

Sustainable biomass for large power generation

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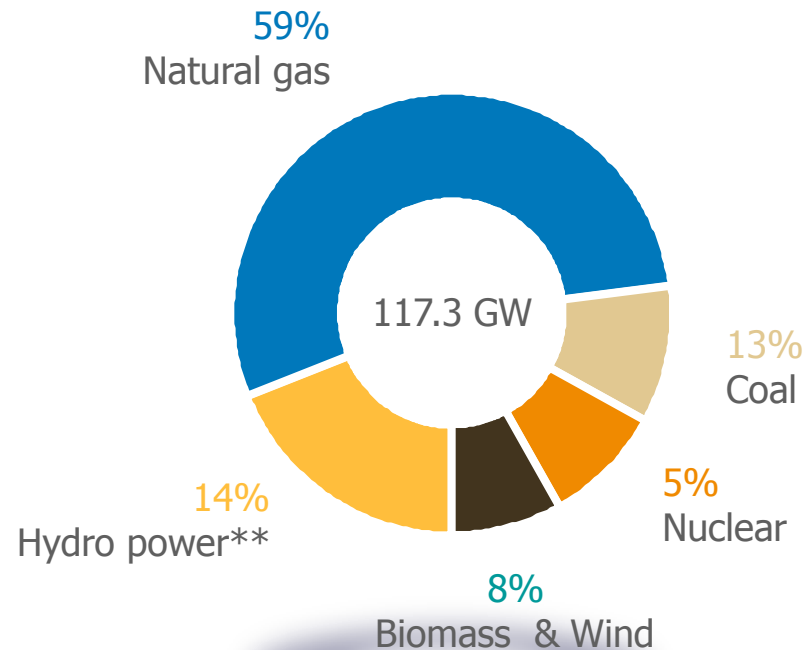
- €90.7 billion in 2011 revenues.
- 1st company in the “utilities” sector worldwide (*Forbes Global 2000*)
- €11 billion invested per year over 2011-2013
- 117 GW of installed power-production capacity *
- 219,100 employees throughout the world
 - incl. 62,400 in electricity and gas
 - and 156,700 in energy services and environmental services
- 1 100 researchers and experts in 9 R&D centers

* Including 100% of the capacity of GDF SUEZ assets at 31 Dec. 2011 regardless of the actual holding rate.

A BALANCED POWER-PRODUCTION MIX

- **117.3 GW** in total installed capacity
- A **competitive** power-generation portfolio
- **Flexible**, high-performance generation capacity with **low carbon emissions**
- Development of electricity production from **natural gas**
- Strong business **expertise**
- **High-performance** nuclear plants

GDF SUEZ installed capacity
at Dec. 31, 2011*



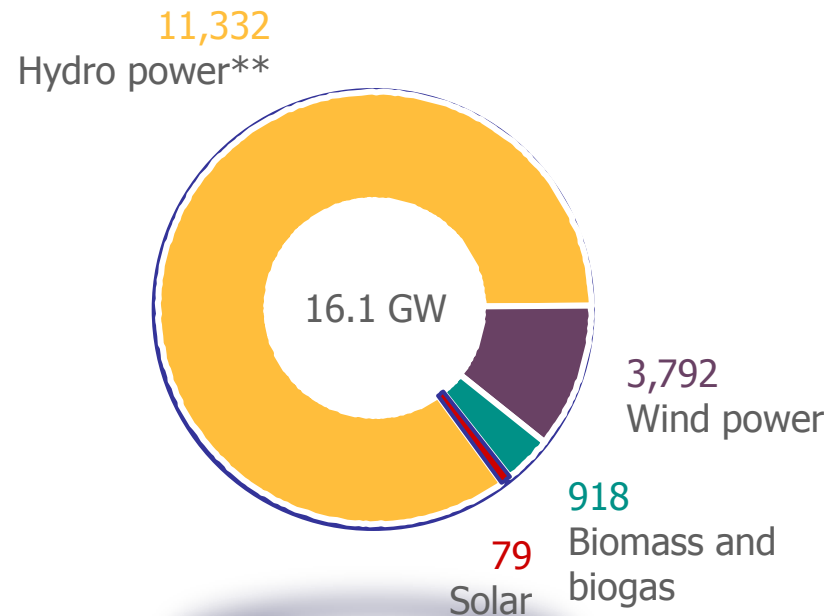
* Including 100% of the capacity of GDF SUEZ assets regardless of the actual holding rate.

** Including pumped storage.

A LARGE SHARE OF RENEWABLE ENERGY: 15%

- **16.1 GW** of total installed power capacity
- **5.6 GW** of capacity under construction
- **50% increase** in renewable energy capacity between 2009 and 2015
- **An international presence:**
Europe (France, Belgium, Germany, Great Britain, Italy, the Netherlands, Poland, Portugal),
Latin America (Brazil, Chile, Costa Rica, Panama, Peru),
North America,
Southeast Asia

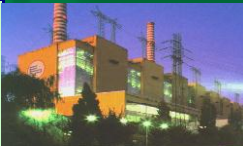
GDF SUEZ installed capacity
in renewable energy at Dec. 31, 2011*
(in MW)



* Including 100% of the capacity of GDF SUEZ assets regardless of the actual holding rate.

