors in Aquitaine

Biomass fuel, a resource of future for industries

- **503,000 t of biomass fuel per year**
  - 219,000 t of barks and fines sub product from pulp mill
  - 200,000 t of forest residues & stumps
  - 84,000 t of pruning residues from Dalkia France / Veolia Waste management

Smurfit Kappa
Cellulose du Pin

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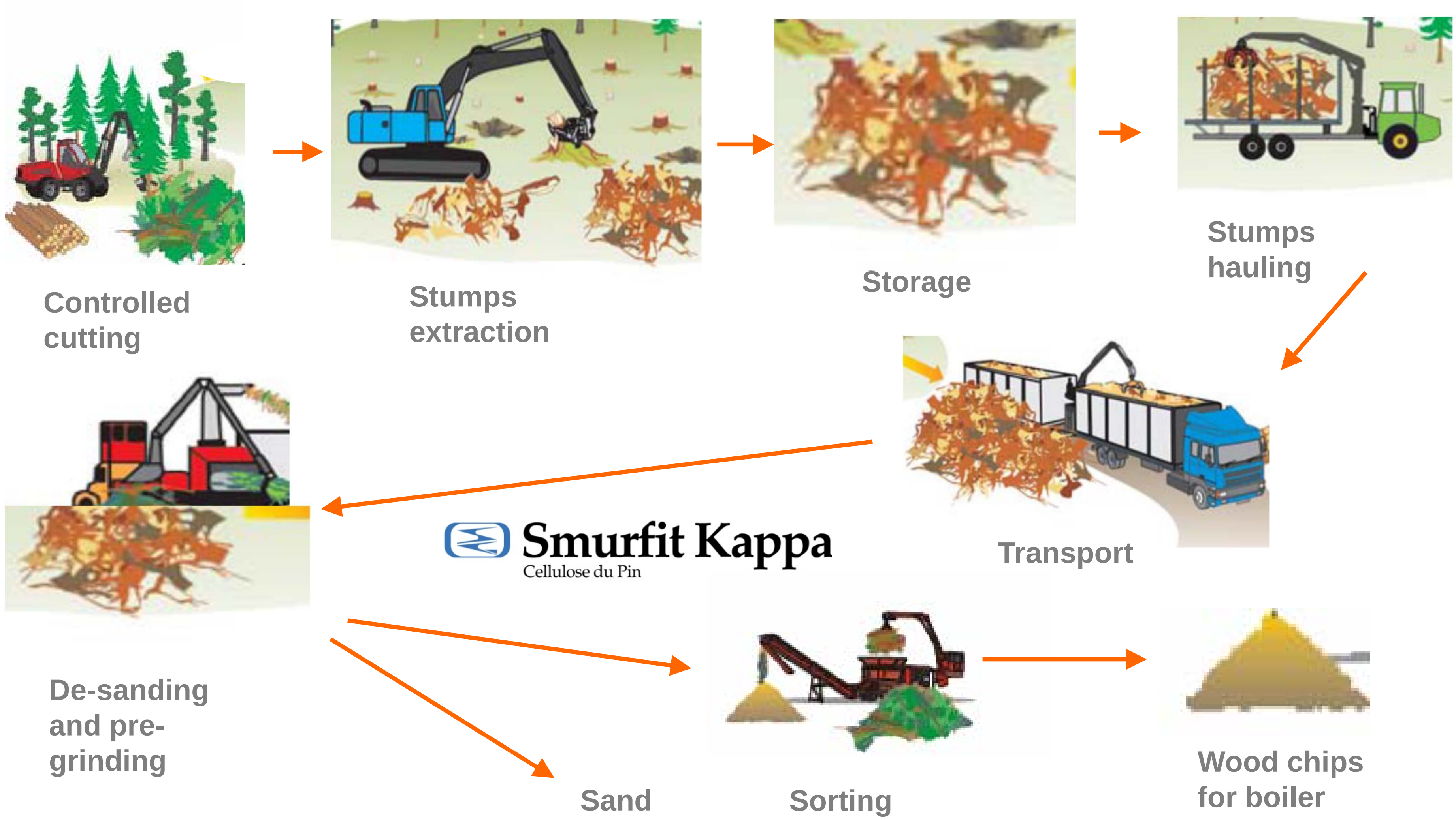
Forest resources in Aquitaine

