

# Green Certificates mechanisms in Belgium: a useful instrument to mitigate GHG emissions

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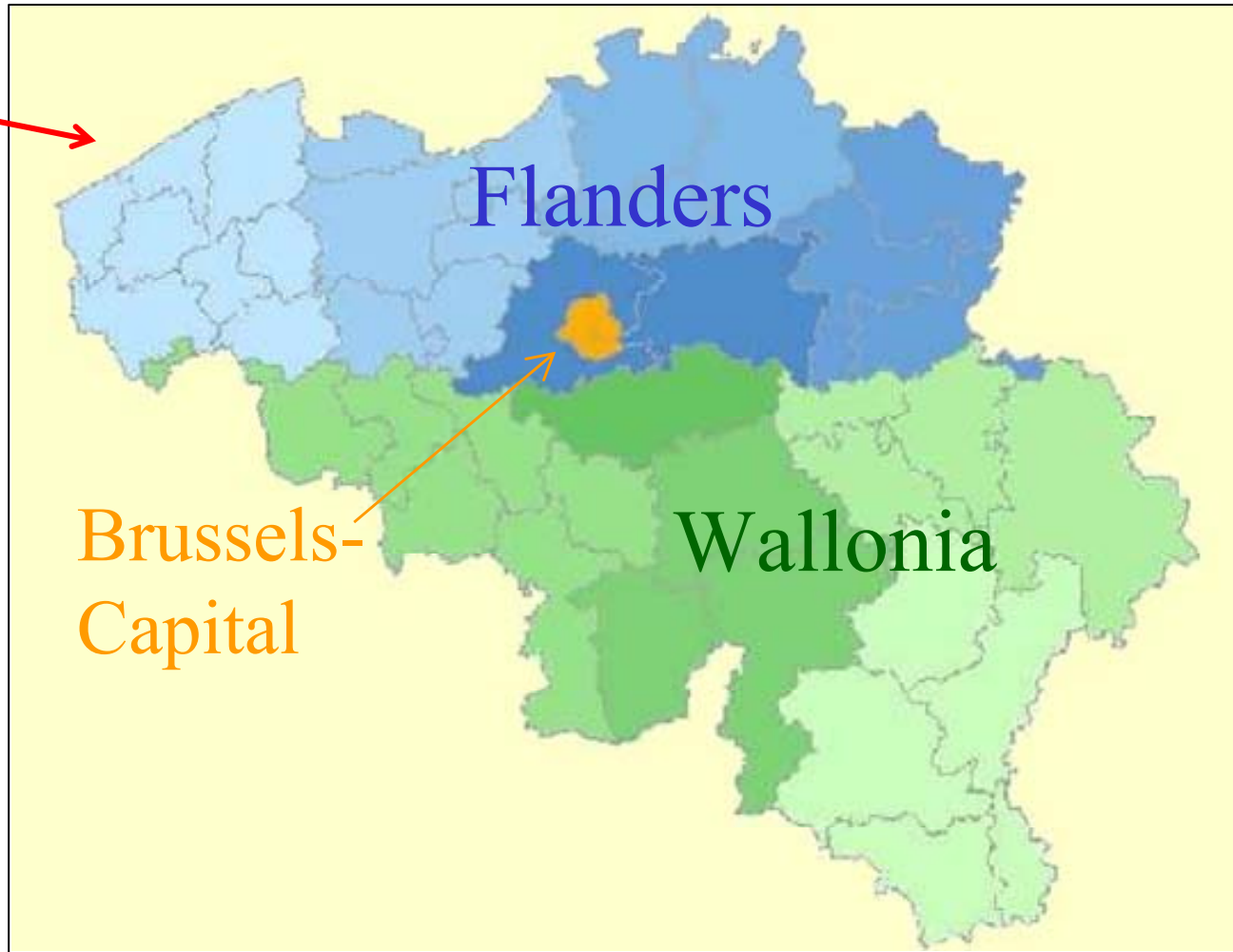
Task 38 – Greenhouse Gas Balances  
of Biomass and Bioenergy Systems



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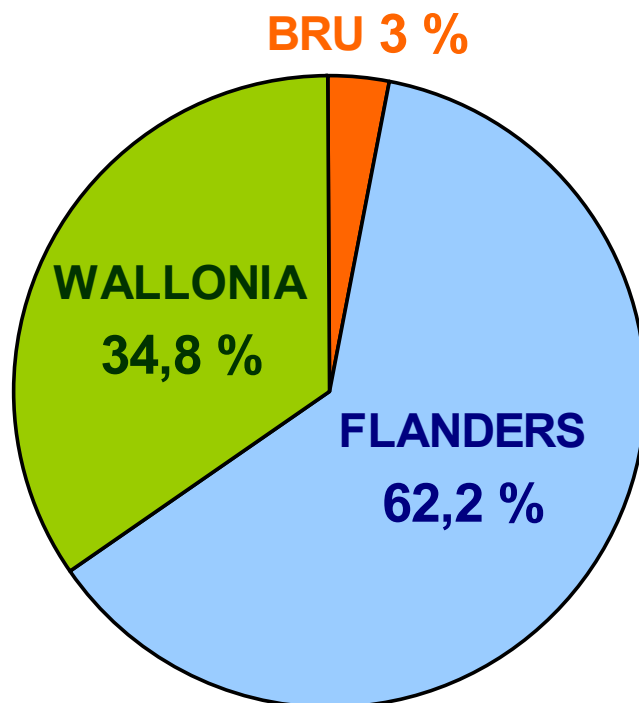
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# BELGIUM: a Federal State divided in 3 Regions