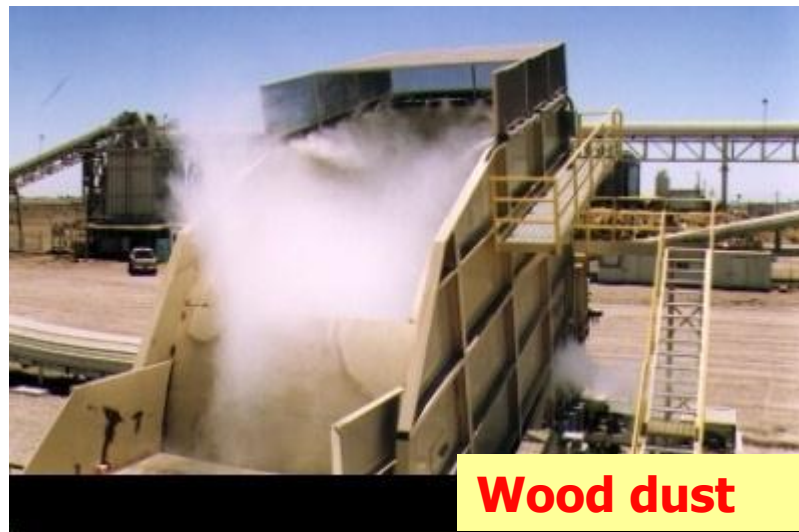
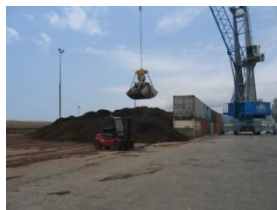
** Excluding pumped storage power stations.

CAPACITY OF CO-FIRING BIOMASS (BE+NL+POL)

GDF-SUEZ CFPP (CO-)FIRING BIOMASS POWER PLANTS							
SITE + % biomass		UNIT	Hardcoal MWe	Biomass products	CAPACITY ton ar/year	Green power MWe	DATE COD
Belgium RUIEN 18%		UNIT 3	130	Olive cake	20.000	7	2003
		UNIT 4	122	Wood dust	35.000	10	2002
		UNIT 5	190	Wood chips gas	120.000	20	2003
				Wood milling	150.000	30	2007
Belgium MaxGreen RODENHUIZE 60% --> 100%		UNIT 4	240	Wood pellets	850.000	190	2011
Belgium AWIRS 100%		UNIT 4	130	Wood pellets	400.000	80	2005
Netherlands GELDERLAND 7% --> 20%		UNIT 13	635	Wood pellets	500.000	138	2010
Poland POLANIEC 10% --> 15%		7 UNITS	1575	Wood chips 2012	150.000	50	2009
				Agri biomass 2012	300.000	100	2009
		Green Unit	190	80% wood-20% agri	1.100.000	190	2012
EUROPE (BE + NL + POL) 25%			3212	Biomass	3.625.000	815	2012
			Essentially imported		1.770.000	601	
			Essentially local origin		1.855.000	214	

BIOMASS FUELS USED WITHIN GDF-SUEZ

Dried sewage sludge
Coffee ground
Straw
Sunflower
Olive cake



Wood dust



**Fresh and
recycled
wood chips**



Wood pellets

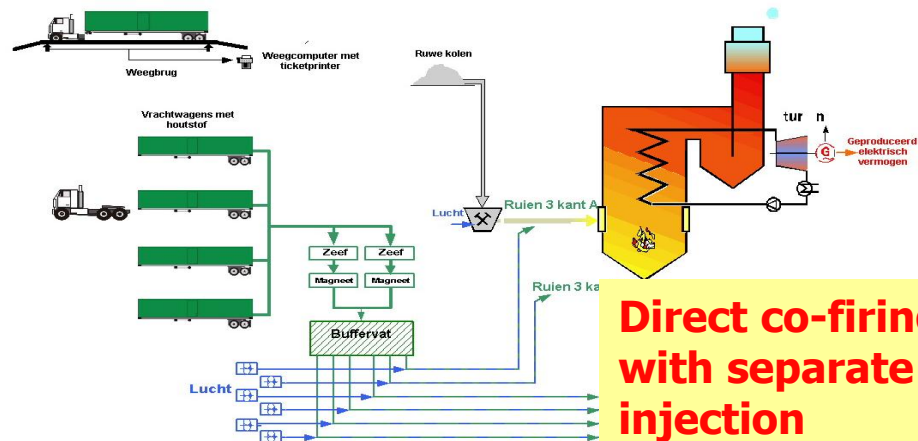
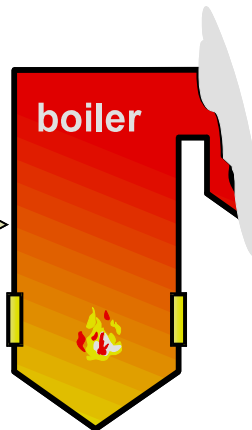
CO-FIRING TECHNOLOGIES WITHIN GDF-SUEZ