REGION AQUITAINE

- Forest Surface : 1,800,000 ha
- Natural forest increase of 12 millions tons/year

Stumps supply chain



Smurfit biomass CHP key figures

- BFB biomass boiler: **140 MW (LHV)**
- Gas back up boilers : **3x25 MW**
- Steam caracteristics : **120 bars @ 520°C**
- GE steam turbines : **69 MWe**
- Steam production for paper process : **260 tons/h**
- Dalkia investment cost : **135M€**
- Biomass fuel : **503,000 tons/y**
  - 219 000 t of barks
  - 200 000 t of forest residues & stumps
  - 84 000 t of pruning residues
- Project : **20 months**
- Commissioning **: Sept 2010**

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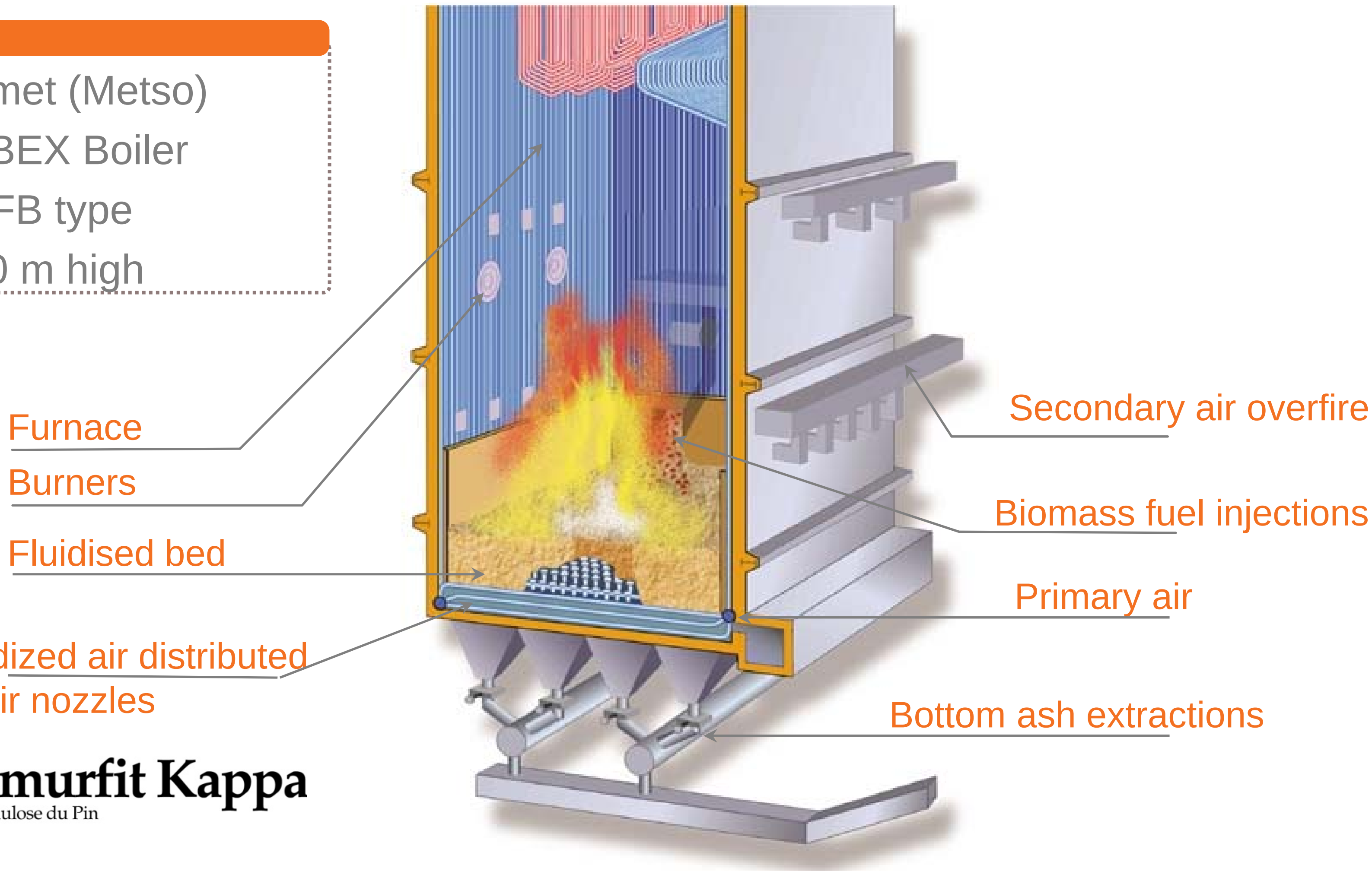
BFB boiler technology