# Belgian GHG emissions

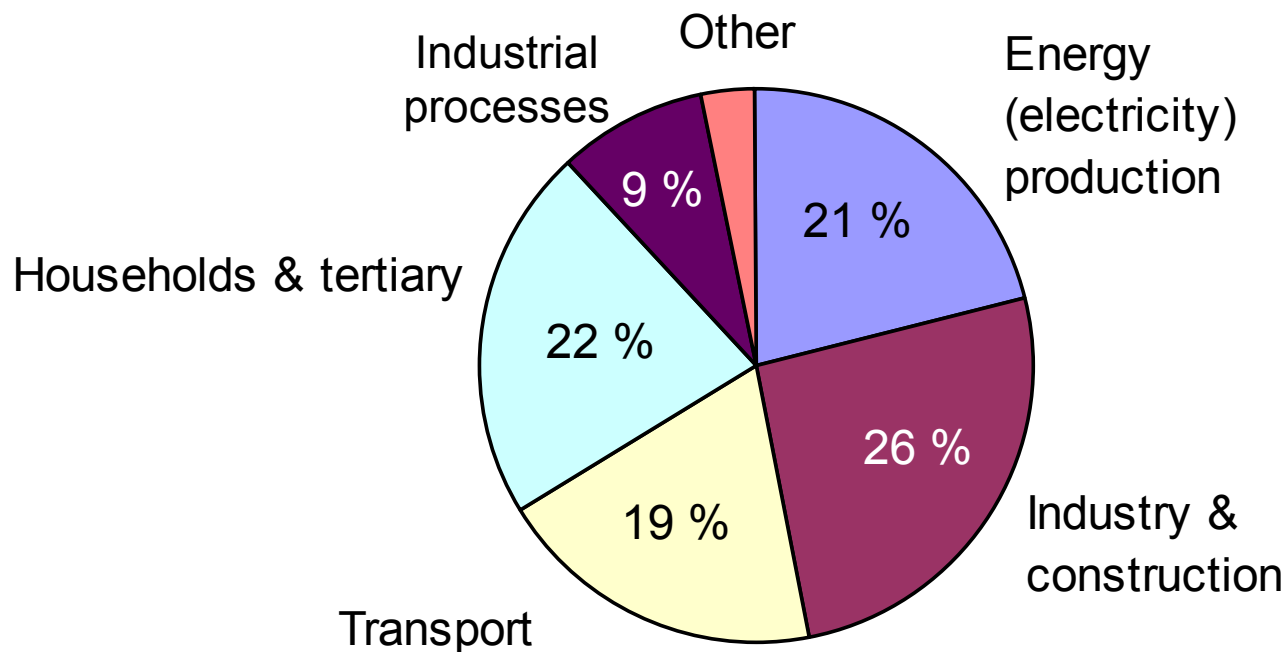
**Belgian GHG emissions in 2004: 147,9 Mt eq CO<sub>2</sub>**



FL: 58% pop 44% terr.  
Wal: 32% pop 55% terr.  
Bru: 10% pop 0.5% terr.

# Belgian GHG emissions

## Belgian GHG emissions per sector (2003: 147,55 Mt eq CO<sub>2</sub>)



# Belgian Objectives

GHG emissions reduction by 2012 = 7,5 % below its 1990 level

→ Green electricity obligation by 2010 = 6 %

→ Flanders = 6 %

→ Wallonia = 12 %

→ Brussels = 3 %

# 5 ingredients to the Belgian Green Certificates mechanisms

1. Growing **obligation %** of renewable power based on yearly electricity sales for each power supplier (high consumers are partially exempted) → receive Green Certificates
2. **Penalty** for the share that is not covered by Certificates (x € / missing GC)
3. **Market** for exchanging Certificates between green producers and suppliers needing them
4. **Regulatory body** in each region granting the Certificates and surveying the market
5. **Certified bodies** for inspecting the green power plants and the bio-fuel resources

# 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&amp;Wave, Hydro &lt; 10 MWe, Biomass accorded to</p> <ul style="list-style-type: none"> <li>a) vegetable products from agriculture and forestry;</li> <li>b) litter and manure;</li> <li>c) sorted organic-biological waste;</li> <li>d) unsorted organic-biological waste with min. 35 % energy recuperated</li> </ul>
W	<p>CHP and HYDRO &lt; 20 MWe (*)</p>
Bru	<p>PV, Wind, Biogas, Geothermal, Hydro &lt; 10 MWe Organic waste from agriculture and forestry</p>

(\*) Future biomass plants also < 20 MWe (= to be constructed, not for retrofit)



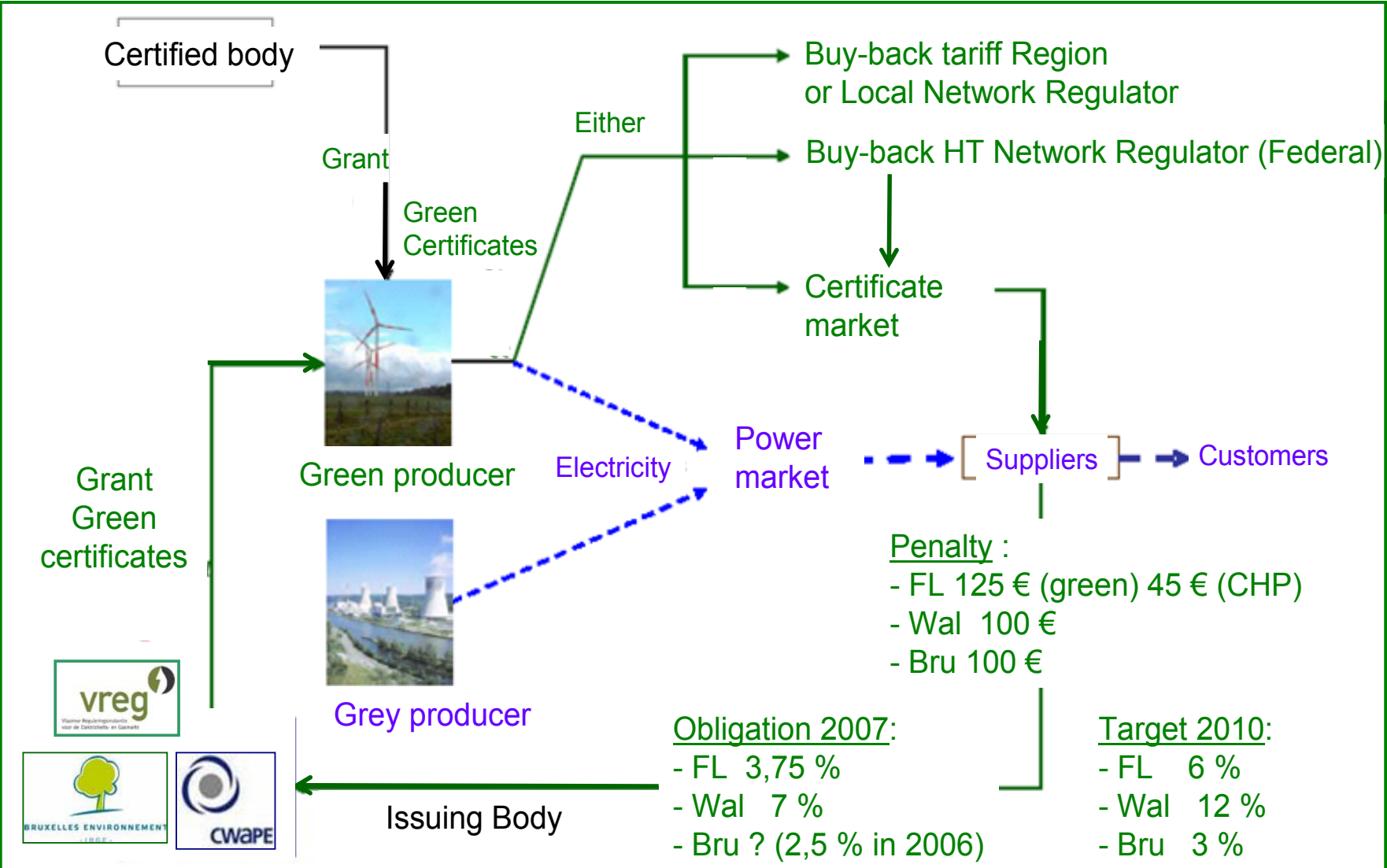
# BELGIUM: 3 Regions = 5 Green Certificates mechanisms

