(Co-)firing biomass in Belgium

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

LABORELEC
Biomass & Waste Competence Centre

The technical Competence Center in green energy processes and emerging technologies.
From innovation to operational assistance.
Belgian certificate systems

\#cert = k \cdot E[MWh]

- **Obligation 2005:**
  - FL 3%
  - W 5%
  - Bru 2.25%

- **Target 2010:**
  - FL 6%
  - W 12%
  - Bru 3%

**Penalty:**
- FL 125 € (green) 45 € (CHP)
- W 100 €
- Bru 75 €
## Buy-back tariff certificates (€/certificate)

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>BEL</th>
<th>FL</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>off-shore wind</td>
<td>90</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>on-shore wind</td>
<td>50</td>
<td>80</td>
<td>65</td>
</tr>
<tr>
<td>hydro</td>
<td>50</td>
<td>95</td>
<td>65</td>
</tr>
<tr>
<td>solar</td>
<td>150</td>
<td>450</td>
<td>65</td>
</tr>
<tr>
<td>biomass</td>
<td>20</td>
<td>80</td>
<td>65</td>
</tr>
</tbody>
</table>
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

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Description</th>
</tr>
</thead>
</table>
| **BEL** | Based upon sustainable development  
Sustainable development  
"All non-fossil non-nuclear energy source that meets the needs of the present without compromising the ability of future generations to meet their own needs."  
PV, Wind, Geothermal, Biogas, Biomass accepted |
| **FL** | 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 |
| **W** | CHP and Hydro < 20 MWe included |
| **Bru** | Hydro < 10 MWe  
Biomass = organic waste from agriculture and forestry |
### B Green certificates: obligation & realisation

#### FL: 50 TWh

<table>
<thead>
<tr>
<th>Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obligation</td>
<td>0.50%</td>
<td>1.20%</td>
<td>2%</td>
<td>2.50%</td>
<td>3%</td>
<td>3.75%</td>
<td>4.50%</td>
<td>5.25%</td>
<td>6%</td>
</tr>
<tr>
<td>Certificates x 1000</td>
<td>250</td>
<td>600</td>
<td>1.000</td>
<td>1.250</td>
<td>1.500</td>
<td>1.875</td>
<td>2.250</td>
<td>2.625</td>
<td>3.000</td>
</tr>
<tr>
<td>Certificates real</td>
<td>150</td>
<td>292</td>
<td>544</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penalty</td>
<td>€ 75.00</td>
<td>€ 100.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
<td>€ 125.00</td>
</tr>
<tr>
<td>Market value</td>
<td>€ 79.04</td>
<td>€ 92.62</td>
<td>€ 110.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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#### W

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obligation</td>
<td>3%</td>
<td>4%</td>
<td>5%</td>
<td>6%</td>
<td>7%</td>
<td>?</td>
<td>?</td>
<td>12%</td>
</tr>
<tr>
<td>Certificates x 1000</td>
<td>701</td>
<td>945</td>
<td>1.195</td>
<td>1.449</td>
<td>1.710</td>
<td>?</td>
<td>?</td>
<td>3.030</td>
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<tr>
<td>Certificates real</td>
<td>752</td>
<td>872</td>
<td>975</td>
<td></td>
<td></td>
<td>1.600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penalty</td>
<td>€ 75.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
<td>€ 100.00</td>
</tr>
<tr>
<td>Market value</td>
<td>€ 84.38</td>
<td>€ 91.74</td>
<td></td>
<td></td>
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</table>

#### Bru: 5 TWh

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obligation</td>
<td>2%</td>
<td>2.25%</td>
<td>2.50%</td>
</tr>
<tr>
<td>Penalty</td>
<td>€ 75.00</td>
<td>€ 75.00</td>
<td>€ 75.00</td>
</tr>
</tbody>
</table>

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Green certificates generation: Flanders 2002-2005

- Biomass co-combustion: 33.1%
- On-shore wind: 20.6%
- Sewage sludge biogas: 18.5%
- Landfill-gas: 18.5%
- Biogas: 18.5%
- MSW incineration: 18.5%
- Ruien gasifier: 18.5%
- Hydro: 20.6%
- Photovoltaics (PV): 33.1%
**Green certificates generation:**

*Wallonia 2004*

- Hydro: 35%
- Fossil CHP: 28%
- Biomass CHP: 21%
- Biogas: 10%
- Wind: 6%
Green certificates generation: Wallonia 2007