Valmet (Metso)
HYBEX Boiler
- BFB type
- 40 m high



Smurfit Kappa
Cellulose du Pin

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Technology behind BFB boiler

- Combustion of solid fuel in an inert particles bed (sand most of the time) in suspension by air

- In a BFB, the combustion occurs in the lower volume of the boiler
- Combustion staged at low temperature (750-850°C)

- Flexible boilers from 10 to 300 MWth using wood, rice husk, peat, recovered fuels etc.

BFB boiler typical issue

Bed agglomeration

- Reaction between alcalin contents from the fuel (K, Na) and quartz particles from the bed, with consequencies of agglomeration of the bed (praticles stick together), Cl and P elements can also have an impact on the phenomena

Solution

- To renew the bed frequently
- To control very closely the bed temperature
- To use a bed material with low quartz content or adding an additive (kaolin for ex.) to react with alcalins content from the fuel
- To control the biomass mix if agro-biomass

BFB Poznan – 20% agro-biomass (Andritz)

BFB : Advantages of this flexible technology

	Reciprocating grate	Spreader stoker	BFB
Air Excess	40 – 60 %	25 – 35 %	20 – 25 %
Unburned	++	+	+++
Boiler efficiency	+	++	+++
NOx & CO emissions	++	++	+++
Electrical Consumption	++	+++	+
Operation & maintenance	++	++	+
Investment	++	+++	+

Flue gas emissions : IED regulation

	NOx	CO	SO_2	(Dust)	COV	HAP	HCl	HF	PCDD/F
20 - 50 MW	400	200	200	30	50	0,01	10	5	0,1 ng/Nm^3
50 - 100 MW	250			20					
100 - 300 MW	200	150							
> 300 MW	150		150						

mg/Nm3 @ 6%O2

Emissions		
NOx	mg/Nm^3	177
CO	mg/Nm^3	115
SO_2	mg/Nm^3	0,8
Poussières (Dust)	mg/Nm^3	0,2
COV	mg/Nm^3	1,5
HAP	mg/Nm^3	0,0007
HCl	mg/Nm^3	0,2
PCDD/PCDF	ng/Nm^3	0,0004
Métaux		
Cd+Hg+Tl	mg/Nm^3	0,001
As+Se+Te	mg/Nm^3	0,002
Pb	mg/Nm^3	0,001
Sb+Cr+Co+Cu+Sn+Mn+Ni+V+Zn	mg/Nm^3	0,14

- Smurfit emissions

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Ashes recovery in BFB

- The ashes quality depends on :
  - The biomass fuel quality
  - The operating parameters and flue gas treatments (ESP, Bag Filters)
  - The ashes distribution (bottom ashes 20% / fly ashes 80% for Smurfit site)
- The ashes extraction system, dry of wet ashes
- Ashes quality on Smurfit site (24,000 t/y) :
  - Very good quality for uses as fertilizer and land spreading

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Plant operating experience : new challenges faced

With the new biomass fuels as aggro residues more and more used, each biomass plant must be design carefully

Distillers' dried spent mash

Coffee grounds

Palm oil press residue

Vine cuttings

Wood chip

A & B grades wood mix

Wheat / rice / barley straws

Rice husk

Olive wastes

Energy crops : Miscanthus

Feedback on maintenance program
Biomass quality

- The quality of the biomass fuel is certainly the most important for the reliability of the plant.