1. **FLANDERS:** 1 GC = 1MWh green electricity produced
2. **FLANDERS:** 1 Cogen Certificate = 1 MWh primary energy saving
3. **WALLONIA:** 1 GC = 456 kg CO<sub>2</sub> avoided+ Reduction factor applied on plants > 10 years old
4. **BRUSSELS:** 1 GC = 217 kg CO<sub>2</sub> avoided
5. **FEDERAL:** 1 GC = 1 MWh green electricity  
→ Territorial waters → Off-shore windmills





# Belgian Green Certificates mechanisms

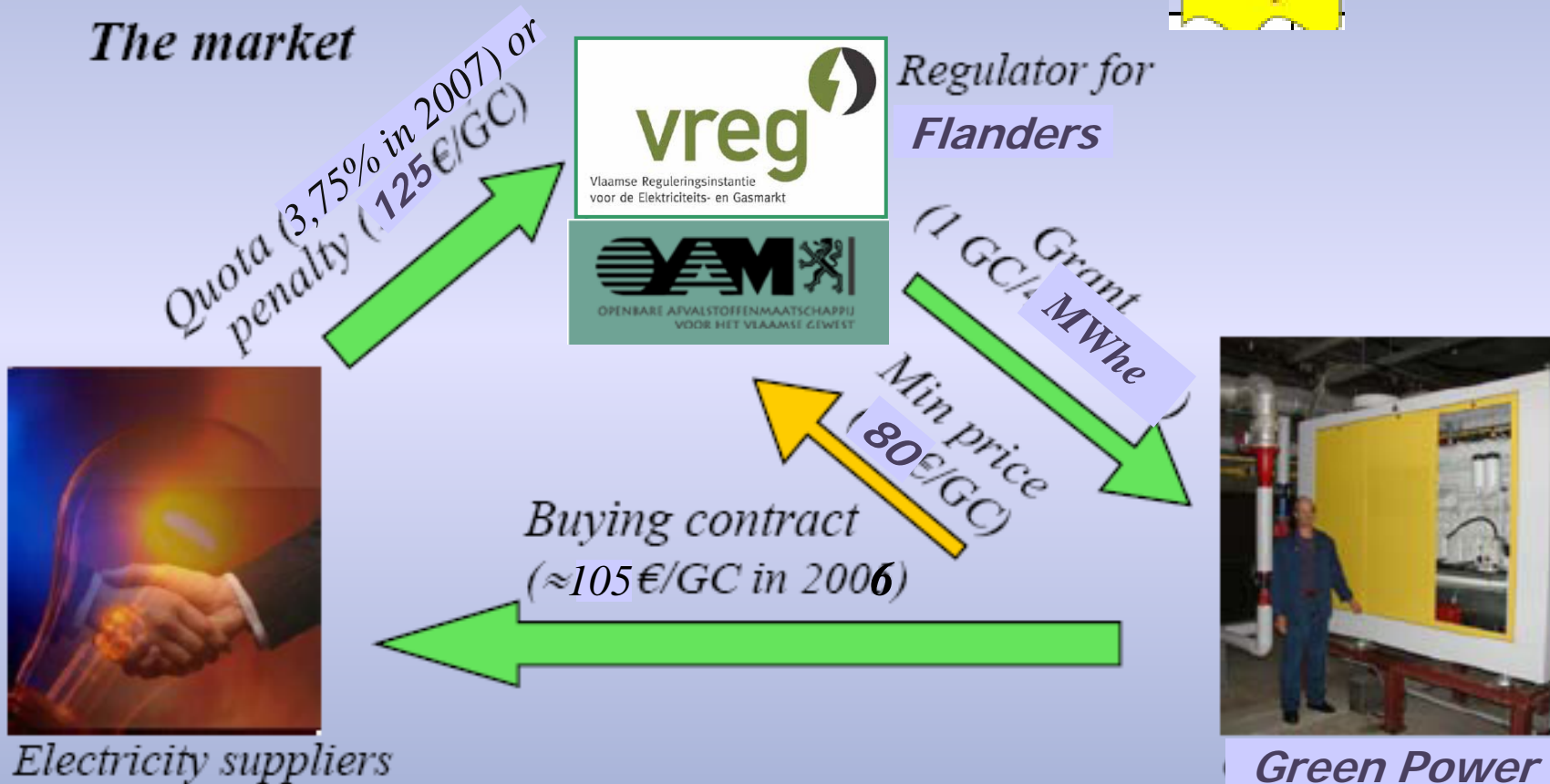


# Flemish Green Certificates mechanisms

The Green Certificates mechanism in Flanders



The market

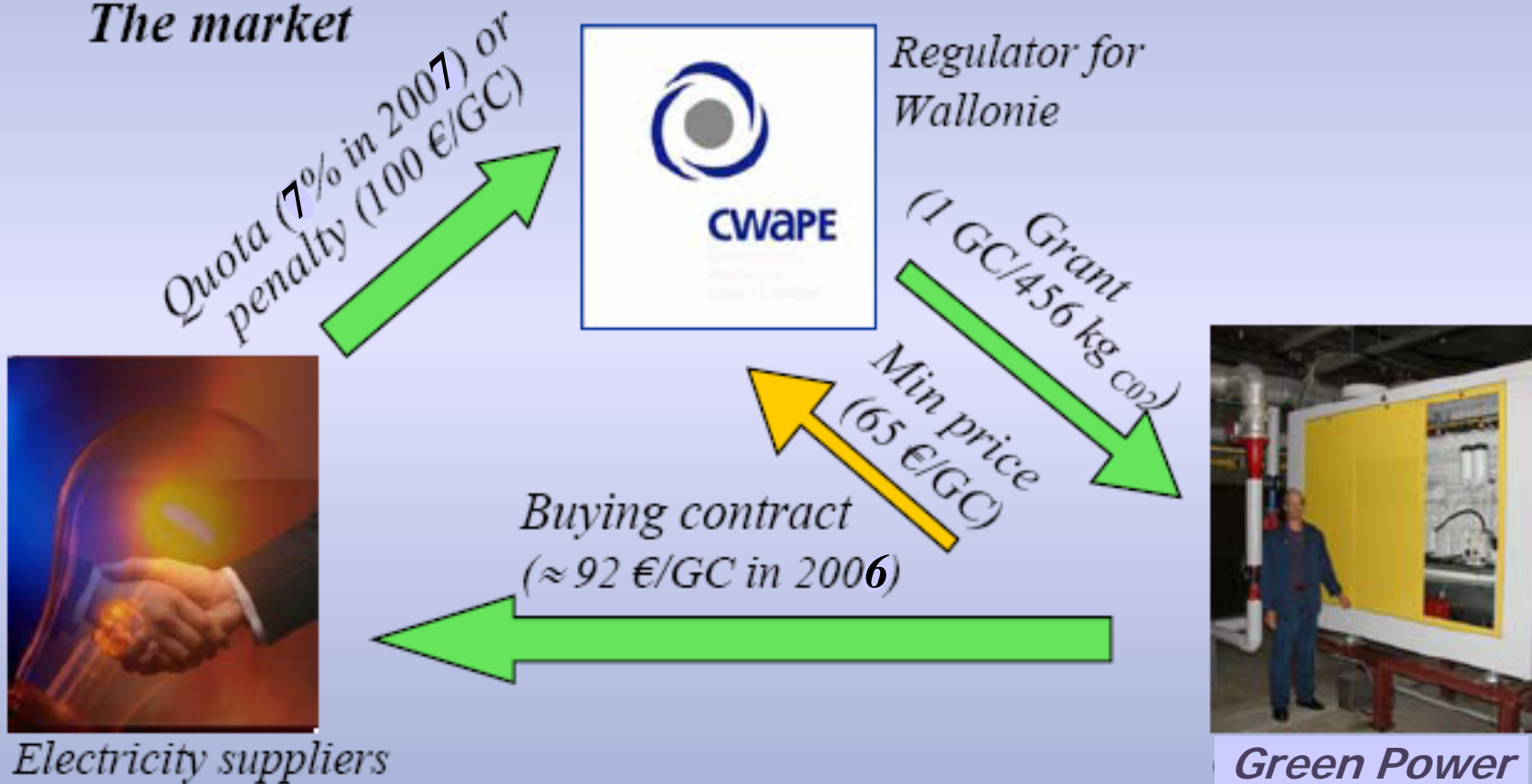


# Walloon Green Certificates mechanisms

## The Green Certificates mechanism in Wallonie



### The market



# Belgian GC's: Obligations & Realisations

<b>FLANDERS</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Obligation (%)	0,5%	1,2%	2%	2,5%	3%	3,75%	4,50%	5,25%	6%
Obligation (GC x 1000)	250	600	1.000	1.250	1.500	1.875	2.250	2.625	3.000
Generated GC x 1000	150	292	544	966	1.429				
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	€ 109,78	€ 105,14				
<b>WALLONIA</b>		<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Obligation (%)		3%	4%	5%	6%	7%	8%	9%	12%