Direct co-firing with common injection

biomass dust

coal mill

boiler



Direct co-firing with separate injection

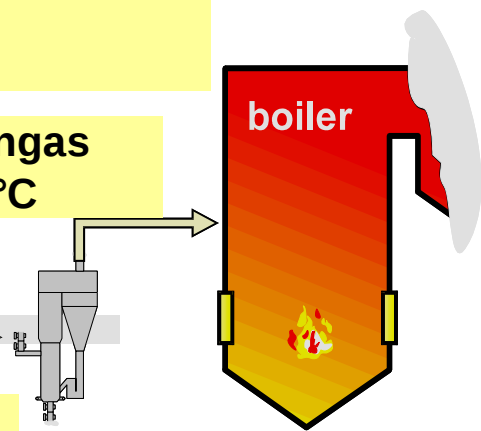
Indirect co-firing with partial gasification

hot syngas
850°C

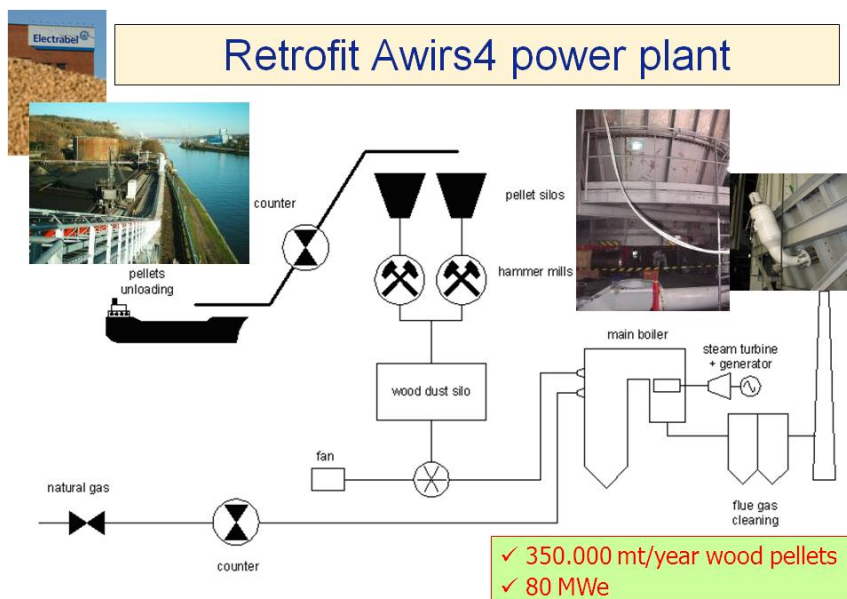
biomass

CFB
gasifier

boiler



Retrofit Awirs4 power plant



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

BELGIUM

Full conversion of pulverised coal plants to wood pellets



MAX GREEN



LES AWIRS UNIT4
1967: 125 MW oil+gas
1982: 125 MW coal
2005: 80 MW biomass

RODENHUIZE UNIT4

1979: 262 MWe

Fuels : hardcoal,
blast furnace gas, fuel-oil A

2005: 55 MW= 30% wood pellets

2008: 110 MW= 60%

2011: 200 MW = 100%



LUCHTFOTO

INSTALLED POWER

200 MW

FUEL

WOOD PELLETS

CONSUMPTION PER YEAR

850.000 TON

AVOIDED COAL

550.000 TON

AVOIDED CO2 PER JAAR

1.400.000 TON

GREEN ELECTRICITY PER YEAR

1.400.000 MWh
equivalent to:
320 000 families

INVESTMENT

125 M€

OPERATION TIME

2011-2017

EMPLOYEMENT

500 man.years

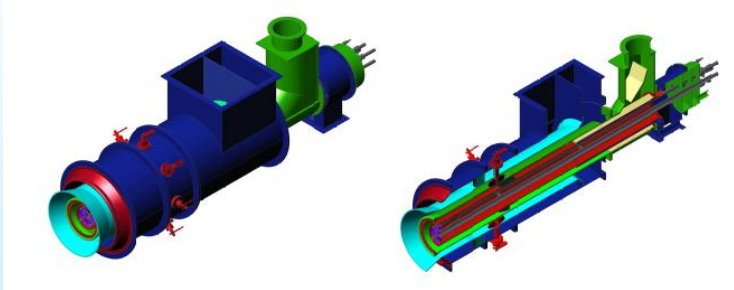
**WORLD PREMIERE OF 100% WOOD PULVERISED
FUEL BOILER WITH HIGH DUST CATALYST**

- Tighter limits on NO_x emission
 - Max 90 mg/Nm³ dry @6%O₂
 - Need for secondary measures: SCR-DeNO_x
 - Low dust ELV's
 - Max 15 mg/Nm³ dry @6%O₂
 - No additive injection
 - NH₃
 - Max 7 ppmv NH₃ (BREF)
 - Biomass combustion
 - Strong reduction of catalyst lifetime !
- Challenge for designers of SCR units!