  - Foreign elements have to be avoided

  - Moisture content must be controled

  - Elementary analysis are essential

Foreign elements

Feedback on maintenance program : Impact of biomass on handling equipments

- Great impacts have been shown when the equipment does not fit with biomass specification

- High wearing on silo extraction screw with locking

Screw before and after 4 weeks

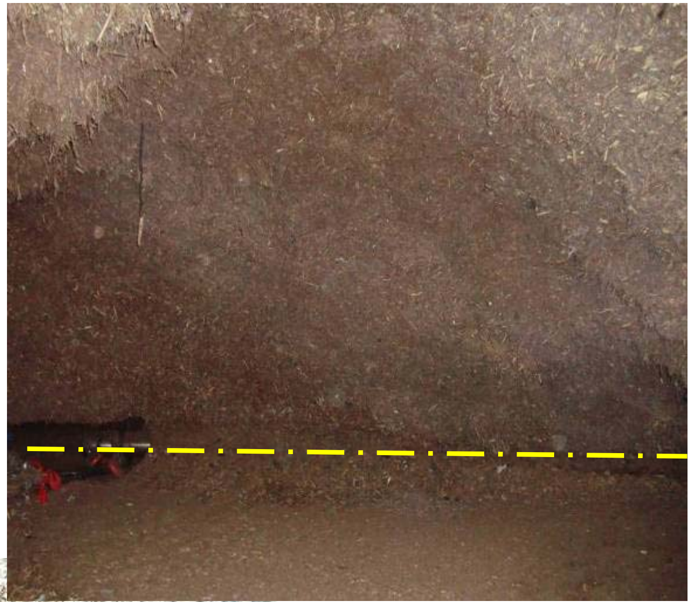
New design with ceramic layer to ensure long life time (2 years)

Feedback on maintenance program : impact of biomass on handling equipment

- The shape of the biomass and sizing are also essential

  - Vaulting due to hammers grinded biomass instead of chipping

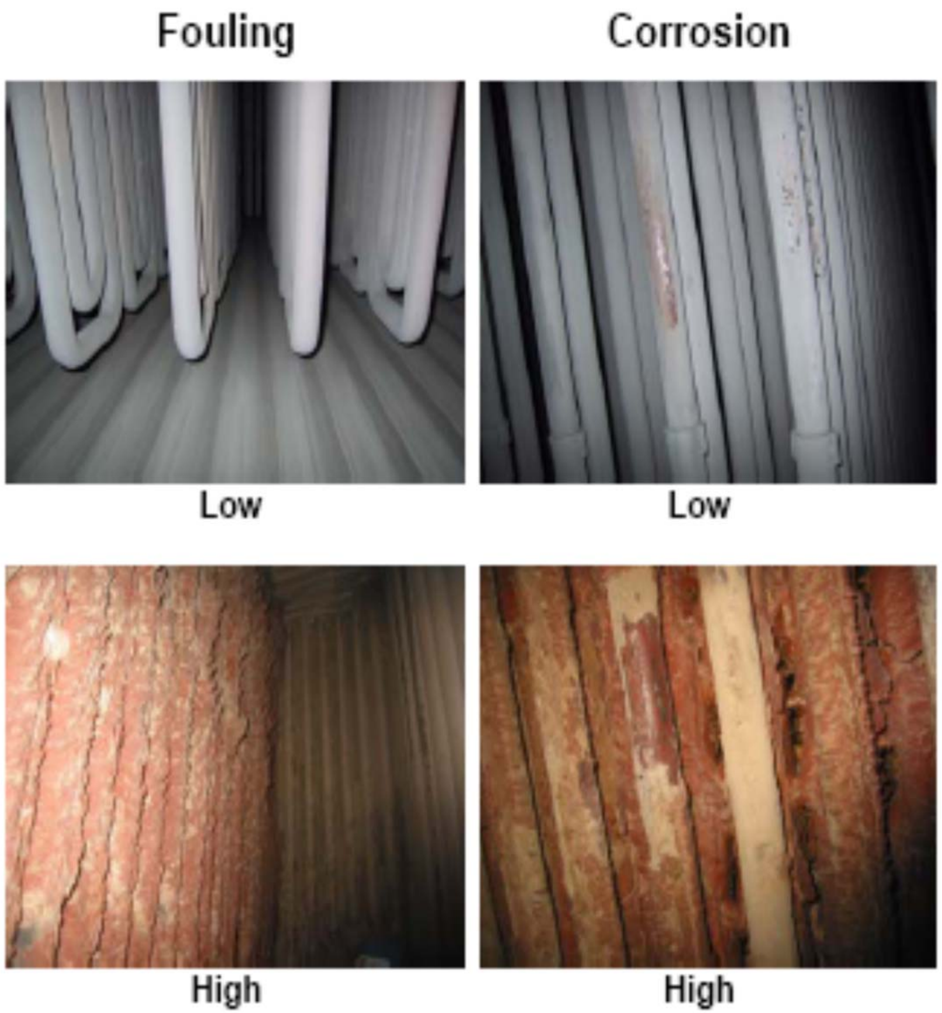
  - An inappropriate extraction system increase the phenomenon