Obligation (GC x 1000)		701	945	1.195	1.449	1.710	1.976	2.247	3.030
Generated GC x 1000		622	715	823	1.074				
Penalty		€ 75,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00
Market value		€ 84,38	€ 91,74	€ 92,09	€ 91,56				
<b>BRUSSELS</b>			<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Obligation			2%	2,25%	2,50%	<i>to be determined</i>			
Generated GC x 1000			3,5	8,0	<i>8,8 (first trimester)</i>				
Penalty			€ 75,00	€ 75,00	€ 75,00	€ 100,00	€ 100,00	€ 100,00	€ 100,00



# Green Certificates in Flanders: Specificities

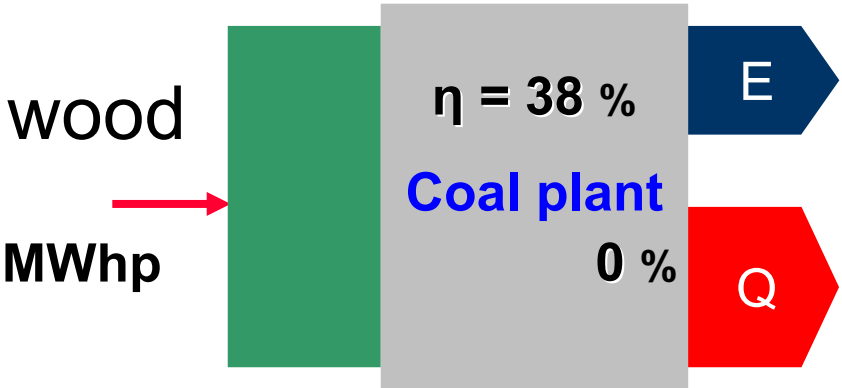
- ✓ 2 separate systems: **Green Certificates & Cogen Certificates**
- ✓ **Co-firing** OK → GC's issued for electricity produced from RES
- ✓ GC's have 2 functions: **Guarantee of Origin & Quota**

**1 GC = 1 NET MWh Green Electricity**

**NET** electricity production or primary energy saving = energy necessary to operate plant, prepare and transport fuel is subtracted



# Co-firing in Flanders: Wood pellets from Canada

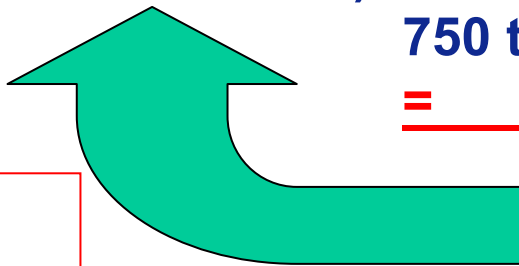


1 ton wood pellet  
 = 4,7 MWhp \* 0,38 = 1,79 MWhe  
 - 0,446 MWhe  
 = 1,34 MWhe

$$\begin{aligned} \# GC &= k * E \\ &= 1.34 / 1.79 * E \\ &= 0.75 * E \end{aligned}$$