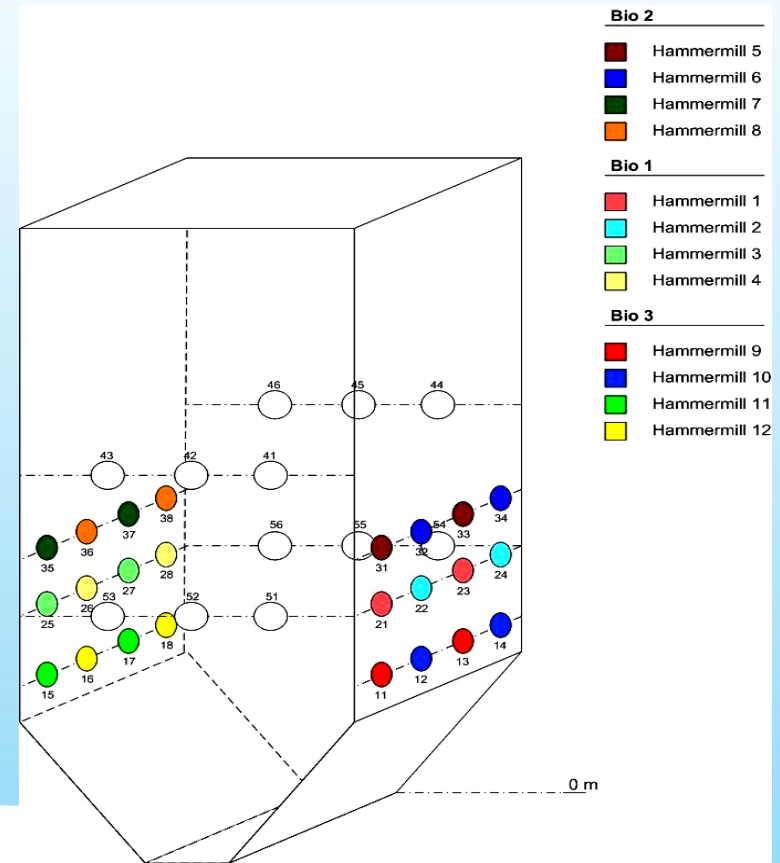
Boiler modifications

- 24 new biomass burners $400 \text{ mg/Nm}^3 @ 6\% \text{O}_2$



12 new BFG burners

- 8 OFA's
- additional sootblowers
- new BFG preheater (GAVO)
- partial replacement of the evaporator
- boiler efficiency not worse than current one**



FIRE & EXPLOSION RISK ATEX SAFETY PRINCIPLES



EXPLOSIBILITY

Lower explosion limit	LEL	g/m ³
Upper explosion limit	UEL	g/m ³
Limiting oxygen concentration	LOC	% (vol)

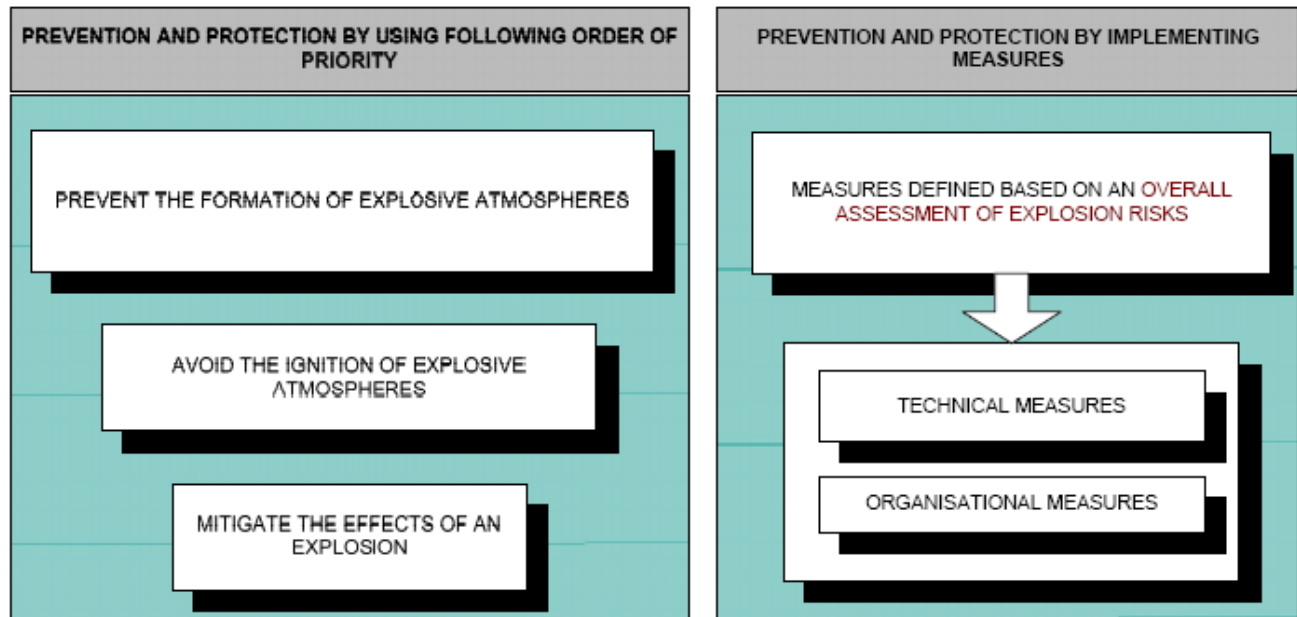
IGNITABILITY

Minimum ignition energy	MIE	mJ
Minimum ignition temperature	MIT	°C
Smoldering temperature	T _s	°C
Auto-ignition temperature	AIT	°C
Ignition and burning behaviour	CC	/