Vaults in 10-13m diameter silos

Lesson learned : biomass combustion

- Fouling and corrosion
  - Fouling risk if
    - Low ash fusibility T°C
    - High CaO, K_2O, Na_2O or P_2O_5
  - HT corrosion risk if
    - K_2O, Na_2O high and Cl high
    - S, KCl and NaCl formation



Lesson learned : Biomass combustion

- Assessment of erosion, fouling and corrosion risk

		Australian coal	Wood waste	Wheat straw	Rice husk	Bagasse
Ash	% dry	14,5	1,5	5,0	20	2,5
Sulphur	% dry	0,45	0,04	0,1	0,08	0,04
Chlorine	% dry	0,01	0,02	1,0	0,1	0,03
SiO_2	%	63,8	17,8	59,9	95,4	73,0
Al_2O_3	%	27,2	3,6	0,8	0,1	5,0
Fe_2O_3	%	3,6	1,6	0,5	0,1	2,5
CaO	%	0,6	45,5	7,3	0,4	6,2
MgO	%	0,4	7,5	1,8	0,3	2,1
K_2O	%	1,0	8,5	16,9	1,8	3,9
Na_2O	%	0,2	2,1	0,4	0,0	0,3
P_2O_5	%	0,7	7,4	2,3	0,5	1,0
Ash fusibility T		high	medium to high	low	high	high
Erosion potential		high	low	low	high	low
Fouling risk		low	medium	high	low	low
Corrosion risk		low	low	high	medium	low

Feed back on maintenance program : safety issues on biomass sites / Risk Prevention

BIOMASS REFERENCES « SECURISATION OF INSTALLATIONS »

– Scope : collect all the available recommendation concerning Prevention and Protection starting at a project design phase

–Result: « Prevention and Protection on Biomass sites »

- Conceived by Dalkia corporate and the Insurances representative of the group
- Containing Prevention and Protection recommendation
- To be used as a handbook during new project conception and design
- to be adapted to all different types of biomass fired boilers
- To be developed thanks to all available feedback from the Group new references

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Risk prevention : biomass grinders

This equipment at high velocity is often uses after screening

metallic foreign elements
+ metal shocks or bearing failure
+ dust
+ junction boxes in the room
= fire + 6 months shut down of the installation

- **All grinders are now equiped with CO or T°C sensors with Sprinkler system and all of electric boxes are away from the grinder room**