- Biomass CHP: 17%
- Biomass Biogas: 21%
- Wind: 27%
- Hydro: 19%
- Fossil CHP: 6%
**CHP certificates Flanders: primary power P**

- Quality CHP > 5%
- Penalty = 45 €

\[
\text{Qual} = \frac{P_2 + P_3 - P_1}{P_2 + P_3} = 1 - \frac{1}{\frac{\alpha_a}{\eta_q} + \frac{\alpha_e}{\eta_e}} \times 100\%
\]

\[
\#\text{cert} = P_2 + P_3 - P_1 = k \times E = \left[ \frac{1}{\eta_e} + \frac{\alpha_q}{\alpha_e \cdot \eta_q} - \frac{1}{\alpha_e} \right] \times E
\]
Reference efficiencies FL

- $\eta_E = 35\%$ biomass

- $\eta_E = 50\%$ network tension $\leq 15$ kV

- $\eta_q = 90\%$ heat is warm water

- $\eta_E = 55\%$ network tension $> 15$ kV.

- $\eta_q = 85\%$ heat is steam
Green certificates in Wallonia: GHG C [CO2eq]

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

\[ \# \text{ cert} = k \times E = E + \frac{\eta_e}{\eta_q} \times Q - \frac{C_{bio}}{C_{NG}} \times \frac{\alpha_e}{\eta_e} \times E \]

**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)

<table>
<thead>
<tr>
<th>NON FOSSILE</th>
<th>0</th>
<th>FOSSILE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>wind/solar/hydraulics</td>
<td>0</td>
<td>natural gas</td>
<td>251</td>
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<tr>
<td>organic biodegradable matters</td>
<td>0</td>
<td>gasoil</td>
<td>306</td>
</tr>
<tr>
<td>milling</td>
<td>4</td>
<td>light fuel oil</td>
<td>310</td>
</tr>
<tr>
<td>transport on max. 100 km</td>
<td>5</td>
<td>heavy fuel oil</td>
<td>320</td>
</tr>
<tr>
<td>drying</td>
<td>10</td>
<td>coal</td>
<td>385</td>
</tr>
<tr>
<td>corn crops</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wood</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cultivated wood (short rotation coppices)</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coleseed oil</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bio-diesel</td>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CASE 1: Co-combustion coal + bio-fuel

CO2 emission rates (CWAPE).

- $C_{NG} = 251$ kgCO2/MWhp,
- $C_{coal} = 385$ kgCO2/MWhp,
- $C_{bio} = 23$ kgCO2/MWhp,

<table>
<thead>
<tr>
<th>Mass ratio</th>
<th>Bio-Energy</th>
<th>$k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>6%</td>
<td>-0.95</td>
</tr>
<tr>
<td>20%</td>
<td>12%</td>
<td>-0.82</td>
</tr>
<tr>
<td>30%</td>
<td>19%</td>
<td>-0.69</td>
</tr>
<tr>
<td>40%</td>
<td>27%</td>
<td>-0.53</td>
</tr>
<tr>
<td>50%</td>
<td>36%</td>
<td>-0.37</td>
</tr>
<tr>
<td>60%</td>
<td>45%</td>
<td>-0.18</td>
</tr>
<tr>
<td>70%</td>
<td>56%</td>
<td>0.03</td>
</tr>
<tr>
<td>80%</td>
<td>69%</td>
<td>0.28</td>
</tr>
<tr>
<td>90%</td>
<td>83%</td>
<td>0.55</td>
</tr>
<tr>
<td>95%</td>
<td>91%</td>
<td>0.71</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
<td>0.88</td>
</tr>
</tbody>
</table>
**CASE 2: NG cogeneration 1 MWe**

\[ k = 1 + \frac{\eta_E}{\alpha_E} \left( \frac{\alpha_Q}{\eta_Q} - \frac{C_{NG}}{C_{NG}} \right) = 1 - \frac{55}{35} * \left( 1 - \frac{48}{90} \right) = 1 - 0.73 = 0.27 \]

\[ NGC = k * E \text{ (MWh / y)} = 0.27 * 3500 \text{ hours / y} \]
\[ = 933 \text{ certificates / installed MWe / y} \]
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