## Subtractions :

- 1) Electricity consumption pelletizing : **100 kWhe/ton**
  - 2) Electricity consumption drying : **6 kWhe/ton**
  - 3) Train transport :  
 700 km per train  
 or **108 kWhp/ton**
  - 4) Sea transport :  
 750 ton diesel/40 000 ton  
 = **232 kWhp/ton**
- 
- 446 kWh/ton**



# Cogen Certificates's in Flanders

✓ Quality CHP = min 5 % Relative Primary Energy saving

$$\text{RPE saving} = \frac{E/\eta_E + Q/\eta_Q - F}{E/\eta_E + Q/\eta_Q}$$

→ 1 Cogen C / 1 MWh Primary Energy saved

$$\text{PE saving} = E/\eta_E + Q/\eta_Q - F$$



# Green Certificates in Wallonia

$$\# GC = E * \tau$$

Where E = Net Energy produced in MWh

$\tau$  = Relative CO<sub>2</sub> saving rate

$$\tau = \frac{E_{\text{ref}}/\eta_{\text{Eref}} + Q_{\text{ref}}/\eta_{\text{Qref}} - C_{\text{bio}}/\eta_{\text{Ebio}}}{E_{\text{ref}}/\eta_{\text{Eref}}}$$

Where  $E_{\text{ref}}$  = CO<sub>2</sub> emissions by reference technology for electricity production

$\eta_{\text{Eref}}$  = Efficiency of reference technology for electricity production

$Q_{\text{ref}}$  = CO<sub>2</sub> emissions by reference technology producing the same amount of heat than green plant

$$Q_{\text{ref}} = \eta_{\text{Qbio}}/\eta_{\text{Ebio}} * \text{CO}_{2\text{ref}}/\eta_{\text{Qref}}$$

$\eta_{\text{Qref}}$  = Efficiency of reference technology for heat production

$C_{\text{bio}}$  = CO<sub>2</sub> emissions by green electricity installation

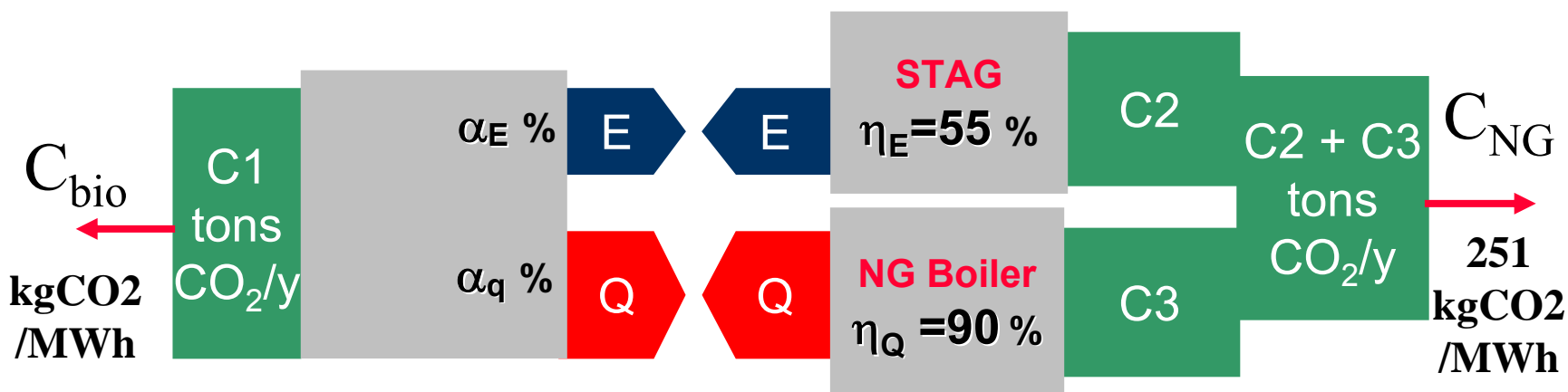
$\eta_{\text{Ebio}}$  = Electrical efficiency of green electricity installation





# Green Certificates in Wallonia

**Reference** = Best fossil plants for electricity & heat separate production  
 = Steam & Gas power plant with  $\eta = 55\%$   
 + Natural Gas boiler with  $\eta = 90\%$



$\rightarrow 251 / 0,55 = 456 \text{ kg CO}_2$

# References CO<sub>2</sub> emissions used in Wallonia (CWaPE)

	kgCO <sub>2</sub> /MWhp
❖ NON FOSSILE	
– wind/solar/hydraulics	0
– organic biodegradable matters	0
❖ milling / chopping	4
❖ transport on max. 200 km	5
❖ transport on more than 200 km	25
❖ drying	10
– corn crops	22
– wood	23
– wood pellets with residues from the forestry	30
– cultivated wood (short rotation coppices)	45
– rapeseed oil	65
– bio-diesel	80
❖ FOSSILE	
– natural gas	251
– gasoil	306
– light fuel oil	310
– heavy fuel oil	320
– coal	385

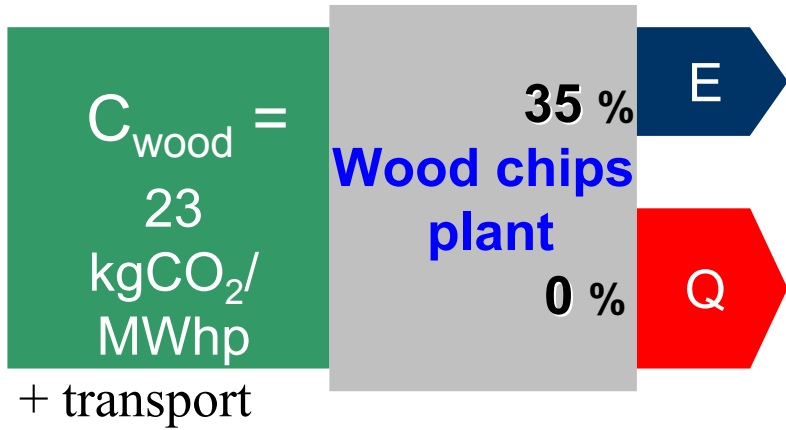
*the reference*



251



# Example in Wallonia: Wood chips-fired power plant



$$\tau = \frac{E_{ref}/\eta_{Eref} + Q_{ref}/\eta_{Qref} - C_{bio}/\eta_{Ebio}}{E_{ref}/\eta_{Eref}}$$