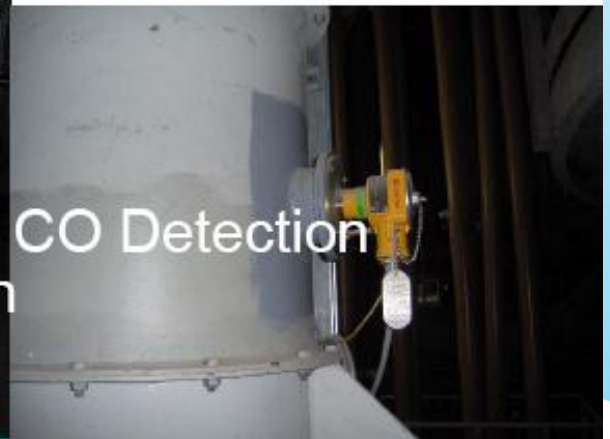
EXPLOSION EFFECTS

Maximal explosion pressure	P _{max}	bar
Maximal rate of pressure rise	K _{st}	bar.m/s

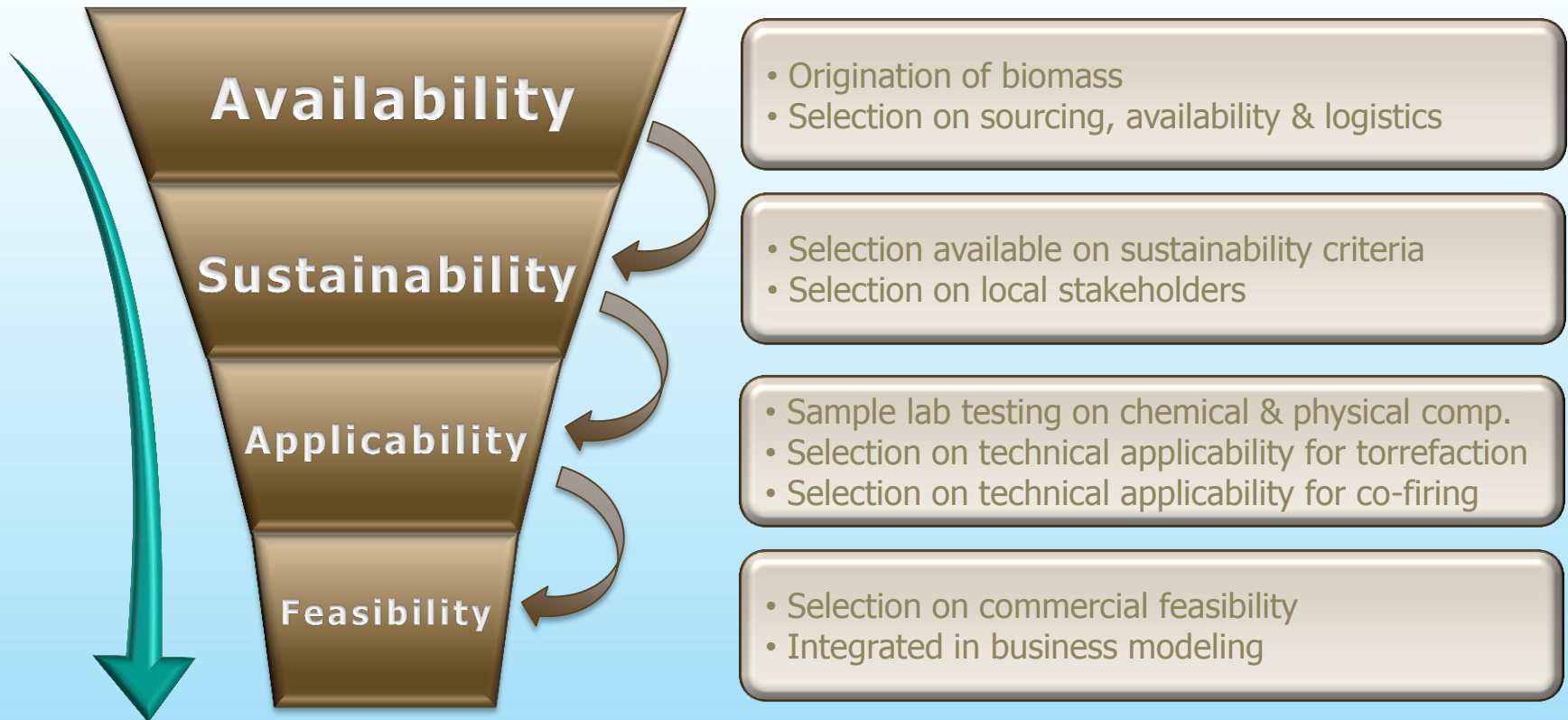
The basic ideas found in the ATEX – regulation