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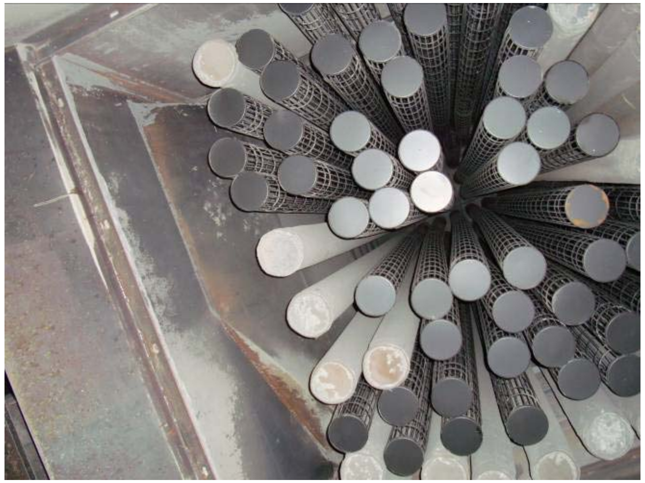
Risk prevention : bag houses

- The bag house is a better filtration (<10 mg/Nm^3 @ 6% O_2) than ESP but sensible to T°C (peak T°C max 250°C)

Unburned fly ashes
+ air leaks
+ no evacuation of ashes hooper
= combustion of the bags
(one week of shut down)

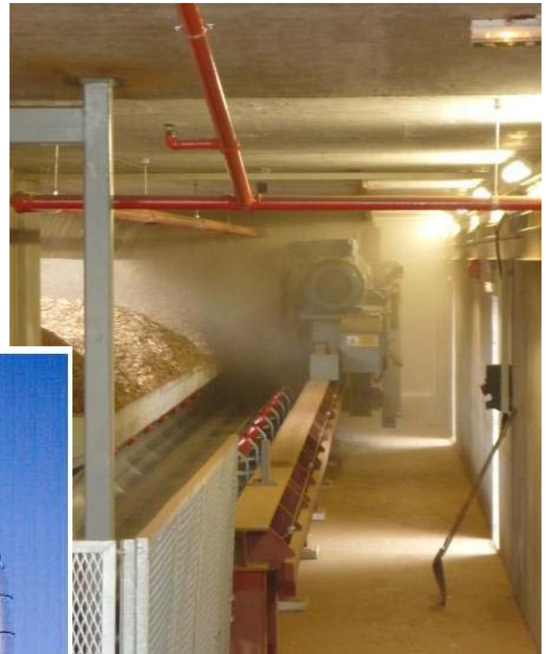
Incandescent fly ashes in bag house hooper



- ➢ **T°C sensors, reliable level sensors and regulation loops are required in specifications**

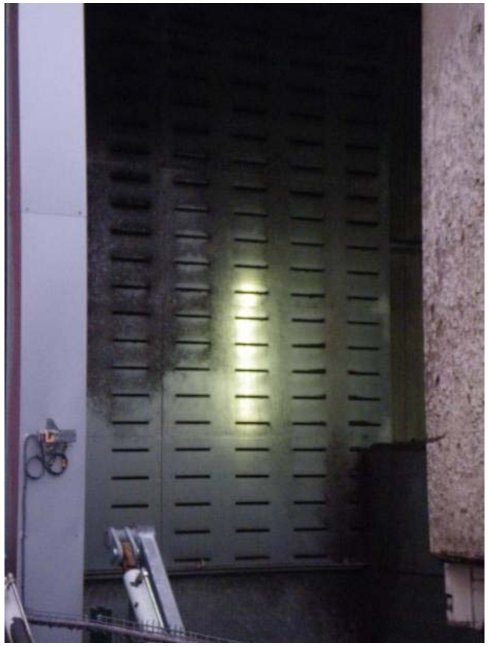
Risk prevention :
Dust and safety systems

We are facing to a dusty fuel, that required de-dusting centralized systems and extinguished networks



Protection by sprinkler system

Dusty dry biomass



All protection systems are installed according to the biomass specification

KEY POINTS FOR BIOMASS

- **By experience, biomass quality is the most important thing. The boiler technology depends on the type of biomass residues or sub products and not the opposit, so each biomass project is unique**

- **The BFB technology is more flexible in term of biomass type and for the respect of emissions regulation. Be careful with high alkaly fuels.**

- **Operation and maintenance of biomass CHP required more manpower in comparison to other fuels (x5 vs Gas)**

The biomass was certainly the first fuel in the history of humanity, and still stay difficult to manage

Thanks for your attention

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