In this case: no CHP →

$$\tau = 1 - \frac{C_{bio}/\eta_{Ebio}}{E_{ref}/\eta_{Eref}}$$

$$\tau = 1 - \frac{(23+5) / 0,35}{251 / 0,55} = 0,82$$

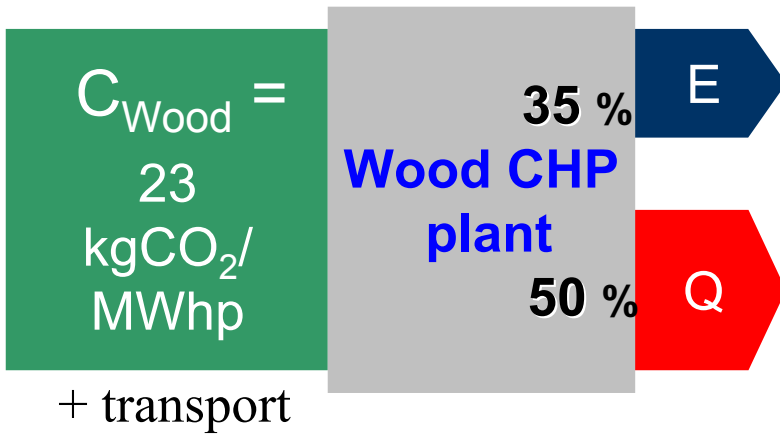
→ Every MWh<sub>el</sub> produced receives **0,82 GC**

Case of sawmill:  
wood chips = by-product

$$\tau = 1 - \frac{4 / 0,35}{251 / 0,55} = 0,97$$

→ Chopping only  
→ Every MWh<sub>el</sub> produced receives **0,97 GC**

# Example in Wallonia: Wood chips-fired CHP plant



$$\tau = \frac{E_{ref}/\eta_{Eref} + Q_{ref}/\eta_{Qref} - C_{bio}/\eta_{Ebio}}{E_{ref}/\eta_{Eref}}$$

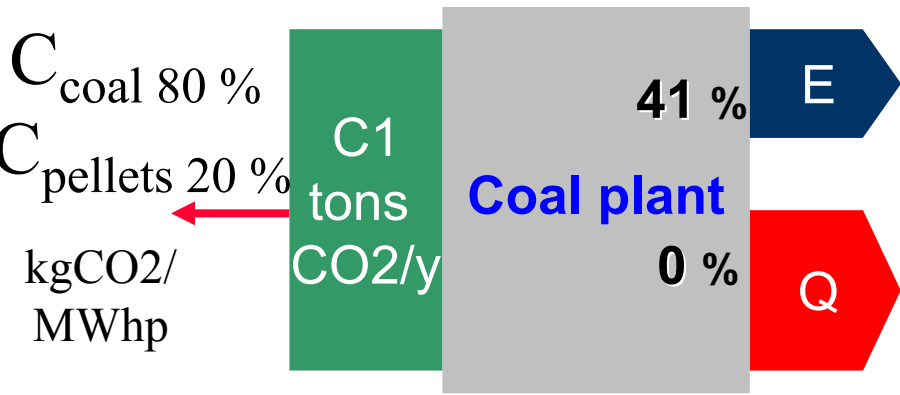
$$Q_{ref} = \eta_{Qbio}/\eta_{Ebio} * CO_2/\eta_{Qref}$$

$$\tau = \frac{251/0,55 + (0,5/0,35 * 251/0,90) - (23+5)/0,35}{251/0,55} = 1,69$$

→ Every MWh<sub>el</sub> produced receives **1,69 GC**



# Example: Co-firing not profitable in Wallonia



- CO<sub>2</sub> emission rates (CWaPE)
- ✓ C<sub>NG</sub> = 251 kgCO<sub>2</sub>/MWhp
  - ✓ C<sub>coal</sub> = 385 kgCO<sub>2</sub>/MWhp
  - ✓ C<sub>pellets</sub> = 30 kgCO<sub>2</sub>/MWhp

Mass ratio	Bioenergy ratio	Tau
10%	6%	-0,94
20%	13%	-0,80
30%	21%	-0,66
40%	29%	-0,50
50%	38%	-0,33
60%	48%	-0,14
70%	59%	0,07
80%	71%	0,30
90%	85%	0,55
100%	100%	0,84

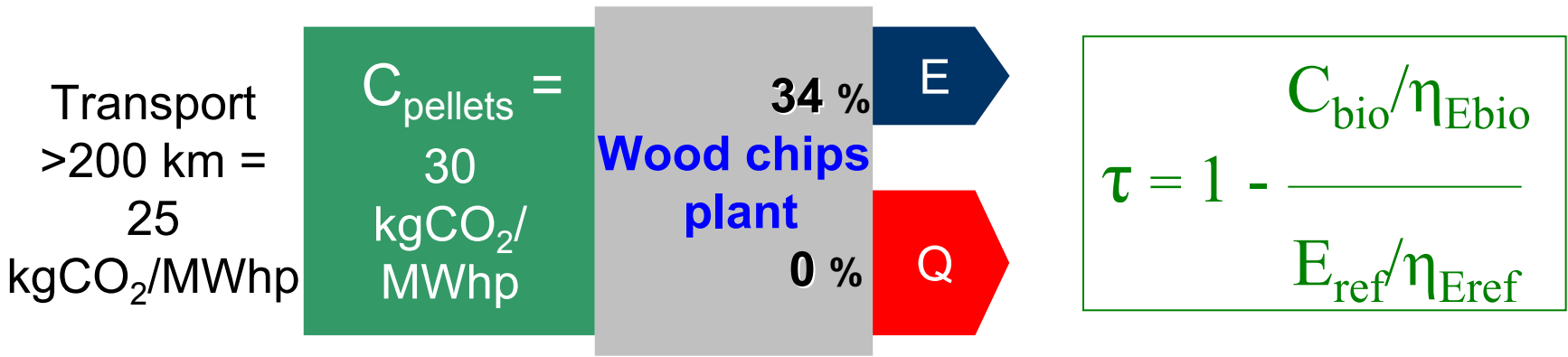
$$\tau = 1 - \frac{C_{bio}/\eta_{Ebio}}{E_{ref}/\eta_{Eref}}$$

$$\tau = 1 - \frac{(30*0,13+385*0,87) / 0,41}{251/0,55}$$

No GC before →



# Example in Wallonia: Les Awirs 4: 100% wood pellets



$$\tau = 1 - \frac{(25+30) / 0,34}{251 / 0,55} = 0,65$$

→ Every MWh<sub>el</sub> produced receives **0,65 GC**

- ✓ Coal power plant converted into 100% pellets: 80,3 MW<sub>e</sub>
- ✓ Yearly production potential = 562 100 MWh<sub>el</sub>
- ✓ Green Certificates potential = 343 489 GC's/year