OVERVIEW OF SAFETY SYSTEMS

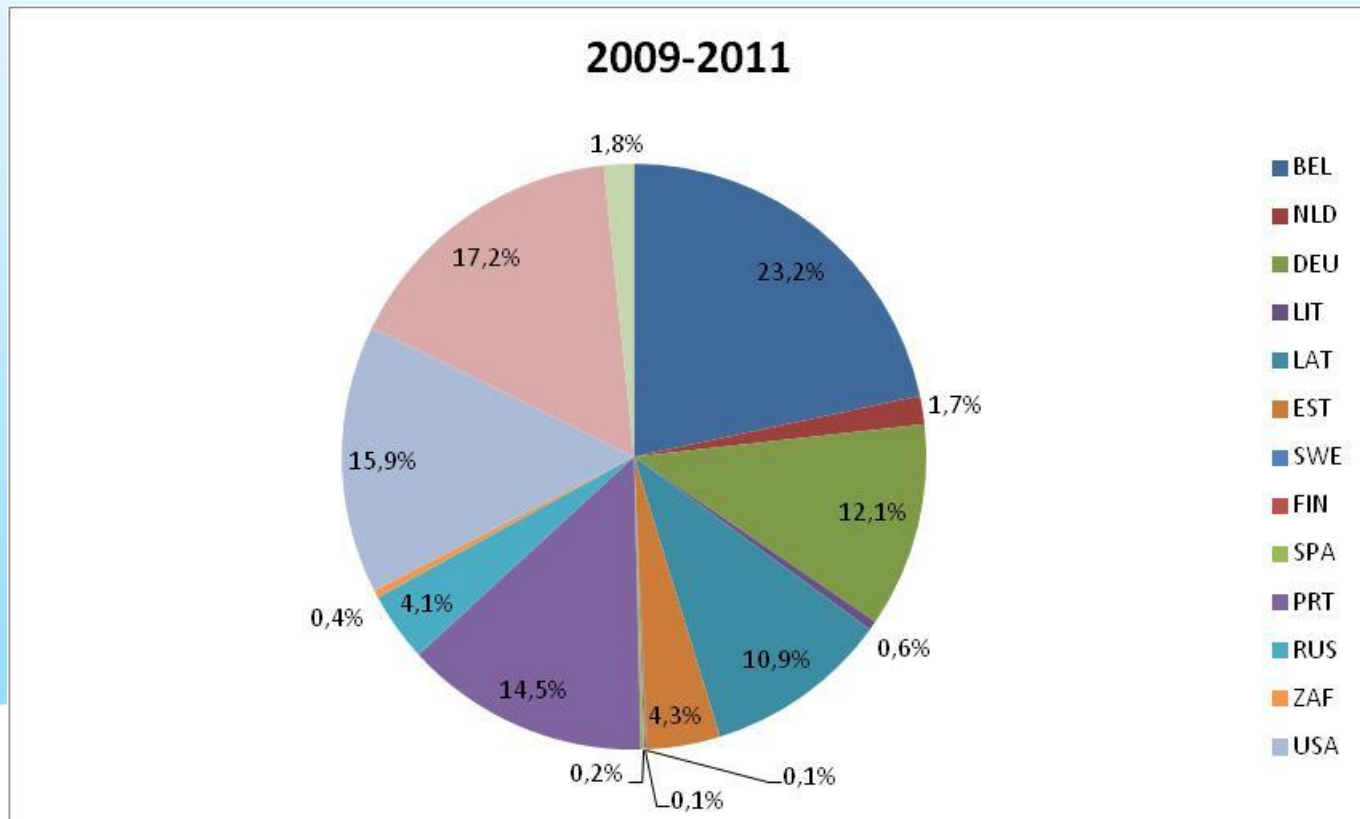


BIOMASS IDENTIFICATION



Wood pellets come from the whole world GDF SUEZ world market share is 10%

- Capacity GDF SUEZ today: 1,7 million ton/y versus 16 million ton/y world capacity in 2011
- Capacity GDF SUEZ tomorrow: 2 million ton/y and more ?
- GDF SUEZ used 3,0 million ton wood pellets between 2009 and 2011
- GDF SUEZ has about 50 suppliers located in the whole world





Woud in British Columbia (Canada)
Woud – aangetast door Mountain Pine Beetle



Vermaling van het hout



Vervoer van het vermalen hout naar de fabriek van
Pacific BioEnergy in Prince George