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Quantity t/a</th>
<th>Power plant</th>
<th>Average MW</th>
<th>Avoided coal t/a</th>
<th>Avoided CO₂ t/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>syngas</td>
<td>104 700</td>
<td>Ruien</td>
<td>17</td>
<td>47 100</td>
<td>111 000</td>
</tr>
<tr>
<td>wood dust</td>
<td>40 100</td>
<td>Ruien</td>
<td>10</td>
<td>28 800</td>
<td>68 000</td>
</tr>
<tr>
<td>olive cake</td>
<td>64 000</td>
<td>LLO/Ruien/ RDH</td>
<td>12</td>
<td>34 600</td>
<td>81 500</td>
</tr>
<tr>
<td>sewage sludge</td>
<td>28 000</td>
<td>LLO</td>
<td>4</td>
<td>11 200</td>
<td>26 500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>304 500</strong></td>
<td><strong>with coal</strong></td>
<td><strong>43</strong></td>
<td><strong>121 700</strong></td>
<td><strong>287 000</strong></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th></th>
<th>Efficiency</th>
<th>MWe</th>
<th>GJ/ton</th>
<th>MWhp/ton</th>
<th>MWhe/ton</th>
<th>tons/year</th>
<th>tons/h</th>
<th>$/ton</th>
<th>€/GJ</th>
<th>€/MWhe</th>
<th>hours</th>
<th>MWh</th>
<th>tau(CO2) min.</th>
<th>certificates/y</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant</strong></td>
<td>34%</td>
<td>80.3</td>
<td>17</td>
<td>4.7</td>
<td>1.6</td>
<td>350,097</td>
<td>50</td>
<td>105</td>
<td>4.9</td>
<td>52,32</td>
<td>7000</td>
<td>562,100</td>
<td>0.70</td>
<td>393,470</td>
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<tr>
<td><strong>Wood Pellets</strong></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td><strong>Generation</strong></td>
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<tr>
<td><strong>Green Certificates</strong></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
Awirs 4 wood pellets: technical concept

- Receiving bins + covered conveying belt
- Existing silo’s
- Hammer mills
- Rotating feeders
- Pneumatic transport (dense)
- Unloading crane
- Screening – 10 cm
- Air fans (<70°C)

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

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Quantity t/a</th>
<th>Power plant</th>
<th>Average MW</th>
<th>Avoided coal t/a</th>
<th>Avoided CO₂ t/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>syngas</td>
<td>120 000</td>
<td>Ruien</td>
<td>19</td>
<td>54 000</td>
<td>127 300</td>
</tr>
<tr>
<td>wood dust</td>
<td>70 000</td>
<td>Ruien</td>
<td>18</td>
<td>50 400</td>
<td>118 800</td>
</tr>
<tr>
<td>olive cake</td>
<td>100 000</td>
<td>LLO/Ruien/ RDH/Mol</td>
<td>19</td>
<td>54 000</td>
<td>127 300</td>
</tr>
<tr>
<td>sewage sludge</td>
<td>30000</td>
<td>LLO</td>
<td>4</td>
<td>12 000</td>
<td>28 300</td>
</tr>
<tr>
<td>wood pellets</td>
<td>275 000</td>
<td>Awirs/ RDH</td>
<td>47</td>
<td>187 000</td>
<td>440 700</td>
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<tr>
<td>coffee ground</td>
<td>15 000</td>
<td>LLO/Mol</td>
<td>4</td>
<td>7 200</td>
<td>17 000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>610 000</strong></td>
<td>with coal</td>
<td><strong>111</strong></td>
<td><strong>121 700</strong></td>
<td><strong>732 000</strong></td>
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</table>
### Forecast green power in 2006

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Quantity t/a</th>
<th>Power plant</th>
<th>Average MW</th>
<th>Avoided coal t/a</th>
<th>Avoided CO₂ t/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>304 500</td>
<td>with coal</td>
<td>43</td>
<td>121 700</td>
<td>287 000</td>
</tr>
<tr>
<td>2005</td>
<td>610 000</td>
<td>with coal</td>
<td>111</td>
<td>121 700</td>
<td>732 000</td>
</tr>
<tr>
<td>2006</td>
<td>1 120 000</td>
<td>with coal</td>
<td>202</td>
<td>652 400</td>
<td>1 537 000</td>
</tr>
</tbody>
</table>
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
Five reasons for you to choose Laborelec:

- You have one-stop shopping for your energy needs
- You get access to more than 40 years of experience
- You get rapid service with reliable solutions
- You increase the profitability of your installations
- You benefit from independent and confidential advice

Thank you for your attention

LABORELEC
Biomass & Waste Competence Centre

The technical Competence Center in green energy processes and emerging technologies
From innovation to operational assistance.

QUESTIONS?