# Financial impact of Walloon GC mechanism

<b>Technology</b>	<b>CO<sub>2</sub> emissions saving rate <math>\tau</math></b>	<b>Average GC price in 2006</b>	<b>Gain (€/green MWh<sub>el</sub>)</b>
PV, Hydro, Wind	1	91,56 €	91,56
Biomass for electricity	0,65		59,51
Oil cogeneration	0,17		15,57
Natural gas cogeneration	0,28		25,64
Biomass dual-fuel cogen	1		91,56
Biomass cogen (farm biogas, rapeseed)	1,5		137,34
Biomass cogen (wood, landfill gas)	2		183,12

## Brussels Capital:

$$1 \text{ GC}_{\text{Wallonia}} = 1 \text{ GC}_{\text{Brussels}} * \text{Penalty}_{\text{Brussels}} / \text{Penalty}_{\text{Wallonia}}$$

Today:  $1 \text{ GC}_{\text{Wallonia}} = 1 \text{ GC}_{\text{Brussels}} * 75 \text{ €} / 100 \text{ €}$

## Federal level: OFF-SHORE WIND projects

→ Impact on Regional markets?

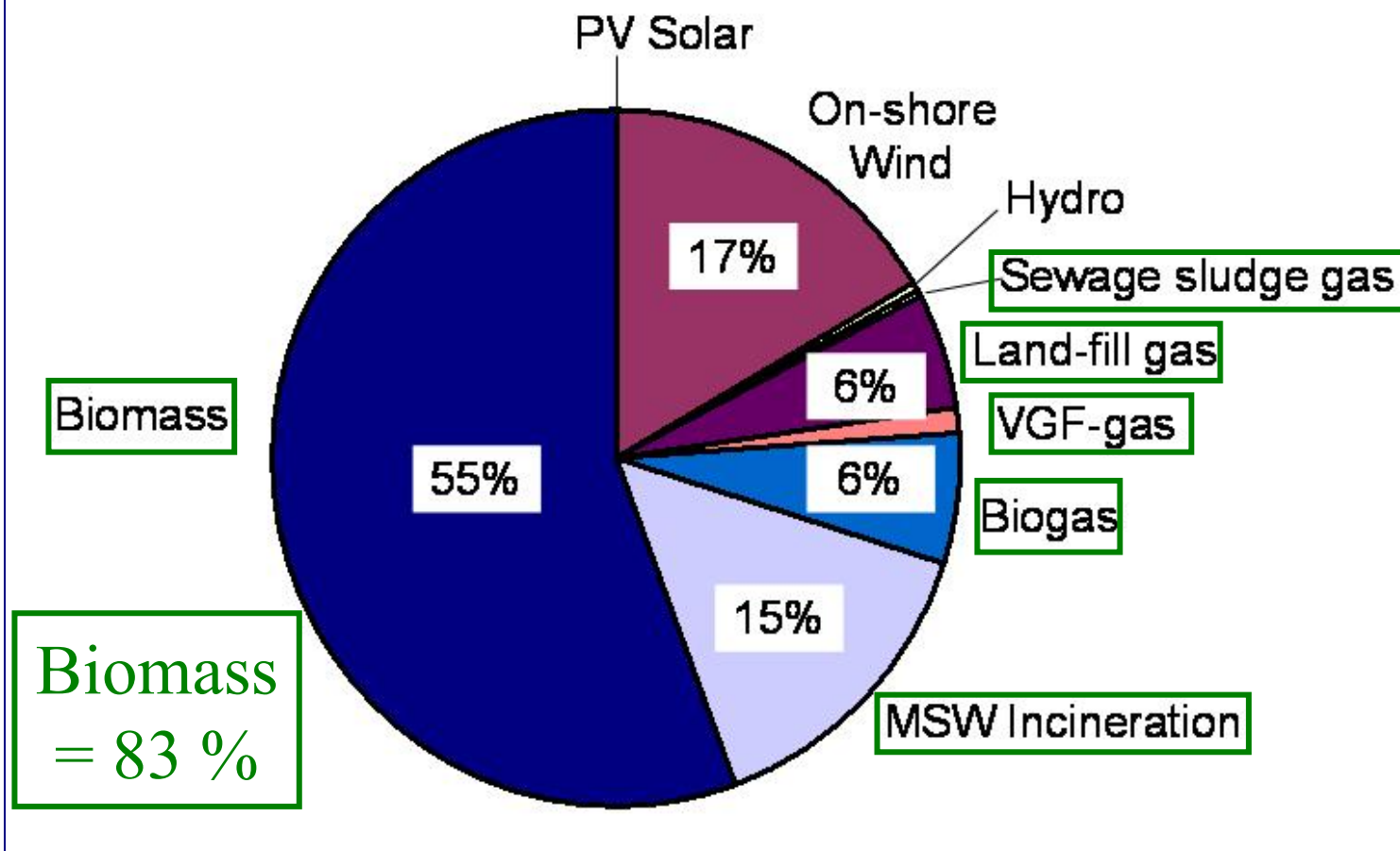
→ 900 000 GC's the 1<sup>st</sup> year for the 1<sup>st</sup> project ! (almost half of the current total yearly amount of GC's)