Prince George - Fabriek productie pellets



Houtpellets

Biomassa
verificatieprocedure



Vancouver Terminal



GDF SUEZ Ghent



GDF SUEZ Ghent – Lading biomassa



Transport Vancouver - Ghent = 27 dagen



Aanmeren in Rodenhulze



Opslagloods bij SEA-Invest

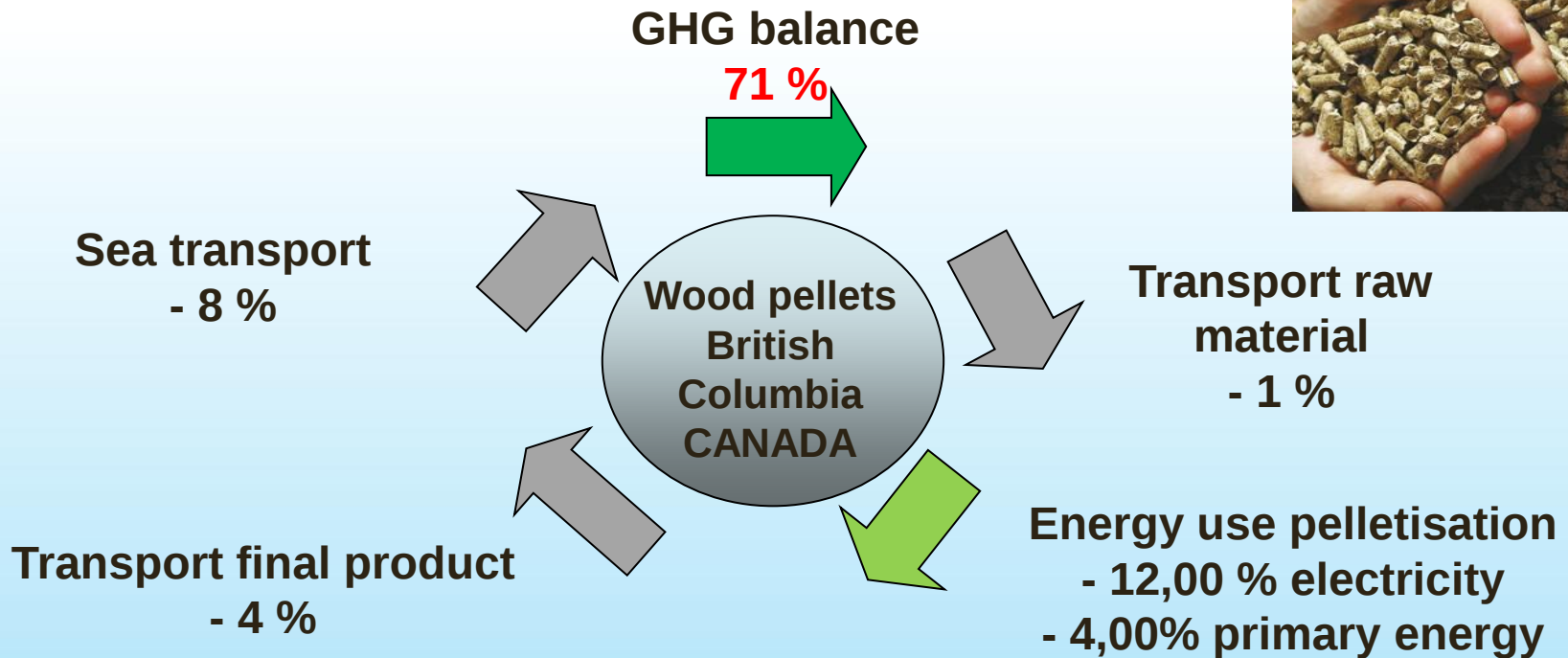


Biomassasilo's en transportband



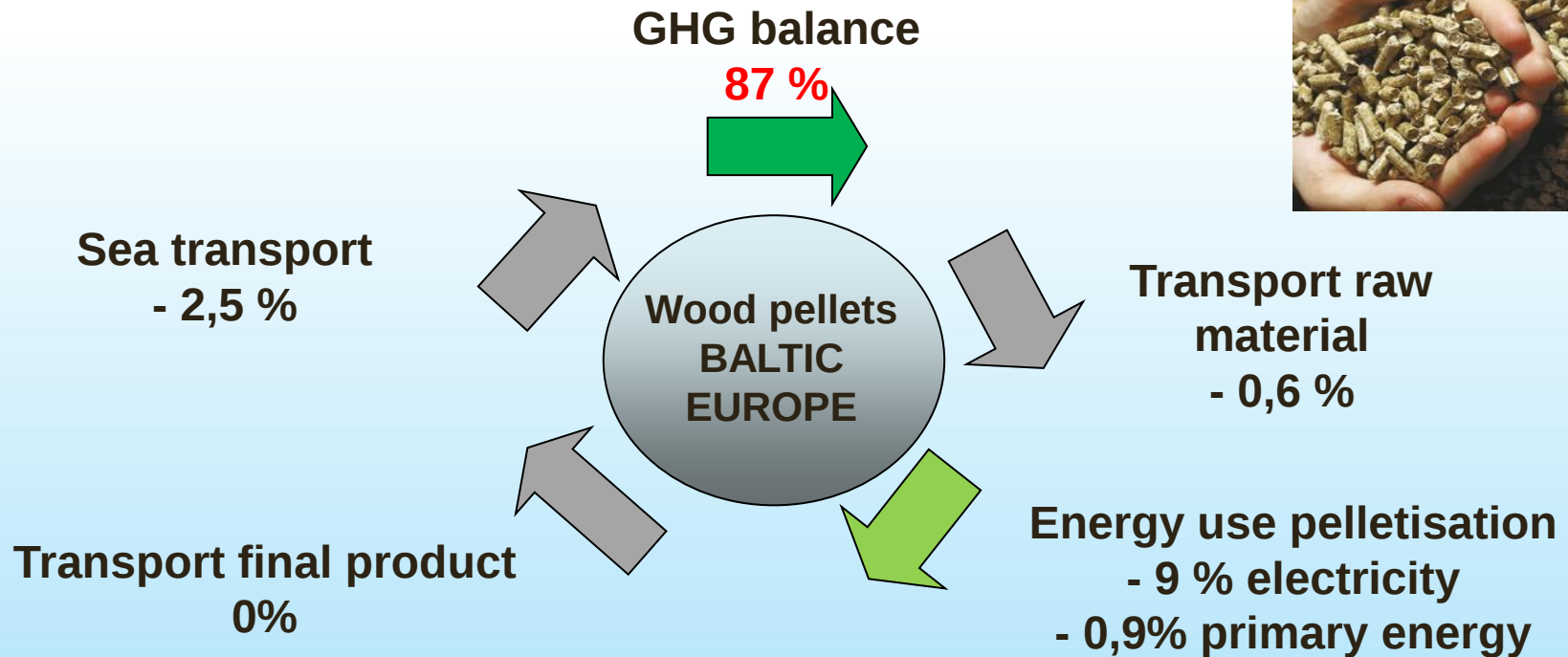
Centrale Rodenhulze

GREENHOUSE GAS BALANCE SUPPLY CHAIN BRITISH COLUMBIA



- **GHG emissions sea transport = $\pm$ 650 km with a truck**
- **In Belgium green certificates are granted in function of the net fossil energy or greenhouse gas savings, taking the whole supply chain into consideration**

GREENHOUSE GAS BALANCE SUPPLY CHAIN EUROPE



- **GHG emissions sea transport = $\pm$ 200 km with a truck**
- **In Belgium green certificates are granted in function of the net fossil energy or greenhouse gas savings, taking the whole supply chain into consideration**

Participants:

- **Big utilities in Europe all operating large scale biomass plants**
DONG, DRAX, RWE/Essent, EON, GDFSUEZ
- **Inspection companies**
CONTROL UNION, BUREAU VERITAS/INSPECTORATE, SGS
- **Wood pellets associations: EPC, WPAC, USIPA**
- **Technical advice and support: LABORELEC**
- **Journalist for public reports on the meetings: ARGUS MEDIA**

Objectives of IWPB:

**facilitate trade between utilities through uniform contracting
→ essential for covering long-term contracts for large plants**

1. Similar legal requirements
2. Common specs for industrial pellets - draft
3. Common sustainability principles

Needs for sustainability:

- Make biomass acceptable and therefore tradable
- Fulfill conditions to get green support
- Cover corporate risk assessment vs public opinion and NGO's
- Get access to broader market in more difficult countries
- Insure feedstock for large biomass power plants

<http://www.laborelec.be/ENG/initiative-wood-pellet-buyers-iwpb/>

BIOMASS SUSTAINABILITY

Principle		Clarification	Cramer NL (NTA 8080)	Corbey NL	RED EC	UK OFGEM	Belgium (LBE)	IWPB EU
1	GHG BALANCE	Positive CO2 balance of total biomass supply chain (against conventional)	✓	✓	✓	✓	✓	✓
2	CARBON STOCKS	Production of biomass not impacting high carbon stocks in vegetation & soil	✓	✓	✓	✓	X	✓
3	BIO- DIVERSITY	No production of biomass at protected or vulnerable biodiversity	✓	✓	✓	✓	X	✓
4	SOIL	Soil (quality) is maintained or improved	✓	✓	X	X	X	✓
5	WATER	Water not exhausted and water quality maintained or improved	✓	X	X	X	X	✓
6	AIR	Air quality is maintained or improved	✓	X	X	X	X	✓
7	SOCIAL	Preserve food- and local biomass applications from unfair competition	✓	X	X	X	✓	✓
8	LOCAL WELFARE	Production of biomass contributes to local prosperity	✓	X	X	X	X	✓

STABLE GREEN SUPPORT ? EXAMPLE OF FLANDERS

Value green certificates	
2011	125 €
2012	118 €
2013	100 €

Green certificates % for co-firing	
Before 2010	100%
100% firing MaxGreen	89%
100% firing after 2010	70%
Co-firing after 2010	50%

STANDARD

Strategic fit

Market demand

Regulation and legal system

Fuel sourcing

Technology

Environmental impact

Social impact

HR / project management

Ethics

SPECIFIC

Regulation for green energy

Explosion (ATEX) and fire risks

Fuel sourcing sustainability

Political and public acceptance



THANKS FOR YOUR ATTENTION
&
FOR MORE INFORMATION

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