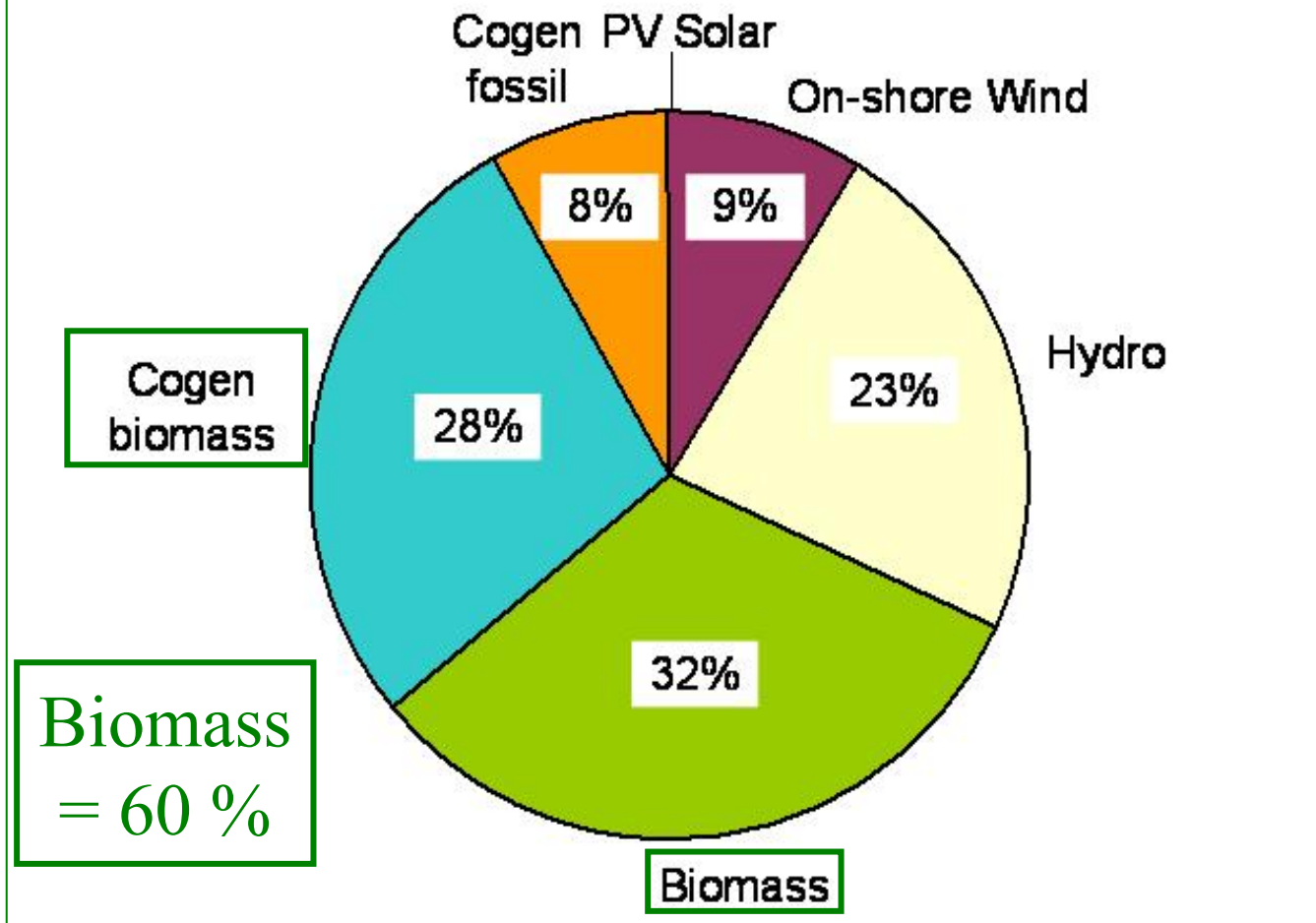
# Belgian GC's: Realisations

1 429 261 issued GC's in Flanders in 2006



# Belgian GC's: Realisations

1 074 774 issued GC's in Wallonia in 2006



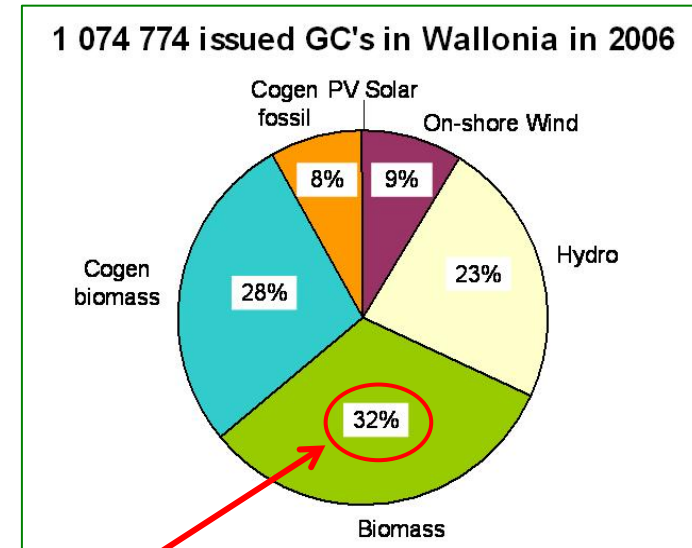
# Belgian GC's: Realisations

**FLANDERS:** Obj: 1,500,000 GC } → **95.3 %**  
Real: 1,429,261 GC } → **70,000 missing GC**  
→ Penalties = **8.8 M€** (125 €/missing GC)

**WALLONIA:** Obj: 1,449,000 GC } → **74.2 %**  
Real: 1,074,774 GC } → **375,000 missing GC**  
→ Penalties = **37 M€** (100 €/missing GC)



# Les Awirs 4 in Wallonia



Green Certificates potential = 343 489 GC's/year

Almost all Walloon GC's from (non CHP) biomass power plants come from les Awirs!



## Evaluation of the avoided CO<sub>2</sub> emissions thanks to the GC's mechanisms in Belgium in 2006:

**FLANDERS** : 652 000 t CO<sub>2</sub> (\*)

**WALLONIA** : 490 000 t CO<sub>2</sub>

**BRUSSELS** : 1 910 t CO<sub>2</sub> (first trimester)

Electricity production = 21 % total CO<sub>2</sub> emissions

→ CO<sub>2</sub> emissions reductions

due to GC's systems ≈ **3,7 %** of the emissions due to electricity production

(\*) Approximation calculated on the Walloon basis: 1 GC = 456 kg CO<sub>2</sub> avoided

29

# Belgian Green Certificates: Conclusions

- ✓ Mechanisms based on **quota – penalties**
  - ✓ Useful instruments to mitigate GHG emissions
  - ✓ 5 systems based on the **same principles**
- **One common mechanism** for whole Belgium in the future?